Behavioral Development Bulletin
2015, Vol. 20, No. 1, 45–59

1942-0722/15/$12.00 http://dx.doi.org/10.1037/h0101039

Rational, Normative, Descriptive, Prescriptive, or Choice Behavior? The Search for Integrative Metatheory of Decision Making

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Decision making, integral to everyday behavior, is the subject of thousands of studies each year. Its long history has led to the emergence of several competing models in the cognitive literature. Meanwhile, behaviorist analysts have carefully studied the mechanisms underlying choice behavior, including the value of reinforcement. Criteria for comparing and contrasting competing models of decision making are generated. Cognitive and behavioral perspectives are analyzed and integrated by emphasizing their commonalities in understanding behavior. The benefits of integrating models of decision making for understanding behavioral development are weighed against the challenges of such as endeavor.

Keywords: decision making, theory evaluation, behaviorism, developmental contextualism

> To be of value to any science, a theory must provide comprehensive coverage and integrate all available data concerning that topic without internal conflict. Miniature theories, which only deal with some narrow aspect of a large phenomenon are valuable only if they can be fitted into a larger structure which relates them to other aspects of the same phenomenon. (Neel, 1977, pp. 15–16)

Decision making has a rich history and a troubled present state. There has always been intrinsic interest in studying decision making because it is a fundamental everyday life process. The prevalence of decision making in prehistory, recorded history, and recent memory has led to innumerous perspectives about decision making, methods for assessing decision making, and theoretical models to explain it. These perspectives span scientific disciplines and subdisciplines. Even within the subdiscipline of cognitive psychology there is tremendous contentious debate about various approaches and models. It appears that researchers are presently focused on generating decision-making models for every and any application, rather than building models that encompass multiple contexts and research questions. Decision making needs a shift from aimless variation to purposeful future direction. We live in a multivariate world; therefore, we need integrative decision-making metatheory that can give meaningful future direction to research. A few decision-making integrativists have begun to identify the overarching themes and issues to resolve for competing theorists to find common ground. The purpose of the present article is to continue the call for integrative decision-making metatheory and to identify starting points for developing such a model.

Anthropologists can trace decision and choice back to prehistoric times and recorded history includes writings of ancient philosophers about human reasoning (see Buchanan & O'Connell, 2006). The dawn of *rational* decision-making theories was sparked by the work of Blaise Pascal and Pierre de Fermat in 1654 with the emergence of probability functions in decision making (Edwards, 1982). During the next 300 years, probability functions dominated formal decision theory, including such applications as Pascal's Wager, the bell curve, regression toward the mean, and risk analysis.

The work of Herbert A. Simon in the mid-late 1950s. specifically his *bounded rationality* approach to decision making and the infamous *satisficing* heuristic (i.e., choosing an outcome that is good enough), created an economics→cognitive psychology line of decision-making research. Theorists within this line have diverged into

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three major competing cognitive perspectives about decision making: logic, probability, and heuristic models. These perspectives account for the bulk of the decision-making literature across disciplines, including economics, psychology, business, political science, and many others.

Decision analysis techniques explain that some of these models fit a *normative* decision analysis (i.e., how ideal people *should* make decisions, based on logic and reason that people often cannot understand; e.g., expected utility theory), some fit *descriptive* decision analysis (i.e., how and why people *actually* make decisions; e.g., prospect theory), and some fit *prescriptive* decision analysis (i.e., how real people *should* and *can* make decisions; e.g., value focused thinking; Bell, Raiffa, & Tversky, 1988; Keller, 1989). These disparate perspectives, just within cognitive psychology, generate tremendous debate in the literature.

At about the same time that Simon revolutionized normative models of decision making, Skinnerean behavior analysts developed simultaneous choice procedures for examining choice behavior, such as presentation of choices that vary in reinforcement delay (Chung & Herrnstein, 1967), and successive discrimination procedures, for multiple schedules. "mentalistic" causes, probabilistic functions, and cognitive process models are traditionally not examined in these paradigms. The differing methods of behaviorists and cognitivists have led to separate isolated mountains of choice and decision research, each with its own culture, language, and technology. Both paint a three-dimensional picture about human behavior, but we need a four-dimensional picture for a four-dimensional phenomenon.

Competing theories of decision making within and between disciplines and subdisciplines has led to rich discussions and advances, but at the cost of convergence, integration, and common future research directions. Over time, approaches have developed independently, diverging in terminology and purpose. Although mathematical and probability models of decision making (e.g., expected value model and expected utility theory) have greatly contributed to our understanding of decision outcomes, they have reached a point of proliferation without amelioration. Decision making-models from varying perspectives are presently applied to any and every context or application, generating mass data and theory, with little integration among perspectives. The result is a jumble of decision-making research, none of which fully accounts for both the observed behavioral elements of decision making in the developing organism and underlying decision-making processes that may facilitate such behavior.

The Call for Decision Meta-Theory

Newell (1973) beseeches psychologists to develop higher-level theories to integrate the numerous advances in cognitive science. Gigerenzer (2010, p. 733) adds "Psychology's most important task is to integrate the various extant patchworks of theories into overarching theories. Theory integration is a longstanding concern in biology, economics, or physics, but not in psychology." In developing common metatheoretical frameworks that can integrate various paradigms, the discipline can focus future research questions on the unknowns, seek links between existing paradigms, and assess the multivariate world with a multivariate lens rather than isolated investigations.

