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Heuristics Made Easy: An Effort-Reduction Framework

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In this article, the authors propose a new framework for understanding and studying heuristics. The authors posit that heuristics primarily serve the purpose of reducing the effort associated with a task. As such, the authors propose that heuristics can be classified according to a small set of effort-reduction principles. The authors use this framework to build upon current models of heuristics, examine existing heuristics in terms of effort-reduction, and outline how current research methods can be used to extend this effort-reduction framework. This framework reduces the redundancy in the field and helps to explicate the domain-general principles underlying heuristics.

Keywords: heuristics, judgment, decision making, effort

The word "heuristic" has lost its meaning. That is to say, researchers have used the word so widely as to render it a vague, catch-all term for explaining decision processes. Oftentimes the word is cursorily defined as a "rule of thumb" or a "mental shortcut" for solving problems, but what does that mean? Because the term "heuristic" is vague enough to describe anything, it has been used to describe nearly everything. It seems that we have reached the point where the literature has become flooded with so many heuristics as to make the term arbitrary. This raises the question: What is a heuristic? Simon (1990), the father of heuristics research in judgment and decision making, argued that heuristics are "methods for arriving at satisfactory solutions with modest amounts of computation," suggesting that people seek to reduce the effort associated with decision processes (p. 11). To further define the nature of heuristics, we propose a framework that focuses on the ways that heuristics reduce the effort associated with tasks. Using this framework allows us to organize previous research on judgment and decision making in a cohesive manner and to provide a new focus for future research. Furthermore, this framework extends current heuristic theories and can be applied to resolve some of the confusions and problems within the literature on heuristic processing.

Before outlining the properties of heuristics, we should remember the purpose heuristics serve in the first place. The term "heuristic" was brought to wide attention in psychology when A. Newell and Simon (1972) used the word to describe simple processes that replace complex algorithms. In judgment and decision making, the weighted additive rule is one complex algorithm for arriving at optimal decisions and accurate judgments (Payne, Bettman, & Johnson, 1993).

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According to the weighted additive rule, decision makers consider all of the available alternatives and cues for each alternative. Decision makers must weight each cue according to objective or subjective impressions of how it contributes to an alternative's overall value. Once decision makers arrive at a weighting principle and assign weights to each cue, they must then calculate the value for each alternative. Each cue's value is multiplied by its corresponding weight, and these products are summed to yield the overall value for an alternative. Ultimately, using the weighted additive rule consistently requires people to expend effort on five tasks:

1. Identifying all cues—all relevant pieces of information must be acknowledged.
2. Recalling and storing cue values—the values for the pieces of information must either be recalled from memory or processed from an external source.
3. Assessing the weights of each cue—the importance of each piece of information must be determined.
4. Integrating information for all alternatives—the weighted cue values must be summed to yield an overall value or utility for the alternative. In the case of inference or judgment, this is the final step, and it produces the target judgment value.
5. All alternatives must be compared, and then the alternative with the highest value should be selected.

Clearly, such an algorithm requires great mental effort; however, people do not have unlimited processing capacity. People must operate within the constraints imposed by both their cognitive resources and the task environment—a concept known as *bounded rationality* (Simon, 1955, 1956, 1990). As the demands on limited cognitive resources increase, people may employ methods or strategies that reduce the effort they expend on computation. We will therefore refer to heuristics as methods that use principles of effort-reduction and simplification. By definition, heuristics must allow decision makers to process information in a less effortful manner than one would expect from an optimal decision rule.

