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Theories of truth as assessment criteria in judgment and decision making

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Abstract

Hammond (1996) argued that much of the research in the field of judgment and decision making (JDM) can be categorized as focused on either coherence or correspondence (C&C) and that, in order to understand the findings of the field, one needs to understand the differences between these two criteria. *Hammond's claim* is that conclusions about the competence of judgments and decisions will depend upon the selection of coherence or correspondence as the criterion (Hammond, 2008). First, I provide an overview of the terms coherence and correspondence (C&C) as philosophical theories of truth and relate them to the field of JDM. Second, I provide an example of Hammond's claim by examining literature on base rate neglect. Third, I examine Hammond's claim as it applies to the broader field of JDM. Fourth, I critique Hammond's claim and suggest that refinements to the C&C distinction are needed. Specifically, the C&C distinction 1) is more accurately applied to criteria than to researchers, 2) should be refined to include two important types of coherence (inter and intrapersonal coherence) and 3) neglects the third philosophical theory of truth, pragmatism. Pragmatism, as a class of criteria in JDM, is defined as goal attainment. In order to provide the most complete assessment of human judgment possible, and understand different findings in the field of JDM, all three criteria should be considered.

Keywords: coherence, correspondence, pragmatism, functionalism, Brunswik(ian), judgment and decision making, representative design, heuristics and biases, fast and frugal.

1 Introduction

Hammond (1996; 2007) argued that there are two main camps of researchers in the field of judgment and decision making (JDM) who have each adopted different criteria for assessing the competence of human judgments and decisions. According to Hammond (1996; 2007) researchers in the Brunswikian tradition tend to emphasize the correspondence of judgment with ecological criteria (see Cooksey, 1996 for examples) while researchers in the Heuristics and Biases (H&B) program tend to assess coherence (see Kahneman, Slovic, & Tversky, 1982 for examples). *Hammond's claim* is that conclusions about the competence of judgments and decisions will depend upon the selection of coherence or correspondence as the criterion (Hammond, 2008). Hammond stated that "understanding the important field of human judgment cannot go forward, cannot eliminate the current disarray, without our acknowledging the role of coherence and correspondence" (Hammond, 2007, p. 225). This is a strong claim and the focus of this paper is the evaluation of this claim.

First, I provide an overview and brief history of the terms coherence and correspondence (C&C) as philosophical theories of truth and as they relate to JDM. Second, I provide an example of Hammond's claim by examining some of the literature on base rate neglect. Third, I examine Hammond's claim as it applies to the broader field of JDM. Fourth, I critique Hammond's claim and suggest that refinements to the C&C distinction are needed. Specifically, I point out there are two important types of coherence and that a third philosophical theory of truth, pragmatism, is needed to complete the framework.

2 Overview of the terms coherence and correspondence

The terms C&C have a long history in philosophy, and Dawson and Gregory (2009) address some of their historic roots. These terms stem from philosophy, where they are considered competing theories of knowledge at-

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tainment, or truth (Kirkham, 1992). Both of these theories of truth answer the same question; which is, how do we know that a statement/belief/judgment is true? The different theories of truth offer different criteria for answering this question and hence, assessing the truth value of a statement/belief/judgment.

The correspondence theory of truth is the oldest of the philosophical theories of truth due to intuitive appeal. Simply put, a belief can be said to be true if it corresponds with the facts. The philosopher Bertrand Russell advocates the correspondence approach stating that "although truth and falsehood are properties of beliefs, they are properties dependent upon the relations of the beliefs to other things, not upon any internal quality of the beliefs. This leads us to the view that truth consists in some form of correspondence between belief and fact" (quoted in Velasquez, 2005, p. 446). This view was dominant with no real opposition until the nineteenth century when it came under attack from pragmatists and idealists (Schmitt, 2004). The idealists objected to the notion of fact. They argued that the apprehension of a fact was itself an act of judgment and perception and consequently, a belief held by an individual. Because objects in the world are not directly knowable, but mediated by our senses, they are only representations of objects in the world. Correspondence of beliefs with facts, they argued, was impossible to assess since facts were also beliefs. This argument is what led to the coherence theory of truth, the idea that truth is assessed via consistency of belief (Schmitt, 2004).