Integrating numerous models of decision making, unfortunately, is a daunting task. Success from such an endeavor can only occur by finding a metatheoretical strategy robust enough to link disparate perspectives. Contextualism is one such world view. Modern behavioral development and cognitive approaches share key epistemological elements of contextualism, such as examining situational behavior (regardless of the generalizability of such analysis), rejection of final causes (see Pepper, 1961), and pragmatism (Morris, 1988; Reese, 1986). Furthermore, neither behaviorists nor cognitivists truly care about behavior and outcomes; they care about functions, causes, and purpose of behavior (Carr, 1993).

In the sections that follow, I describe the historical roots and recent state of the economics→cognitive psychology decision-making literature. Then, I outline theory evaluation criteria for assessing models' contributions to an integrative framework. A thought experiment on theory evaluation reveals that no model can be a perfect everyday decision-making model and that there are tradeoffs in designing a model to understand everyday behavior. Next, I review modern decision-making theories in light of

their potential contributions to metatheory of decision making. Finally, I approach differing metaperspectives underlying cognitive and behavioral models, finding contextualism to be common metaperspectives underlying the study of decision making and choice, and recommending the creation of a holistic and dynamic metaprocess model to organize decision-making research today and going forward.

A Definition of Decision Making

Decision making involves the internal processes by which a course of action or inaction is chosen from a set of two or more alternatives, but may or may not result in behavior. Inaction, such as withholding a response or avoiding a stimulus, implies that such a response was one alternative that happened to be selected for implementation (Reese & Rodeheaver, 1985). Behavior can also emerge from the decision-making process even if two or more alternatives are not fully considered. In this case, the behavior is less internally effortful and may appear automatic.

Redish (2013) views these seemingly automatic behaviors as decisions, even if the decider is not fully aware of the internal processing that occurs under low effort, heuristic, or "reflexive" conditions. Redish argues that it is even possible to override default automatic action (i.e., a truly reflexive behavioral response) in a situation, using a more conscious cognitive system. For example, a person can, albeit unwise, leave a hand on a hot stove, fighting the urge to remove it, should the motivation exist (e.g., there is extrinsic value to being burned in that person's context). This demonstrates that decision making is an internal process, which impacts purposeful behavior, and does not include purely reflexive or automatic or associative behavior, but can alter automatic verbal behavior.

History of Modern Decision-Making Models

Being an everyday process that all individuals perform constantly, decision making has intrinsic interest for study and analysis at least since the dawn of recorded history (and archeologists can trace interest in decisions back further; Buchanan & O'Connell, 2006). The emergence of decision-making theory, as known today, can be traced back to mathematicians Blaise Pascal and Pierre de Fermat in 1654 (Edwards, 1982). Pascal was challenged by Antoine Gombaud to solve the "problem of points," proposed by with Luca Pacioli in 1494 (Buchanan & O'Connell, 2006). Gombaud supposedly tasked Pascal with this Sisyphean task to prove the inability of mathematics to apply to real world problems. Through Pascal's letters to de Fermat about how to solve this dilemma of distributing stakes to players in an incomplete game, the pair independently came up with the same solution: a probability function in which the value of a future gain should be directly proportional to the chance of getting it.

Pascal's famous wager in 1670 (i.e., the proof that it is rational to live as if God exists) further inspired the first rational model of decision making, *expected value theory*. Expected value theory suggests that a choice should equal the probability-weighted average of possible values for a variable. Their work inspired future theory of probability, especially the notion of rational choice. Benjamin Franklin referred to this model as "Moral or Prudential Algebra" (Franklin, 1772/1956). Daniel Bernoulli in 1738 revised expected value theory, creating *expected utility theory,* which emphasizes the role of "subjective value" as a better predictor of behavior under uncertain outcomes, as well as the "assumption of decreasing marginal utility" (see Goldstein & Weber, 1995; see Lengwiler, 2009). In this approach, the alternative with the maximum subjective expected utility is selected by the rational decision maker, allowing for the important role of "risk aversion" in economics. These mathematical models of decision making flourished, inspiring advances in economics, public administration, politics, morality, motivational, and health decision-making literatures.

Ramsey (1926) made an impact on utility theory by suggesting that subjective probability, or the impact of personal beliefs, plays a role in decision making. Expected utility theory was revised by Von Neumann and Morgenstern (1944) who applied utility theory to mathematical economics, creating *Game Theory,* which has been influential in economics, political science, social psychology (e.g., Prisoners' Dilemma), and computer science literature. Game

Theory was originally based on objective probability, assuming that all individuals operate under the same probability distribution, namely that which maximizes rewards. Subjective probability entered game theory with the work of Savage (1954), which also inspired developments in Bayesian statistics (Kadane & Larkey, 1982).