As we propose throughout the article, the most basic effort-reduction principles can be derived by examining the demands that optimal rules place on decision makers. For our purposes, we use the weighted additive model as the optimal processing rule against which to compare heuristics. Some may consider this an arbitrary starting point, as one can develop several optimal rules within and beyond judgment and decision making. However, there is good reason to take this rule as our point of reference. The weighted additive rule is considered "the traditional gold standard for rational preferences" and inferences (Gigerenzer, Todd, & the ABC Research Group, 1999, p. 26) and a primary route to maximizing value or utility (for a detailed discussion, see Keeney & Raiffa, 1976). Furthermore, previous research has shown that using this rule requires the most effort and is the most accurate of common decision rules (Payne et al., 1993). Additionally, this rule can be applied to both judgment and choice. The primary distinction is that, in judgment, only the final value for an alternative matters, whereas in choice, decision makers must select the alternative with the best value. Throughout the article we discuss heuristics for both judgment and choice, and we use this rule as the optimal model for both. We use this rule to highlight the effortful demands of judgment and decision-making tasks, and we posit that the heuristics that people use will reduce the cognitive demands compared with this rule. Although there are variants of this rule, such as the additive difference model (Tversky, 1969), most of the demands placed on decision makers are the same. At its core, the weighted additive rule describes how decision makers use and integrate relevant information. And the demands placed on decision makers stem from how the weighted additive rule specifies the use of information. Other complex rules that consistently lead to optimal choices must also use and integrate relevant information, and they will therefore place demands on decision makers that are similar to the demands of the weighted additive rule.

Although current theories of heuristic processing do suggest that people simplify how they make judgments and decisions, these theories rarely explain how these processes reduce the amount of effort required. Existing models are successful in pointing out *what* people do when they face difficult tasks and limited resources. And, to some degree, the models address *when* people use heuristics. Yet only a small subset of researchers has discussed *how* people reduce the effort associated with decision processes (Gigerenzer et al., 1999; Payne et al., 1993; Todd, 2000). Because the field has largely ignored effort-reduction, it has become susceptible to several confusions and redundancies. We aim to highlight the previous research on effort-reduction, and we extend this line of work by developing a new framework that specifies more basic principles than previously identified in the field.

Problems Within Current Research

Three major problems have surfaced in the literature on heuristics over the years. First, there is a significant amount of redundancy in the field. And researchers have failed to recognize the similarities between various research programs. For example, the heuristics and biases program and fast-and-frugal programs have engaged in heated debate, despite remarkable similarities in their approach (Gigerenzer, 1996; Gigerenzer & Goldstein, 1996; Kahneman & Tversky, 1996). Whereas heuristics and biases researchers have posited the *availability heuristic* (Tversky & Kahneman, 1973), fast-and-frugal researchers have suggested the conceptually similar *recognition heuristic* (Gigerenzer et al., 1999; Goldstein & Gigerenzer, 2002). Still other researchers have identified equally similar fluency heuristics (Jacoby & Dallas, 1981; Metcalfe, Schwartz, & Joaquim, 1993; Schacter, Cendan, Dodson, & Clifford, 2001; Schooler & Hertwig, 2005; Whittlesea & Leboe, 2003). Furthermore, heuristics and biases researchers have proposed the idea of attribute substitution (Kahneman & Frederick, 2002), through which people make judgments and decisions by using a limited amount of information and sometimes even just one readily accessible cue. According to attribute substitution, decision makers substitute a piece of readily available information for information that might be difficult to access but more likely to yield accurate judgments. That is, they use the answer to an easy question to solve a related problem. Similarly, Gigerenzer et al. (1999) put forward fast-and-frugal decision making, which outlines several heuristics that also use a single piece of information, following Brunswik's (1943) theory of cue substitutability. We believe that if research explicitly focused on how decision makers reduce effort, then the similarities between theories would become apparent and the redundancy less prominent. In a sense, if researchers used a common language to discuss heuristics, then the similarities and differences between theories would not be lost in translation as they are today.

Another problem facing researchers today lies in the tendency to overextend and misapply existing theoretical constructs. For instance, Sunstein (2005) has outlined numerous moral heuristics and has stated that attribute substitution is "pervasively involved" (p. 533). However, much of the research fails to demonstrate the type of evidence required to prove that attribute substitution is at work. Consider the heuristic that states people "punish, and do not reward betrayals of trust" (Sunstein, 2005, p. 537). Although Sunstein has noted that approximately two thirds of participants punished betrayals of trust, it is not immediately clear whether this heuristic is truly operating via attribute substitution. If participants are using attribute substitution as Sunstein has suggested, then they ought to be substituting the question "Is this a betrayal of trust?" for "Is this behavior immoral?" If this substitution were taking place, then the "betrayal cue" ought to serve as the only cue for this judgment. Moreover, the former question about betrayal ought to be easier to answer than the latter question. Yet no steps have been taken to ensure that participants are reframing the question in this way or whether one question is easier to answer than the other. This is not to say that Sunstein's moral heuristics are not heuristics at all. Indeed, they may work to reduce the effort associated with moral decision making. However, it may be that these heuristics reduce effort in some other way.