The coherence theory of truth states that "a set of two or more beliefs are said to cohere if and only if (1) each member of the set is consistent with any subset of the others and (2) each is implied … by all of the others taken as premises or, according to some coherence theories, each is implied by each of the others individually" (Kirkham, p. 104, 1992). In other words, internal consistency and logical standards are the heart of the coherence theory of truth. This can be seen in Blanshard's statement that, "It is perhaps in such systems as Euclidean geometry that we get the most perfect examples of coherence that have been constructed" (cited in Kirkham, p. 106, 1992).

The coherence theory of truth is not limited to beliefs held by one person; what I will refer to as *intrapersonal coherence*. Intrapersonal coherence requires simply that a statement or belief held by an individual be consistent with other statements or beliefs held by the same individual. Within the field of JDM, the assessment of transitivity is an assessment of intrapersonal coherence. The coherence theory of truth extends beyond *intrapersonal coherence* to *interpersonal coherence*. That is, beliefs held by an individual are true if they are consistent with widely accepted beliefs of other individuals. This interpersonal coherence is what gives the coherence theory of truth normative standing. Hammond's use of the term includes this broader view of interpersonal coherence as he includes the assessment of judgment against normative standards, such as Bayes's Theorem, under the coherence metatheory (Hammond, 1996; 2007).

Philosophers acknowledge that it is possible to have two internally coherent belief systems, meaning that individually they are not self-contradictory, that may contradict each other. The assumption of coherence philosophers is that reality cannot be self-contradicting. So, while the coherence of a set of beliefs does not necessitate that the beliefs are true, coherence is a necessary feature of true beliefs. A related weakness of the coherence theory of truth is the criticism that it "seems possible for a coherent system of beliefs, even an ideal coherent system, to be false. We can imagine a system of beliefs that describes a fantasy world, one substantially different from the actual world" (Schmitt, 2004, p. 15). Likewise, Hammond (1996; 2007) has argued that coherence of judgment does not guarantee correspondence of judgment with facts. Baron (2004) uses the terms coherence and calibration, rather than correspondence, to describe these approaches. Baron (2008) writes, "judgments can be coherent without being calibrated. For example, I can say that the probability of heads is .90 and the probability of tails is .10. These two are consistent with each other, but not with the facts" (p. 119).

Because the coherence of a set of beliefs does not guarantee truth, some correspondence of the beliefs with facts is needed. Despite the limitations of C&C theories of truth, and their historic opposition, they are inseparable. If nature is necessarily lacking in self-contradictions, as the coherence theorists argue, then beliefs that correspond with nature should ultimately be coherent as well. Coherence is seen as a necessary, but insufficient condition for truth. Because coherent beliefs systems can be widely accepted and false, such as the previously accepted view that the earth was flat, correspondence is inescapable as a criterion of truth.

Modern scientific reasoning advocates using both coherence in the form of rationalism and correspondence in the form of empiricism. Coherence is used to organize data through the creation and modification of theories, and in reasoning about specific hypotheses. Theories must be coherent. That is, theories cannot be self-contradictory and generally, they must be consistent with other widely held beliefs within that scientific community. It was for this very reason that Einstein never accepted the probabilistic nature of quantum physics and the notion of complementarity. Einstein rejected the idea that a quantum element could act as both a particle and a wave and assumed that there must be some coherent explanation that has yet to be discovered. New theories that contradict widely held beliefs face an up-hill battle because they challenge normative beliefs. In time, such theories can achieve normative standing as the field reexamines its core beliefs and engages in a paradigm shift (Kuhn, 1962/1996; Ziman, 1984).

From theory, specific hypotheses are developed and then tested empirically. Hypotheses are evaluated for how well they correspond to empirical facts. If the hypothesized data are found to correspond to the observed data, then we claim to have supported the coherent theory. If not, then we try and make sense of the data and the theory and engage in rationalism to modify the theory or explain the discrepancy. In order for scientific theories to be considered true, they must: 1) be internally consistent, 2) be consistent with other widely held beliefs and 3) correspond with empirical facts. Internal consistency and consistency with other beliefs are examples of coherence criteria while a match with empirical facts is an example of a correspondence criterion. In the search for scientific truth, JDM researchers, embrace the strategies of both C&C.