Descriptive models of rational decision making emerged from organizational behavior fields, emphasizing a thinking process involving logical analysis. Simon (1955, p. 102) notes that the "classical" rational model of decision making requires "a[n exhaustive] set of *behavior alternatives* (alternatives of choice or decision)," the "subset of *behavior alternatives that the organism 'considers' or 'perceives*,'" "*the possible future states of affairs*, or outcomes of choice," "a '*pay off*' function, representing the 'value' or 'utility' placed by the organism upon each of the possible outcomes of choice," "*information as to which outcome in S will actually occur*," and "*information as to the probability that a particular outcome will ensue*." He continues by suggesting that there is no evidence to actually support this rationality model of decision making. People often evaluate alternatives sequentially until a first satisfactory option is found. This counters the rationality model that supposes all alternatives were examined prior to selecting an alternative.

Simon (1956, p. 131) cautions that the organism's individual factors (i.e., perceptual skills) and environmental factors "limit sharply its planning horizon," and "the nature of its needs and environment create a very natural separation between 'means' and 'ends.'" Simon proposes a new version of rational choice behavior that requires no utility function to choose among alternatives and no "problem of maximization" of value (i.e., requiring that the optimal alternative be selected). This revised perspective of rationality gave birth to *bounded rationality* models of decision making, which posit that a decision maker does not always have complete information in a decision environment; furthermore, optimal choices are not always required to accomplish a goal.

Simon refers to the typical decision-making process as "satisficing," the behavior of doing just enough to meet minimum requirements. In bounded rational models, individuals *search* for alternatives and evaluate them sequentially until *satisficed* (Simon, 1979, p. 502). Decisions can be based upon criteria other than logical analysis. Later, Simon (1997, p. 270) writes that bounded rational choice must take into account "the limits of human capability to calculate, the severe deficiencies of human knowledge about the consequences of choice, and the limits of human ability to adjudicate among multiple goals."

Proliferation of the Decision-Making Literature

Since Simon's revitalization of decision making research, the number of publications each year across relevant disciplines is substantive. However, psychological research in decision making has proliferated over the past decade. In general, the amount of published psychological research produced over the past 15 years has grown exponentially, some areas having longer histories and greater research bases than others (see Figure 1 for five example keywords). The growth of decision-making articles, however, exceeds other keywords of equal historical perspective.

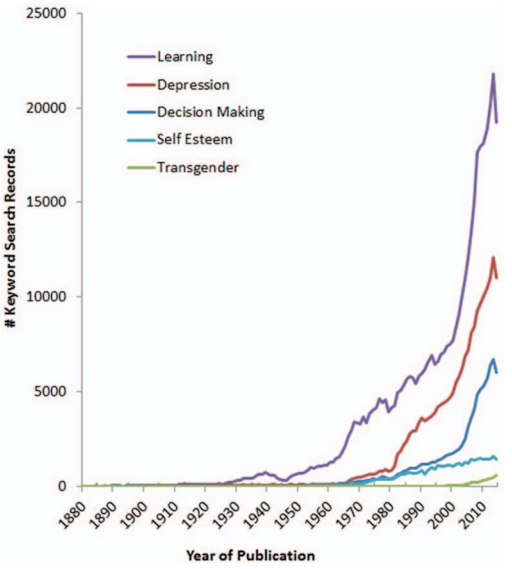

Figure 1. PsycInfo # of keyword search records per year, from 1880–2014. See the online article for the color version of this figure.

Mining the APA (2015) PsycINFO® database[1] for the keyword "decision making" reveals that 50% of the entirety of decision-making research (i.e., 44,047 of the 87,725 records on file from the late 17th century through the end of 2014) has been generated just within those last 8 years.[2] For comparison purposes, Figure 2 shows the yearly contributions to the same keywords presented in Figure 1. Decision-making research exceeds the growth rate of both "depression" and "learning," which have equal or longer histories.

A search for "decision making models" yields 4,278 hits, beginning in 1956. Refining the search by adding the word "process" before "models" yields 585 results (i.e., 395 journal articles, 113 dissertations, 72 books, and five book reviews). Browsing the search results reveals applications of decision processes to just about any topic in any country. Most of these decision models are particular to extremely specific applications. Such specificity is beneficial for fitting models to data obtained for the current application, but limits the sensitivity of the model to fit data from other contexts. For example, of the 4,278 records related to "decision making models," only 449 contain the keyword "learning" and just four contain "behaviorism" in any search field.

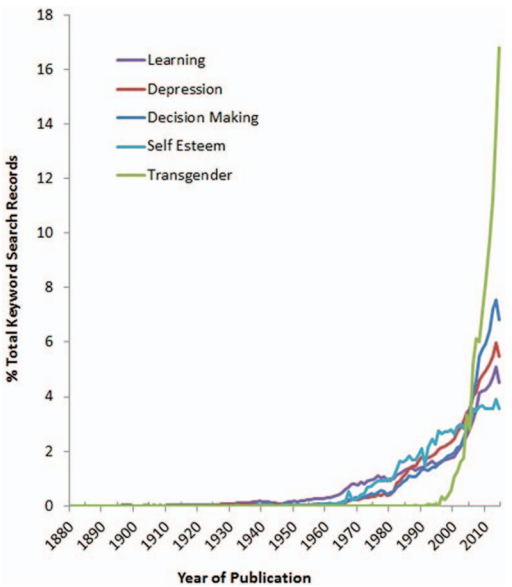

Figure 2. PsycInfo yearly % of cumulative keyword records generated, from 1880–2014. See the online article for the color version of this figure.