Similar confusion surfaces in the description of the *warm glow heuristic* (Monin, 2003; Monin & Oppenheimer, 2005), which refers to how positively valenced stimuli will be judged as more familiar. The authors have described this in terms of attribute substitution, yet the results indicate that positive valence accounts for only a modest amount of the variance in familiarity ratings. Again, if people are using attribute substitution, then they ought to substitute an answer to "How positively do I regard this item?" for "How familiar is this item?" Yet it is not clear that this is the case. It seems that a lack of focus on basic heuristic principles has led to misapplying such constructs when describing different behaviors.

Third, much current research has described heuristics that are highly domain-specific. Such research often fails to identify whether these patterns of behavior are reducing effort and, if they are, whether these phenomena can be well described by a domain-general effort-reduction principle. Two areas of research in which many heuristics have been proposed are persuasion and marketing. Yet many of these proposed heuristics appear to be domain-specific instantiations of more domain-general principles. Consider, for example, the *brand name heuristic* (Maheswaran, Mackie, & Chaiken, 1992), which states that people more favorably evaluate products with positively valenced brand names, or the *country of origin heuristic* (Chang, 2004), which states that people will more favorably evaluate products from positively regarded countries. The *price heuristic* (Mitra, 1995) suggests that people judge expensive products to be of high quality. The *scarcity heuristic* (for a review, see Brannon & Brock, 2001) suggests that people judge rare products to be of high value or quality. The *effort heuristic* (Kruger, Wirtz, Van Boven, & Altermatt, 2004) suggests that people will judge objects that took a long time to produce to be of high value. Furthermore, the *idiosyncratic fit heuristic* (Kivetz & Simonson, 2003) suggests that people will evaluate consumer loyalty programs (e.g., buy 10 coffees, get 1 free) with personally relevant features to be more valuable. Thus, although these heuristics vary in the specifics, they all appear quite related in describing how certain cues are used to make positive evaluations.

Still other overly specific heuristics populate the persuasion literature. The *audience response heuristic* (Axsom, Yates, & Chaiken, 1987), for example, states that an enthusiastic audience response (e.g., hearty applause) to a message will lead observers to positively regard or agree with a message. Closely related to this is the *consensus heuristic*, which is a generalized version of the audience response heuristic (Giner-Sorolla & Chaiken, 1997; Maheswaran & Chaiken, 1991). There is also the *endorsement heuristic* (Forehand, Gastil, & Smith, 2004), which suggests that people will find messages more convincing if a positively regarded organization endorses them. The *likeability heuristic* suggests that people will be more convinced by likeable than unlikeable speakers (Chaiken, 1980). Furthermore, according to the *expertise heuristic* (Ratneshwar & Chaiken, 1991), people will be more convinced by experts than novices. As in the marketing literature, these heuristics vary in specifics but are all closely related by the fact that they specify how people are more convinced by messages that are associated with positively valenced information.

This long (but hardly exhaustive) list illustrates how related, but domain-specific, heuristics are relatively common in the literature. It seems that any cue that indicates positive or negative associations will be used in evaluating items. However, it is not immediately clear that this strategy reduces effort at all. In a sense, these heuristics are implicitly defined as cues that are used when they are present, rather than processes that reduce effort by using certain cues.

Supposing that using these cues does reduce effort, then researchers might consider whether there is a more general, but well-defined, effort-reduction strategy that can account for the numerous specific findings. By looking at how heuristics simplify the demands on cognitive resources, we can avoid being overly domain-specific. Many of the heuristics above are based on the heuristic-systematic model (Chaiken, 1980; Eagly & Chaiken, 1993) and the elaboration likelihood model (Petty & Cacioppo, 1986) of persuasion, which in their most basic forms do argue that these heuristics will reduce demands on cognitive resources. Yet, a more rigorous definition of how heuristics simplify these demands will aid us in organizing the literature according to common, general heuristics, rather than becoming bogged down in seeking out new, specific heuristics.