Despite the embrace of C&C concepts in our practice as scientists, it is rare for researchers in JDM to explicitly use the terms C&C and even rarer for researchers to assess both the C&C of human judgment (for a notable exception, see Adam & Reyna, 2005). *Hammond's claim* is that research on the competence of human judgment often paints a contradictory picture because some researchers, implicitly or explicitly, adopt one criterion while other researchers adopt the other. Without the recognition that they are using different kinds of criteria, the conclusions cannot be synthesized. Research on base rate neglect provides an example of Hammond's claim.

3 Base rate neglect: An example of Hammond's claim

Research on our ability to use base rate information is a good example of how dominant the coherence approach is in evaluating judgment. The vast majority of evaluations of base rate usage utilize the criterion of Bayes's Theorem. Bayes's Theorem is a normative standard based on logic which makes it a coherence criterion.

Kahneman and Tversky published "On the Psychology of Prediction" in 1973, which included the now famous lawyer and engineer problem. In their experiments, subjects were presented with a variety of word problems and asked to estimate probabilities and likelihoods. The correct answer was established by the use of Bayes's Theorem. When provided with word problems that include base rate information and specific information from a test, "graduate students relied on a description derived from such tests and ignored the base rates" (p. 239). When base rates were manipulated in the lawyer and engineer problem, they had "a minimal effect on subjective probability" (p. 242).

Conclusions drawn from research on base-rate neglect argued that base-rate neglect was an inevitable bias and a result of either heuristics, incompetence, or both (see Koehler, 1996 for a review of this work). In an often quoted statement, Bar-Hillel (1980) wrote that, "The genuineness, the robustness, and the generality of the base-rate fallacy are matters of established fact" (p. 215). Gigerenzer and Hoffrage (1995) would later show that base rate usage could be improved by changing the information format of the word problems from probability to a frequency format. Although there has been debate about whether or not this result is due to the information format itself or a confound in the presentation of the summary statistics (see Neace, Michaud, Bolling, Deer, & Zecevic, 2008 for a recent example), the approach is still fundamentally that of the coherence variety. A word problem is presented and judgment is assessed against the normative standard of Bayes's Theorem.

In Koehler's review of this literature, he points out that there are few instances in the real world where Bayes's Theorem can be unambiguously mapped to provide a clear criterion. He questions the conclusions from this literature by stating, "We have been oversold on the base-rate fallacy in probabilistic judgment from an empirical, normative, and methodological standpoint" (Koehler, 1996, p. 1). In other words, Koehler argues that the coherence criterion of Bayes's Theorem has few instances where a clear correspondence criterion is available. Indeed, base rate neglect has seen very little in the way of investigation using correspondence criteria.

Goodie and Fantino (1995; 1996; 1999a) introduced a correspondence criterion to the study of base rate neglect when they provided subjects direct experience with base rates and individuating information and required subjects to make predictions in simulated environments. Simulations such as these create micro-worlds where the correspondence of judgments with an ecological criterion (that is, the ecology of the micro-world) can be assessed. Although Goodie and Fantino did observe greater sensitivity to individuating information than base rate information, they noted that there might be some environments where the strategy of base rate neglect would produce better correspondence. They write, "… when base rates change relatively often and cue accuracy relatively seldom isn't it just as well to underweight base rates, since they're liable to change at any moment?" (1999b, p. 327). In examining base rate neglect with a correspondence criterion, they opened the door to considerations of how base rate usage might be shaped by correspondence.

Dunwoody, Goodie, and Mahan (2005) sought to examine how manipulating correspondence influenced base rate usage. Using a design based on that of Goodie and

Fantino (1995; 1996) they created several different simulated environments in which subjects had to learn to accumulate points by accurately predicting binary events. Subjects directly experienced base rates and the accuracy of individuating information over a series of learning trials. Base rates were defined by the probability that a particular event was the correct response and cue accuracy (the individuating information) was defined as the probability of the cue, given the correct response. Subjects were randomly assigned to either a condition where cue accuracies were stable and base rates varied or a condition where cue accuracies varied and base rates were stable. Correspondence was assessed as a match between the choice of the subject and the empirical outcome in the micro-world. In this task, correspondence was equivalent to reinforcement because subjects received a point for every correct prediction. After 200 training trials with outcome feedback, subjects completed 100 additional without feedback. Base rate usage was evaluated in these last 100 trials. Although the long-term reinforcement of base rates and cue accuracies was equal, correspondence would be more stable if subjects relied on the information source that was stable. Subjects who had experienced variable base rates chose a response that matched the base rate 37% of the time while those that experienced a stable base rate chose a response that matched the base rate 56% of the time. Experienced correspondence had a significant impact on base rate usage in both studies 1 and 2 despite the fact that long-term correspondence was identical between conditions, only short-term correspondence varied.