Perhaps hundreds or thousands of decision-making models are needed to explain human behavior as it occurs in each and every application, situation, and culture. However, a more likely circumstance is that the literature is oversaturated with highly contextualized decision-making models, some of which may be considered "miniature models" that only apply to a narrow aspect of decision making (see Neel, 1977, p. 15). Decision making occurs in all contexts; therefore, model integration is needed to identify the processes underlying decision making in all contexts. The first step toward model integration is to identify and evaluate existing decision-making models.

Evaluating Decision-Making Models

Theory Evaluation Criteria

To determine the relative contributions of various decision-making theories, one must select and apply theory evaluation criteria. Theories are designed to serve two broad functions: (a) organize or integrate knowledge, and (b) guide the generation of future research to increase knowledge (Baltes, Reese, & Nesselroade, 1988, p. 17). Therefore, to assess the validity of theoretical models, one must apply the following 10 criteria: (a) testability (i.e., empirical validity or verification: can a reliable and valid measurement approach be designed to test a falsifiable hypothesis and collect data that may support or not support the theory?); (b) organization and interpretation (i.e., a clear structure to concepts and well-defined relationships among theory components); (c) generativity/fruitfulness (i.e., generates numerous research questions both within the theory's domain and across disciplines, or *heuristic value*); (d) precision and clarity (i.e., clearly defined and closely interrelated constructs); (e) parsimony or simplicity (i.e., free of excess concepts and needless explanation); (f) comprehensiveness (i.e., scope or range of explana-

[1] Search results include available publications as of the February 2015 database update that have a publication date no later than 12/31/2014.

[2] PsycINFO database accessed using EBSCOhost Research Databases, EBSCO Industries, Inc.

tion); (g) operationality (i.e., ease at which constructs can be operationalized into measurable variables in the real world, or *applied value*); (h) importance (i.e., does the theory advance our understanding of the domain); (i) practicality (i.e., does the theory address practical and social problems, or *ecological validity*); (j) adaptability/ accommodational (i.e., can the theory adapt to changes in methodologies and knowledge as the field develops, or does it become stagnant and irrelevant?); and (k) universality and empirical validity (i.e., correctly predicts and controls behavior in a variety of settings; Cramer, 2013; Goldhaber, 2000, p. 5; Neel, 1977; Patterson, 1996).

Considering the extensive state of the literature, I am confident that the major competing theoretical models of decision making (i.e., those with the largest number of citations in the highest impact journals) satisfy the first three criteria of validity plus the seventh. That leaves precision, parsimony, comprehensiveness, importance, practicality, adaptability, and empirical validity as criteria for judging extant decision-making models.

A Thought Experiment on the Best and Worst Models

One of the customary methods of assessing model fit to data is the percent of variance explained by the model, often referred to as r^2. Essentially, the greater the r^2, the better the model fit—greater correlation of the data to the model. Although this is a very useful measure, the use of r^2 has several limitations and can lead to misleading interpretations. Like any other correlation analysis, r^2 is appropriate for linear models. The r^2 value also is sensitive to the distributions of the model's independent variables (Achen, 1982, pp. 58–67). Therefore, comparing r^2 values across studies is futile, reducing the usefulness of the statistic.

Limitations aside, let us assume we have comparable r^2 values for the most highly cited models of decision making across several perspectives. What would the value be? What is the maximum percent of variance for which one would reasonably expect the best model of decision make to account? Or, what percent of all the factors that influence a person's decision in any particular situation can be determined by a linear function of some set of predictors? The answer to this question depends partially on the level, or scope, of the model. Baltes, Reese, and Nesselroade (1988, pp. 18–20) describe the varying levels of models, from the smallest scope of scale models used in very specific applications in a particular domain (e.g., sensation), to general theoretical models (e.g., prospect theory), to research paradigms (e.g., decision making), to the largest scope of world view (e.g., contextualism). Generally, the more specified the model, the better defined the relations among independent variables and greater variability predicted in the particular testing context.

Assuming comparable r^2 values and scope, a second consideration is the complexity of the model, including the number of independent variables, the interactions of such variables, the functions of those variables respective to the behavior under examination (e.g., linear, quadratic, exponential), and the number of nested/ hierarchical levels of variables (including their interactions), to name a few. A final consideration is the application or behavior under analysis. Whereas modeling data in a tightly controlled experimental procedure may yield high r^2 values, everyday decisions are influenced by countless factors. All things considered, the best models of decision making would probably account for a small to moderate percent of variance.

There is one model that accounts for 100% of the variance in behavior: the *elusive saturated individualized model* (ESIM), which does not exist. This hypothetical model *is* the method that actually occurs in the real world as one organism makes a decision. The ESIM may, and should, differ for each individual organism, in each context, at every moment of that organism's life. However, the ESIM perfectly fits each decision, because it is unique to that decision and accounts for every possible parameter involved in making that decision. Therefore, the ESIM is the best model, in terms of r^2 value.