Ultimately, most of the research on heuristics has not yet identified how heuristics reduce the effort associated with decision processes. As Hammond (1990) has noted, the goal of research on heuristics is "to describe as definitely as possible those task or environmental conditions that induce, or even permit, 'nonextensional heuristics'" and that research should do more than offer "only a list of heuristics that have been demonstrated to occur under conditions created to demonstrate them" (p. 243). Years later, the field has a substantial list of heuristics but little in the way of comprehensive theory, leaving it vulnerable to the aforementioned problems. As such, the word "heuristic" has become a catch-all phrase for describing suboptimal or unexpected behavior in general. By calling so many behaviors "heuristic," we have misled ourselves into believing that we understand these processes more than we truly do. To address this gap in the literature, we propose a framework for studying how heuristics reduce the effort associated with a task.

An Effort-Reduction Framework for Studying Heuristics

We believe that heuristic behavior in the realm of judgment and decision making necessarily relaxes the difficult requirements of the weighted additive rule. By simplifying one or more of the requirements of the weighted additive rule and its variants, heuristics predictably reduce cognitive effort. Because there are five effortful components of the weighted additive rule, there are also five principles for effort-reduction. We propose that all heuristics rely on one or more of the following methods for effort-reduction:

1. Examining fewer cues.
2. Reducing the difficulty associated with retrieving and storing cue values.
3. Simplifying the weighting principles for cues.
4. Integrating less information.
5. Examining fewer alternatives.

We do not assume that people explicitly choose these effort-reduction strategies. We argue that the heuristics people use consist of these effort-reduction principles, even if people are not consciously aware of having adopted them. This framework allows us to understand existing heuristics in a new and cohesive manner by highlighting the role that heuristics play in reducing the effort required by a task. As we will see, this effort-reduction framework provides new insight into how various heuristics simplify processing, and it also allows us to formulate testable hypotheses about new and existing heuristics with regard to these effort-reduction principles.

Examining Fewer Cues

To relax the first demand of the weighted additive model, decision makers can use heuristics that reduce the number of cues that are considered for each alternative. Decision makers might focus on what they deem the most important cues or on what cues most validly predict judgments about alternatives. For instance, the *lexicographic heuristic* (Fishburn, 1967, 1974) requires decision makers to decide which cue will be the most important and then select the alternative with the best value on that cue. In the case of a tie on the most important cue, decision makers search the tied alternatives again according to the second most important cue, and so on until choosing a single alternative. Variants of the lexicographic heuristic include the *lexicographic semi-order heuristic* (Tversky, 1969), the *priority heuristic* (Brandstätter, Gigerenzer, & Hertwig, 2006), the *Take the Best heuristic* (Gigerenzer et al., 1999), and the *single variable heuristic* (Hogarth & Karelaia, 2005a, 2007).[1] Note that even when decision makers must search multiple cues because the first cue does not discriminate between alternatives, they are still reducing effort because they consider only one cue at a time, which reduces the amount of information that must be kept in working memory. Consider another variant of the lexicographic heuristic, the *elimination by aspects heuristic* (Tversky, 1972). According to this heuristic, decision makers select and establish a cutoff value for the most important cue. Decision makers eliminate any alternatives that do not satisfy the criterion value on this cue and continue to choose cues in this manner until only one alternative remains. Decision makers may still have to consult most of the cues available before finally limiting the outcome set to one alternative. However, by consulting fewer cues during each comparison of alternatives, the decision task becomes significantly easier. A heuristic might reduce the number of cues used but use more than one cue, as is the case with the *CONF heuristic* (Karelaia, 2006). This heuristic is similar to the Take the Best heuristic (Gigerenzer et al., 1999) but requires two confirming cues instead of just one.

To understand when decision makers examine fewer cues, it is necessary to explain what we mean by "cue" with respect to effort-reduction. The traditional definition of a cue as a piece of information certainly still holds; however, the question now is about which cues are atomic and which can be divided into more elemental cues. Consider, for example, affective cues such as outrage (Kahneman & Frederick, 2002). Although there is evidence that outrage is used as a cue toward judgment, the affective experience of outrage is itself determined by other pieces of information, such as who was hurt or how much harm was done. Each of these cues can also be broken down into more basic pieces of information, and this process of dividing cues can continue. Similarly, sportscasters evaluating players often refer to "athleticism." However, this can be broken down into more basic elements, such as speed, strength, and height, all of which are what we could call cues.