In study 3, Dunwoody et al. expanded the investigation by manipulating long-term correspondence as well. Short-term correspondence (information consistency) was manipulated as it was in studies 1 and 2 and orthogonally crossed with long-term correspondence (the reinforcement rate using a particular information source). Would subjects still prefer consistent information if it resulted in a 10% lower reinforcement rate? Subjects switched from utilizing the consistent information source in studies 1 and 2 to utilizing the information source with the highest long-term correspondence in study 3. When base rates were inconsistent but resulted in 10% higher correspondence, subjects chose base rate responses 69% of the time. When base rates were consistent but resulted in 10% lower correspondence, subjects chose base rates only 26% of the time.

The combined results of the studies by Dunwoody et al. (2005) show that base rate usage varies as a function of experienced correspondence. Subjects will use, or neglect, base rates depending on how base rates help them predict events. They are sensitive to both short-term manipulations of correspondence consistency that result in no long-term gains and long-term manipulations of correspondence that cause more short-term losses. These studies demonstrate that subjects have a sophisticated sensitivity to base rate information when it is experienced in a way that allows them to evaluate the correspondence value of using base rate information. This conclusion is strikingly different from the more pessimistic conclusions drawn when base rate usage is evaluated only with coherence criteria.

4 Hammond's claim applied to the field of JDM

Coherence based theories of judgment focus on evaluating the competence of judgment using logic and mathematics as criteria. For example, do judgments follow the laws of probability? Do decisions violate transitivity? Are probability judgments consistent with Bayes's Theorem? Do judges make conjunction probability errors? Correspondence based theories of judgment focus instead on evaluating the predictive ability of a judge based on some ecological criteria. For example, do judgments accurately predict events in the world? How often is weather prediction accurate? How often are medical diagnoses accurate? How well calibrated are judges? These two standards for evaluating judgment have produced different conclusions about the competence of human judgment aside from the base rate example provided above.

Specifically, Hammond (1996; 2007) argues that the Heuristics and Biases (H&B) program of Kahneman and Tversky emphasizes coherence criteria and a pessimistic view of human judgment while the Fast and Frugal Heuristics (F&FH) program of Gigerenzer and colleagues emphasizes correspondence criteria and an optimistic view of human judgment. Although research in both traditions focuses on heuristics, their conclusions about the competence of human JDM differ.

Tversky and Kahneman write that "people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors" (1982, p. 3). Their program is widely known as the H&B program and this title emphasizes their main findings: heuristics produces biases, or systematic errors, in judgment. Research in this tradition regularly adopts coherence criteria in assessing competence and human judgment is often shown to deviate widely from these coherence criteria. According to much of the research in this tradition, human judgment fails the coherence assessment and therefore humans are not rational. For example, Kahneman and Tversky (1972) stated, "man is apparently not a conservative Bayesian: he is not Bayesian at all" (p. 450).

Goldstein and Hogarth (1997) point out that the H&B program has often been criticized. They state, "experiments were conducted so that the word problems set up a 'trap' that subjects would fall into *if* they were using a particular heuristic. In this way, biased behavior was merely a device used to provide (dramatic) evidence that hypothesized psychological processes were at work." This research agenda emphasizes, "that behavioral deviations from a presumed standard of rationality are the 'interesting' phenomena requiring explanation" (p. 26). In other words, the presumed standard of rationality from which people deviate is typically a coherence criterion.

Much, but certainly not all, of the research in the correspondence tradition is rooted in the work of Egon Brunswik. Brunswik was a functionalist, influenced heavily by the work of Darwin and Tolman and was concerned primarily with how organisms adapt to their environments (Doherty & Kurz, 1996; Hammond & Stewart, 2001; Tolman & Brunswik, 1935/2001). Brunswik was interested in issues of perceptual constancy (Brunswik, 1944/2001; Doherty & Kurz, 1996). Perceptual constancy is fundamentally focused on correspondence; the correspondence between a percept and the distal object. Brunswik (1957/2001) believed that the proper focus for psychology was the understanding of how the organism achieves this correspondence. Hammond is credited with demonstrating the relevance of Brunswik's arguments for understanding human judgment (Cooksey, 1996; Goldstein & Hogarth, 1997). While Hammond extended Brunswik's initial ideas, he retained the strong focus on achievement, defined as the correspondence between judgment and empirical event, as the central problem of psychology. As such, most JDM researchers in this tradition focus on how well judgments correspond to empirical events in the world.