Clearly, the ESIM is impractical: It cannot be specified for more than one use, and that one use applies to only one situation for one individual, its parameters are unknown, its complexity is unknown, and it is outside the score of any single research investigation. As a theoretical model, the ESIM has importance (i.e., it provides deep understanding of actual behavior) and adaptability (by definition, the ESIM adapts

to each application), but fails on all other seven criteria for validity. Most notable, the ESIM is not parsimonious, fruitful, nor testable. Therefore, the ESIM is also the worst model.

One may wonder whether the opposite of the ESIM is any better of a model. The opposite of the elusive saturated individualized model is the *obvious independence generalized model* (OIGM). It assumes that there is one general explanation for all decisions, regardless of context, time, or individual. If this model had multiple components, they would not relate to one another. Clearly, the OIGM is no better than the ESIM, despite having perfect parsimony and precision.

An important conclusion from the above thought experiment is that no model, neither existing nor yet to come, is or can be perfect. All models have strengths and weaknesses. In a metamodel, ideally the best characteristics of its component models are integrated. Ultimately, the integration of decision-making theories into metatheory will be based upon choices. These choices will be between competing strengths and competing weakness. Therefore, decision metatheory will consist of a subset of component model strengths and weakness, plus the strengths and weakness of the integration strategy. The approaches that follow highlight a subsection of existing decision-making models in the literature. They are reviewed to determine the qualities that most likely will contribute to a metatheory of decision making.

Evaluating Disparate Theories of Decision Making

Expected utility theory provides precise, parsimonious, important, practical predictions about choices and contains a high level of universality. It is more comprehensive and universal than the expected value model, which is a scientifically useful advantage. However, expected utility theory is a normative approach, which tends to be less ecologically valid and less comprehensive than later models. Furthermore, it only predicts outcomes, not processes. Glöckner & Betsch (2011, p. 714) point out that "process models could, however, have a higher precision by making additional predictions on further dependent variables such as time, confidence, information search, and others."

Simon's bounded rationality model has been applied across disciplines as an alternative to rationality models and their failure to incorporate the decision maker's constraints, while maintaining the high degree of universality. Barros (2010) hypothesizes that much of the popularity of the model stems from its low degree of specificity. This low specificity lends the bounded rationality model to numerous applications across disciplines. This model exceeds prior models' practicality and importance, but to a modest cost in parsimony and precision.

Throughout economic research, the general application of the bounded rationality model is in determining actual decision outcomes, rather than the process by which those outcomes are obtained (Simon, 1978b). Simon calls these former approaches, "substantive rationality" and distinguishes them from the approach that developed within cognitive psychology, "*procedural rationality*" (Simon, 1976). Simon spent a significant part of his career, especially post-Nobel Prize, describing procedural rationality as the process by which the decision maker engages in decision making. Simon used the term "mental representation" in his study of how information is symbolically stored in the brain (Simon, 1978a). Simon's description of procedural rational is likened to a system of *symbolic* processes, mostly based on the steps of the satisficing heuristic (Barros, 2010).

Also dissatisfied with the assumptions of rationality models, like utility theory, Kahneman and Tversky (1979) developed *prospect theory* as an alternative approach to describing decision making under risk. They describe several descriptive patterns of behavior that are incongruent with the assumption that individuals are rational through using subjective utility to make choices. First, the certainty effect is a tendency to value *certain* outcomes and undervalue *probable* outcomes. Certainty contributes to *risk aversion* for decisions that lead to sure gains (even if insignificant) and risk-seeking behavior in situations with sure losses (e.g., the "Asian disease study"). Finally, the isolation *effect* describes a tendency to ignore options that have shared components.

Prospect theory assigns value of choices to gains and losses. Decision weights are the basis of judgment of alternatives over probability functions (Kahneman & Tversky, 1979). This theory is high in universality and empirical va-

lidity; there is a large basis of research to support its predictions. It is also relatively high in precision, importance, and practicality. However, prospect theory is an outcome-based approach, which makes predictions for choice outcomes, but not other outcome variables (Glöckner & Betsch, 2011).

Heuristic models of decision making, focused on the benefits and efficiency of heuristics, emerged as scholars revisited Simon's satisficing heuristic. Some of these theories generate single heuristic models and some are multiheuristic theories. Single-heuristic models are limited in application and scope; thus, they have low universality. Precision may be high, depending on the degree to which the particular heuristic avoids ambiguous and nonspecific predictions (Glöckner & Betsch, 2011).

Gigerenzer and Goldstein (1996) compared satisficing with models of rationality in a computer simulation and found the computational heuristic (i.e., a "Take The Best" algorithm) to outperform rational inference procedures (i.e., multiple regression analysis). The old school probability models, including rational decision theories, assume that good decisions are made by careful logical analysis to determine the best alternative. Under these paradigms, heuristics are less accurate because they are fast and automatic, bypassing careful analysis. However, Gigerenzer and colleagues posit the "Less-is-More Effect:" The more information that is analyzed, the less decision accuracy; therefore, people's minds rely on simple heuristics to generate accurate responses (Gigerenzer & Brighton, 2009; Goldstein & Gigerenzer, 2008).