Correspondence based research also has a long history in what is known as multi-cue-probability-learning (MCPL) (Cooksey, 1996; Hammond & Summers, 1965; Holzworth, 2001). Studies investigating MCPL often create micro-worlds where empirical accuracy can be measured as correct predictions within the micro-world. Cooksey (1996) states that:

> The central goal of MCPL research was to establish . . . the conditions under which a person could learn how to predict an ecological criterion of interest; that is, how achievement (in Lens Model terms) was maximized by a person . . . . Such learning was demonstrated through the person's acquisition of the appropriate task properties . . . needed to predict the criterion (p. 63).

Achievement is a correlation between an individual's judgments and some ecological criterion and is a measure of correspondence. While this research has shown many limitations on human judgment, it has often demonstrated that human judgment is capable of achieving the level of accuracy allowed by the environment (Cooksey, 1996).

Gigerenzer and colleagues have taken a similar approach to evaluating human judgment by emphasizing the correspondence of human judgment within a particular ecology. Gigerenzer and Todd (1999) explicitly state that their research agenda "dispenses with the focus on coherence criteria . . . . Instead, we study correspondence-based performance of heuristics in real-world environments" (p. 28). They introduce the term "ecological rationality" to distinguish their correspondence-based rationality from the more traditional coherence-based rationality. Their findings are consistent with the title of their 1999 book, *Simple heuristics that make us smart*. In short, they argue that F&FH are essential for adaptive human judgment. They argue that the H&B approach has focused on artificial environments where heuristics are likely to produce biases. However, their own approach is explicitly biased in the opposite direction. They state that they "focus on the ways and settings in which simple heuristics lead to accurate and useful inferences" (p. 28).

Gigerenzer and colleagues' research on F&FH has shown that given the right environment, intuitive use of heuristics that may lack coherence can work well in achieving correspondence. Gigerenzer and Kurz write:

> What we call ecological rationality is an elaboration of the Brunswikian program of studying the texture of environments. Heuristics are not rational in the classical sense of coherence . . . . They derive their rationality through a match with the structure of the environment, not with the laws of logic or probability (2001, p. 346).

Although both the H&B program and the F&FH program study heuristics, they have reached different conclusions about the competence of human JDM. While much of the research in the H&B program has focused on demonstrating a lack of coherence in human judgment, and hence a lack of logic and rationality, the F&FH program of Gigerenzer has focused on demonstrating correspondence in human judgment, and hence ecological rationality. Much of the research in the H&B program ignores correspondence criteria in defining "rational judgment" while the F&FH program explicitly rejects coherence criteria in favor of correspondence criteria. Similarly, research in the Brunswikian tradition, including MCPL, typically ignores coherence criteria in assessing human JDM.

In the philosophy literature, the coherence of a judgment is considered a necessary but insufficient feature of truth. True beliefs are those that are both coherent and correspondent. It may be likewise true in the field of JDM that increases in the coherence of judgment are (imperfectly) associated with increases in the correspondence of judgment. Baron (2008), using the term calibrated in place of correspondent, writes, "If my judgments are perfectly calibrated, however, they must also be coherent" (p. 119). However, few studies have empirically examined the relationship between C&C. Dunwoody et al. (2005) found that, while manipulations of experienced correspondence influenced base rate usage under conditions of direct experience, the same manipulation failed to improve Bayesian responses to word problems in a related task. Adam and Reyna (2005) examined the coherence and correspondence of experts' judgments about sexually transmitted infections and noted a disconnect between coherence and correspondence measures. They write:

> Coherence and correspondence are not competing criteria for rationality, as commonly assumed. Instead, each criterion captures a distinct aspect of rationality: irrational judgments either conflict with reality or with other judgments. The same experts received a positive appraisal based on correspondence criteria, but a negative appraisal based on coherence criteria, with close correspondence for some judgments and large coherence errors for other judgments. p. 183

Weiss, Brennan, Thomas, Kirlik, and Miller (2009) examine performance (not judgment) in a golf-putting task and found that a coherence based measure (CWS) correlated with a correspondence based measure (the mean absolute distance between the golf ball and target) at .676. This is a strong correlation and indicates that at least under some conditions, coherence is correlated with correspondence. It is conceivable that task differences between studies might account for the differing relationships observed between coherence and correspondence. The research findings suggest that it might be best to conceive of C&C assessments as orthogonal dimensions. When assessed jointly it is possible to be high on both dimensions, only one dimension, or neither dimension.