Through analysis of multiple heuristics, Gigerenzer and Todd (1999) describe the "Adaptive Toolbox" to explain the cognitive tools that people use in everyday life. This multiheuristic theory yields much higher universality than single-heuristic approaches because it applies to broader applications. However, Glöckner and Betsch (2011) warn that multiheuristic models can easily be low in empirical content (i.e., the combined universality and precision) should they promote an "open" toolbox, (i.e., an open set of undefined heuristics, which allows the theorist to avoid operationalization, maintain low organization, and "have no empirical content because each deviation can be explained by adding a new heuristic."

Simon's justifications for bounded rationality models, especially that humans have limited cognitive resources (e.g., memory and attention), may support the less-is-more effect findings. Malcom Gladwell's popular book, *Blink,* also adopts the perspective that heuristic decisions can be just as good as the cautious, deliberative decision (Gladwell, 2005, p. 14). From a behavioral perspective, one could imagine that a heuristic is a reinforced behavior pattern. The "mental shortcut" may be no more than a stimulus-reinforced association that is activated in that environment. Upon a prior successful "heurist" enactment, an individual continues using the strategy in the future.

A less-optimistic view of heuristics arises from the application of dual process approaches to decision making. Wason and Evans (1975) applied dual-process perspectives to decision making to identify the roles of separate *Type I* and *Type II* systems of thought. The fast, automatic, intuitive, heuristic-based, Type I system provides the default behavioral response, which may or may not be modified by Type II, the slow, effortful, deliberative, controlled system (Evans, 2011). The Type I system is viewed as containing "evolutionarily compiled encapsulated knowledge bases," and overlearned information. More often than not, according to this perspective, the reliance on Type I processing leads to biased or erroneous outcomes. A major contribution of dual process models of decision making is a focus on sources of individual differences in decision outcomes (see Stanovich & West, 2000).

Fuzzy-trace theory further advances the dual-process approaches by studying the effects of memory representations during reasoning about risky decisions. In a situation, both "verbatim" and "gist" memory representations are encoded from the environment, with people often relying most heavily on the gist representations (Reyna, 2004; Reyna & Brainerd, 1995). This is consistent with Evan's (2011) model in which decision making begins with Type I processing; although Type II is always involved, like verbatim representations in fuzzy-trace theory, it may be limited. As a memory theory, fuzzy-trace highlights the tendency for retrieval cues in a risky situation to access morality, values, and ethical principles. Often, fuzzy processing leads to intuitive behavior that is more adaptive than that which arises from Type II controlled

processing. However, interference during retrieval can lead to negative heuristic-like behavior (Reyna, 2004).

An alternative view, from behavioral research on choice, may explain heuristics as a previously reinforced behavior under stimulus generalization conditions. The degree to which cognitions are involved may be irrelevant, as the learning history predicts current and future responding. Commons and colleagues further identify behavioral developmental stages that interact with one's valuation of consequences in a decision-making situation (Commons & Pekker, 2008; Commons, Trudeau, Stein, Richards, and Krause, 1998). Their Model of Hierarchical Complexity posits that situation difficulty can be organized by *orders of hierarchical complexity.* A decision maker who operates at a lower stage of hierarchical complexity within a domain (e.g., "abstract") than demanded by the situation or task complexity (e.g., "formal") will apply a less effective strategy in that situation (Commons & Tuladhar, 2014).

Many of the previously described models were outcome-based models, describing the choice that was made, but not the process of making that choice. Process models introduce a much greater degree of universality. Glöckner and Betsch (2011) find that many process theories apply to other psychology research areas, increasing their fruitfulness. Process models, like Anderson's ACT-R Architecture (Anderson, 1983, 1996), may be highly specified, very precise, and involve numerous variables, both as predictors and outcomes. ACT-R is an architecture from which computational models can be built to test a variety of cognitive experiences. Essentially, ACT-R involves modules, buffers, and a pattern matcher process. The downside to process models like ACT-R is reduced parsimony. Precision can also decrease if computational models leave numerous undefined parameters.

An opposite form of process model from ACT-R can be seen in Strough, Karns, and Schlosnagle's (2011) motivational model of decision making. This is a highly contextual model that demonstrates the importance of a person's affective, experiential, and deliberative internal processes, nested within an immediate, then cultural context, on the decision-making process. The process, itself, consists of motivational factors mediating the developing person's decision-making process, which leads to biased or unbiased decisions. As a newer model, there may not be sufficient studies to evaluate all the theory evaluation factors. However, its strengths appear to be in parsimony, importance, and practicality. As a conceptual model, it has low operationality.

Integrating Decision-Making Theories

Some decision-making researchers have begun to engage in model comparison with begin the conversation about integration research (Dunwoody, 2009; Katsikopoulos & Lan, 2011; Reyna & Brainerd, 2011). However, these works are generally limited in scope, such as to integrating logic, probability, and heuristic models; or analyzing articles in one journal from a specific year range; or integrating very close theories (e.g., dual process of decision making and fuzzy-trace). These integrative analyses also have not crossed metatheoretical perspectives.

Barriers to Integration

Scholars have both lauded the emergence of rich systems of psychological thought during the discipline's short history and criticized the barriers to unifying psychology behind clear, accepted goals (for a review, see Marsh & Boag, 2014). Some barriers to integration and unification include, for example, the terminology used within the paradigm, standard assumptions of the subdiscipline, and the pervasive mental sets of theorists.