5 Critiquing Hammond's claim

Hammond's claim is essentially correct; researchers in JDM either adopt coherence or correspondence criteria and the adoption of different criteria has lead to different conclusions about the competence of human JDM. Although I support Hammond's goal of greater recognition of C&C in the field of JDM and am in agreement with his main claim, I have two criticisms of his claim. First, Hammond's focus on research programs paints with too broad a brush and second, his framework is incomplete. I address each point below.

While there is undeniable benefit in examining schools of thought, or programs of research, important connections between the programs, and subtleties within the programs, can be lost when painting with such a broad brush. Although in general Hammond is correct in his categorizations, one does not have to look far to find notable exceptions. Calibration research, which focuses on the correspondence of judged and actual probabilities, is a main area of research in the H&B program (see Lichtenstein, Fischhoff & Phillips, 1982 for an early review of this literature). Similarly, a traditional measure in Brunswikian research is cognitive control, written as R_s in the lens model equation (see Cooksey, 1996; Hammond & Summers, 1972), which measures the degree to which an individual judge consistently applies his or her policy. Research in the Brunswikian tradition also examines judgments of repeated cases to examine the consistency of judgment. Both cognitive control and consistency focus on intrapersonal coherence, not correspondence (see Beckstead & Stamp, 2007 for a recent example utilizing measures of both cognitive control and consistency).

It is therefore an oversimplification to discuss the entirety of the H&B program as coherence oriented and the entirety of the Brunswikian program as correspondence oriented. While each program may emphasize one type of criterion over the other, C&C are used by both research traditions. It is more accurate to use the C&C distinction to classify the criteria used to assess judgment, than to use it to classify research programs, which are much broader and more nebulous. Classifying assessment criteria, rather than research programs, may also make it more likely that researchers examining a specific topic do so via multiple criteria. To achieve a more complete understanding of human competence, it is necessary to examine topics via multiple criteria, as demonstrated in the base rate neglect example above.

My second critique, that the C&C framework is incomplete, is based on two points. First, it ignores the distinction I introduced earlier in this paper between *intrapersonal* coherence and *interpersonal* coherence. Intrapersonal coherence is the examination of consistency within a person. Assessing judgments and decisions for transitivity or consistency are good example of intrapersonal coherence. The phenomenon of cognitive dissonance shows that people are motivated to achieve intrapersonal coherence when inconsistencies are made salient. Interpersonal coherence is the examination of consistency in belief or judgments among people. Specifically, assessing judgments and decisions of a subject against the normatively held beliefs of others, such as Bayes's Theorem, is an assessment of interpersonal coherence. Although both appeal to logic, assessing judgments for internal consistency is different from assessing judgments against normative standards of which the judge may be unaware. It is easy to see that measures of interpersonal coherence need not also measure intrapersonal coherence but the reverse is not true. Consistency within a person's beliefs/judgments is a normative standard of logic and therefore assesses both intra and interpersonal coherence.

The second aspect of Hammond's C&C framework that is incomplete is the absence of pragmatism. Coherence and correspondence are two of the three main philosophical theories of truth, pragmatism is the third. In adopting only two of the three main theories of truth for use as a categorization scheme, Hammond's C&C framework neglects an important class of assessment criteria, goal-oriented assessment. I will first address pragmatism as a philosophical theory of truth and then explain why it is a necessary criterion for human JDM.

5.1 Pragmatism and its necessity in JDM

Pragmatism is the most recent of the three main theories of truth and attempts to deal with some of the limitations in the correspondence and coherence views. These limitations, addressed earlier in the paper, include the possibility of a coherent set of beliefs that do not correspond with reality, and the difficulty in selecting and identifying facts for correspondence. The pragmatic theory argues that the utility of a belief is a good measure of truth value. False beliefs are not likely to be useful. This theory of truth is primarily associated with Charles Pierce and William James.

Charles Pierce argues that reality impinges itself upon our senses and slowly forces beliefs to conform to reality (Kirkham, 1992). At first this may sound like correspondence, but the emphasis here is on the function, not objective reality. Reality forces us to adopt pragmatic beliefs. One thing that may make them pragmatic is that they are true. William James shares this type of pragmatism with Peirce. Both argue that it is the functional value of the beliefs that makes them true (and that true beliefs are functional). James does not appear open to the idea of correspondence, what he refers to as "copying," in the absence of functionalism. He writes:

> From the frequency of copying in the knowledge of phenomenal fact, copying has been supposed to be the essence of truth ... the whole notion of copying tends to evaporate .... Their objects can be better interpreted as being created step by step by men, as fast as they successively conceive them. (Kirkham, 1992, p. 92).

For James then, truth is not copying reality, which is a form of correspondence, but "The possession of true thoughts means everywhere the possession of invaluable instruments of action" (quoted in Kirkham, 1992, p. 92). Truths that correspond to reality are only useful in that they help one achieve a goal. James states, "Those thoughts are true which guide us to beneficial interaction with sensible particulars as they occur, whether they copy these in advance or not" (Kirkham, 1992, p. 92). For pragmatism, the correspondence of a judgment is not as important as the utility.

Correspondence in and of itself, is not necessarily adaptive and it may even be adaptive to have beliefs that lack correspondence. For example, some have argued that it is evolutionarily advantageous for our species to have an overconfidence bias in certain domains (Haselton & Nettle, 2006). Haselton and Buss (2000) argue that men are more likely to achieve their goals by overestimating the number of females interested in them sexually. The costs of false-negatives (missing a sexual encounter) outweigh the costs of false-positives (being turned down). This bias, which is a lack of correspondence with our actual abilities, leads to a certain degree of risk taking that may be beneficial for the organism, and in the long run, beneficial for the species. These biases should be expected when the evolutionary costs of false-positive and false-negatives are asymmetric. Haselton and Buss argue that:

> ... optimal designs are sometimes those that result in errors that historically minimized overall costs or maximized overall benefits. This rule of good design contrasts with the nearly ubiquitous assumption in psychology that optimal reasoning systems are those that best correspond to normative rules or that best produce veridical inferences (2000, p. 90).

They note that, "Heuristics and biases researchers have assumed that ... errors reveal information-processing shortcuts" but from their perspective, "some errors reveal the cost and benefit asymmetries present over evolutionary history. Errors may be evidence of evolved adaptive biases, not simplifying heuristics" (p. 90). To reframe their argument, optimal decisions are not necessarily measured by a coherence criterion ("those that best correspond to normative rules") or a correspondence criterion (those that "produce veridical inferences,") but by a pragmatic criterion (utility/goal attainment).

Pragmatism is indispensable as a criterion for JDM and can be found in the major research traditions in JDM. Although Brunswik focused on achievement, a correspondence criterion, his emphasis was on practical achievement rather than veridical correspondence. Brunswik writes, "Constancy-research ... is concerned with *practical* achievements of living beings. Therefore, it may not be expected to find as ideal results as have been assumed

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in the previous chapters" [italics added] (1937/2001, p. 45). Likewise, Gigerenzer and colleagues' focus on F&FH highlights their functional value in specific environments. They do not argue that F&FH produce veridical correspondence, but rather that F&FH are functional because they exploit a match between the heuristic and the environment. Gigerenzer and Todd emphasize this functional perspective in explaining their research agenda. They state, "What works to make quick and accurate inference in one domain may well not work in another. Thus, different environments can have different specific fast and frugal heuristics that exploit their particular information structure to make adaptive decisions" (1999, p.18).

Pragmatism in the field of JDM is not limited to the correspondence research, but also clearly seen in the normative expected utility framework. In his introduction to the idea of utility, Baron (2004) equates utility with good and states that, "good is the extent to which we achieve our goals" (2004, p. 24). Baron (2008) writes, "utility is supposed to be a summary measure of how consequences realize our ultimate values or goals" (p. 234). The extent to which our decisions bring us closer to our goals is an assessment based on the criterion of pragmatism for pragmatism is fundamentally about the utility of beliefs. In discussing William James's pragmatic theory of truth, Schmitt (2004) writes "that a belief is true just in case it has practical utility in life (or belongs to a system of beliefs that has practical utility)" (p. 9). In these statements we see that pragmatism is closely associated with the notion of utility, a major focus in the field of JDM.