Disciplinary terminology within a field of research is a barrier for many disciplines. In organizational behavior, the unique terminology across economics, psychology, and sociology is one pervasive barrier to successful integration of multilevel theory for the field (Molley, Ployhart, & Wright, 2011). Within psychology, such barriers exist across subdisciplines. For example, whereas a behavior analyst studies the Concorde fallacy in rats, a cognitive developmentalist tests the sunk cost effect in humans. The only difference between Concord and sunk costs is the organism under analysis (Arkes & Ayton, 1999). This is a fairly insignificant justification for using disparate terminology, especially considering that the goal of studying lower organisms is to identify more-controlled models for explaining human behavior.

The assumption that decision making involves cognitive process can be a source of integration stress among cognitive and mechanistic behaviorists, who may overemphasize or underemphasize, respectively, the causal role of internal events on behavior. An integrative metatheory of decision would likely assume that internal events do contribute causally to other internal events and behavior, as behavior is neurological a result of motor pathways which communicate to higher cortical processing areas, the types that neuropsychologists believe to relate to cognition.

Boneau (1974, p. 308) reminds us that "despite some of the connotations of a cognitive theory, there is no need to deal with concepts such as consciousness in order to get one in operation." Rather, information-processing approaches utilize naturalistic causes of behavior which must be observed indirectly by observing other behaviors that correspond to the intended behaviors. In a sense, behavior analysis is also the measurement of behaviors that correspond to cognitive processes; the difference is that the behaviorist does not have the goal of exploring those associations.

It is, perhaps, impossible to fully define the processes that occur in the "mind." However, decision making ultimately ends in some internal activity and external action or inaction. After enough observations within or between individuals, under varying contextual forces, reliable patterns emerge. By integrating established and supported models of the decision-making process, a metatheory of decision making can be hypothesized. With clever research design, these patterns can reveal types of events or processes that must occur during the decision-making process.

Integrating Mechanistic Behavioral Approaches and Developmental Contextualism

An example of an area that shows great promise for integrating the cognitive and behavioral paradigms in decision making is the heuristic model. Earlier, the Concorde fallacy and sunk cost effect were discussed as examples of disparate terminology across subdisciplines. However, within each discipline, similar results have been obtained regarding the influential role of past behavior (i.e., prior investment) on future choice, despite availability of a better choice alternative (Arkes & Ayton, 1999).

However, as was discussed earlier, a heuristic model is limited as a theoretical approach. Rather than build a metamodel based on heuristics, the heuristic approach can be utilized to highlight several conceptual issues that have implications for integration of decision-making theories, in general. Hutchinson and Gigerenzer (2005) describe five issues that cognitivists and behavior analysts must resolve to make integration progress: (a) universal versus situation-specific mechanisms, (b) outcome versus process models, (c) optimality, (d) heuristic selection, and (e) chasm. I will describe the first two issues, which are more relevant to any integration of perspectives, not just heuristics. Optimality and heuristic selection are more relevant for applications in which heuristics are base modes for integration. Finally, chasm, or barriers to integration, has been previously discussed.

Universal versus situation-specific mechanisms. One's world view determines the types of potential explanatory mechanisms that are explored in decision making. These mechanisms may be universal to situation-specific. The heuristic approach designs environment-specific models to test heuristics, assuming that varying constraints can occur. A mechanistic or organismic perspective is likely to emphasize the universality of learning mechanisms, such as learning theory. Hutchinson and Gigerenzer are concerned about the applicability of the Skinner box paradigm to the natural world of choice. In the real world, decision-making situations are not tightly controlled, often involve rare events, a single poor decision can be dangerous (e.g., looking at one's text message while driving), lifetimes for some organisms are shorter than in the lab, and, notably, it is difficult to get immediate feedback about the consequences of the choice (Hutchinson & Gigerenzer, 2005).

Perhaps the issue at hand is not a question of *which* type of mechanism is more appropriate to understanding decision making, but at what levels of analysis do *both* types of mechanisms exist? When we zoom in on a particular behavior in a particular context under highly controlled conditions, the "laws" of decision making may appear universal and mechanistic. However, as the level of analysis expands to

broader contexts, situation-specific factors may emerge that account for large portions of variance. Perhaps the utility of situation-specific factors is proportionate to the uncertainty of an organism's learning history. For example, the less we know about prior decisions, reinforced behaviors, and punished choices, or any relevant individual and contextual factor, the more constrained we become to analyzing situation-specific factors. An integrative model of decision making must allow for the analysis of the zoomed in level of analysis as well as the broader situations in which contextual factors constrain behavior.

Outcome versus process model. Many existing models of choice and decision making examine outcomes rather than process. Behavioral models typically analyze outcome behavior, as do some descriptive decision-making theories (e.g., prospect theory). Heuristic approaches are interested in decision-making outcomes, but the heuristic approach also develops models of the decision process that predict outcomes. Outcome-based models, however, tend to be inferior to process models during theory evaluation. Process models can include outcome predictions in addition to specifying relations among component processes; therefore, they have greater theory universality and would be a preferred framework for developing a metatheory. Heuristic models are not, however, the most efficient decision-making approaches. Each type of decision situation often requires a separate model. Therefore, integrating contextual behaviorists and mechanistic behaviorists into a metatheoretical process model is more promising for identifying a robust decision-making framework than an outcome model.