The connections between pragmatism and both C&C can be seen in the writings of James. James indicates three main types of utility. First, "a belief can be useful ... if it helps us to manipulate the objects in the world" (Kirkham, 1992, p. 93). Beliefs that meet coherence criteria appear to be particularly useful in this regard. Coherent theories by their very nature involve causal narratives. Coherent theories allow us to manipulate the environment because of their causal nature. Second, "beliefs are useful when they allow successful communication with our fellows" (Kirkham, 1992, p. 93). Again, the coherence based truths seem well fitted to this purpose in that coherence is a consistency in belief expressed through language. A lack of coherence in belief, thought, and language is a major barrier to communication (see Tetlock, 1997 for a similar argument). Third, a "belief can be useful if it leads to accurate predictions" (Kirkham, 1992, p. 93). Here the correspondence-based beliefs are most functional as they are excellently suited to the task of prediction. Pragmatic-based criteria allow for the use of C&C criteria as long as their use is functionally adaptive.

We can see above that of the three main theories of truth, pragmatism is the most closely linked with functionalism. As such, pragmatism appears to be the most appropriate class of criteria for Brunswik's Probabilistic Functionalism and expected utility theory. Even Gigerenzer, who explicitly rejects coherence standards in favor of correspondence standards, is more appropriately categorized as a pragmatist since he is ultimately interested in the adaptive value of judgments. While Hammond (1996) has pushed for recognition of the C&C theories of truth in JDM, the criterion of pragmatism, and the similarities it shares with functionalism, has been overlooked.

6 Conclusion

In philosophy, coherence is a necessary but insufficient feature of truth. Philosophical theories of truth have highlighted the need to consider both coherence and correspondence when evaluating a judgment. A full view of the competence of human JDM should assess with a multitude of criteria. It is not always possible to study outcome achievement and therefore, not always possible to evaluate correspondence (see Dhami, Hertwig, & Hoffrage, 2004 for more on this point). Representative Design might be useful in this regard as Representative Design explicitly focuses on including the conditions one wishes to generalize to in the research study (Brunswik, 1956; Dhami, Hertwig, & Hoffrage, 2004; Dunwoody 2006/2007). Understanding the conditions one is generalizing to will help clarify the relative roles of coherence, correspondence, and pragmatism. For this reason and others, coherence, correspondence, and pragmatism criteria have a central place in the evaluation of human JDM. It remains to be seen under what conditions increases in coherence leads to increases in correspondence. The limited research evaluating the relationship between C&C paints an inconclusive picture. The precise relationship between these criteria may depend on task conditions and is an important research question that deserves more attention.

Goal-attainment is one of the most basic aspects of human behavior. It is a main focus of Brunswik's probabilistic functionalism and the foundation of utility theory. Any framework for classifying criteria in the field of JDM would be negligent to exclude the organism's own goals as a major class of criteria. Necessarily, the inclusion of pragmatism as a classification criteria means that many criteria used to assess JDM will fall under more than one of the three theories of truth. For example, achievement is a measure of correspondence but if the organism's goals include achievement, or if achievement facilitates goal attainment, then achievement can be considered a criterion of both correspondence and pragmatism. Likewise, utility theory has normative standing and as such, is an example of intrapersonal coherence. Since utility is also about goal attainment, it is also a criterion based on pragmatism. Other normative criteria, such as Bayes's theorem, *may* have little to do with the organism's goals.

I have argued in this paper that Hammond's claim has merit and I support greater recognition of these terms within the field of JDM. I have also argued that the C&C distinction should be refined to include intra and interpersonal coherence, and expanded to explicitly include a category of assessment criteria based on goal attainment; that is, pragmatism. Interpreting and generalizing the findings of research in JDM will benefit from explicit recognition of the three main philosophical theories of truth as categories of assessment criteria. This is not only true for understanding past research in the field of JDM, as shown in this paper, but for understanding engineering decisions (Katsikopoulos, 2009), medical research (Adam & Reyna, 2005; Tape, 2009), and aviation research (Mosier, 2009).

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