An Example of Integration

An example of a successful integration of mechanistic and contextual approaches occurs within systems theories. McDowell, Bass, and Kessel's (1993) revision of linear systems theory posits that not all behavior depends on an additive linear history of reinforcement, but that interaction terms within linear differential equations can serve to account for nonlinear violations. To accomplish this, second-order and higher-order terms are integrated into the formulas. The need for interaction terms to describe reinforcement history highlights the notion that behavior is relative to its present contexts, not only its history.

Thelen and Smith's dynamic systems theory argues that development involves simultaneous interactions of multiple levels of developmental forces, from the molecular to the cultural. These levels are nested and can cycle over various time scales, from milliseconds to years. Furthermore, these levels can be intra- and extraindividual, integrate, and lead to novel behavior (see Lerner, Theokas, & Bobek, 2005). The nature of development is that these interacting levels of developmental forces are fused: "Behavior and its development are melded as ever-changing sets of relationships and the history of those relationships over time" (Thelen & Smith, 1998, p. 572).

Choice and Decision Making

Dynamic systems theory provides an example of the value of a metatheoretical approach containing multiple levels of analysis. Often, theories and worldviews disagree about the level at which behavior should be measured, the conclusions that can be made about those observations, and the assumptions underlying why those observations are obtained. However, each perspective contributes to the broader goal of analyzing the totality of humanity. Although psychologists are good at analyzing parts of the whole, we struggle putting them back together again. Perhaps a metatheory of decision making can provide varying levels at which individual research can take place, but also a framework for integrative or "meta" analyses on the larger sum of evidence.

Unlike the tenants of the expected value models of decision making, behavioral theories acknowledge the link between individual factors and behavior. Within behavior analysis paradigms, the individual differences are purposely eliminated to reduce within-subjects error and residual is cancelled out through multiple trials in multiple blocks of repeated observations. The goal is not to identify individual differences in behavior, but to identify the functions that predict and control behavior. Furthermore, the behaviorist is not interested in material causes of behavior, such as physiological structures and neurological processes, but "functional relations that emerge from the biological activity taking

place under physical conditions (Delprato, 1993).

Likewise, cognitive and developmental psychologists are interested in predictors and causes of behavior and development, respectively. They may look to cognitive processes as internal representations of biological internal processes. A metatheory of decision making that views the causes of behavior on multiple levels (e.g., varying from biological and physiological processes, to the effects of those processes for verbal behavior, to external behavior, then higher levels of nested behavior within social, societal, and cultural contexts over time) allows for researchers to study any level of analysis that suits their individual world views and specialties, yet provides a framework for multiple levels of analysis (which, when integrated over numerous studies, could provide rich data for "meta-analyses").

Summary

Decision-making theory has a long and fruitful history, rich in perspectives. Classic decision-making theories have been repeatedly revised over many decades, giving rise to several popular theories, including dual process, fuzzy-trace, and motivational and contextual process models. However, the current literature is growing at an unsustainable rate as new models are generated each year to explain every type of decision in any situation. Furthermore, little work has crossed the cognitive–behavioral divide in studying choice behavior. Many researchers seem bound to particular subdisciplinary assumptions, which tend to create collaborative barriers, such as diverging terminology and disparate methodological approaches.

A metatheoretical perspective is needed to integrate decision making across contexts and methodologies. By allowing for research at various levels of analysis, an integrative metamodel can organize the contributions of the physiological, behavioral, cognitive, and cultural approaches to studying everyday decisions. The most promising metamodel of decision making will be a process model, which identifies the links among contributing mechanisms to decision outcomes. A process model is preferred to an outcome model for integrating decision-making theory because the former can subsume the latter, but the latter cannot account for the former. If integration barriers can be overcome, a metamodel may help formulate future research directions and organize data for higher-level analyses on the meta level.

Simon's tenet of bounded rationality transformed decision-making theory across literatures. His emphasis on the constraints of the human decision maker during the decision-making process is integral to many models of everyday decision making, including the competing perspectives of heuristic, dual process, and behavioral approaches. However, the individual is not the sole contributing factor to the complex phenomenon of everyday decision making. A successful developmental approach to studying decision making must take into account the complex relations of the individual in context.

The contextual world view is a most promising framework integrating competing perspectives and building metatheoretical links among psychological subdisciplines' approaches to studying decision making. Contextualism emphasizes that the individual and the environment are not only mutually influential, but act on one another in dynamic interaction, or transaction. Therefore, there is a holistic level of analysis (Dixon & Lerner, 1999). However, contextualism is robust enough to allow for many of the idiosyncrasies of theoretical orientations within the subdisciplines that produce inspired and enriched contributions to the field.

There will likely never be a perfect model of decision making. We can, however, continuously reevaluate theoretical models and attempt to improve their predictive and generative power by formulating metatheoretical approaches that encompass the multitudes of micro-level models in the literature.

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Received August 23, 2014
Revision received January 15, 2015
Accepted January 29, 2015 ■