For the purposes of the current framework, we adopt the notion of *natural assessments* (Tversky & Kahneman, 1983). According to the idea of natural assessments, basic cues are representations that result from routine perceptions and cognitions. For example, although a feeling of outrage may result from numerous other pieces of information, outrage and anger are naturally calculated on a daily basis and therefore can be thought of as a basic level cue.

Of course, it is not always self-evident whether a particular cue is a natural assessment or an integration of multiple basic cues. The *peak-end heuristic* (Kahneman, Frederickson, Schreiber, & Redelmeier, 1993) serves as an example of how the line between natural assessment and cue-integration can become blurred. This heuristic describes how people make judgments and decisions regarding painful and pleasurable experiences. Rather than integrating moment-by-moment hedonic experiences over time, people appear to attend solely to the peak experience of pain and the final experience of pain. Judgments of hedonic experience closely correspond to the average of these two experiences. Kahneman et al. (1993) have posited that this heuristic uses a single cue, resulting from a natural assessment of the average of the peak and end. However, it is not obvious whether this heuristic should be thought of as using a single cue (the natural assessment of hedonic experience) or two cues (the peak experience and the end experience that are then averaged). It is worth noting that in both cases people are using only a small subset of the available information when making judgments—ignoring all the information aside from the peak and the end.

This suggests that researchers need to take great care when arguing that a process reduces effort by using fewer cues. For example, one would not want to propose a "utility heuristic" by which people are said to only consider the single cue of total utility of an option, because the calculation of utility is effortful and requires the use of several other cues. Nonetheless, in many cases only a subset of the available cues is actually used, and in these cases the behavior could be described as heuristic.

Reducing the Difficulty Associated With Retrieving and Storing Cue Values

Decision makers can reduce the difficulty associated with accessing cue values in two ways. The first form of these processes dispenses of actual cue values and instead stores the result of a simple comparison (greater than, less than, equal to). By using a simplified value, it becomes easier to store and retrieve cue values. For example, when using the *weighted pros heuristic* (Huber, 1979), decision makers only consider the information pertaining to which alternative is superior on a certain cue. So, if decision makers were comparing a Mini Cooper and Hummer on fuel efficiency, they would not retain the actual difference in miles per gallon, but they would instead store the comparison as a "positive" for the Mini Cooper. By reducing the complexity of the information used during the decision process, decision makers expend less effort.

The second form of this effort-reduction principle suggests that decision makers access information that is easier to retrieve, either because it is computed quickly or has been made readily available through other means. This type of effort-reduction has attracted much research and is akin to Kahneman and Frederick's (2002) attribute substitution theory, which we describe in detail later in this article.

[1] Note that the Take the Best heuristic is actually a variant of the lexicographic heuristic that is used for inference rather than for choice or preference. That is, the lexicographic heuristic might be used for choosing between two different automobiles, whereas the Take the Best heuristic could be used for deciding which automobile will be faster. Indeed, the ABC Research Group has adapted several heuristics from choice to inference. In a sense, these inferential heuristics are used to answer factual questions—such as "Which of these two options has or is higher on property X?"—whereas choice heuristics are used to answer the more personal question of "Which of these two options do I prefer?" This distinction makes it possible to assess the accuracy of these inferential statistics against real-world data, whereas the accuracy of heuristics for choice cannot be compared with real-world data. However, there is significant overlap between the inferential and choice heuristics as well, and it of course seems plausible to use an inferential heuristic for choice if one wishes to choose the alternative that is higher on property X—for example, if the person wished to buy the automobile that was faster.

This form of effort-reduction notably includes the three main heuristics from the heuristics and biases program (Tversky & Kahneman, 1973, 1974): *availability*, *representativeness*, and *anchoring and adjustment*. Note that availability inherently refers to reducing cognitive effort, as decision makers use the ease with which they can imagine an event as the basis for predicting how likely that event is to occur again. In other words, the availability of these mental images is itself an easily accessible cue for the likelihood of an event. Offshoots of the availability heuristic include the *fluency heuristic* (Jacoby & Dallas, 1981; Metcalfe et al., 1993; Whittlesea & Leboe, 2003), the *distinctiveness heuristic* (Schacter et al., 2001), and the *recognition heuristic* (Gigerenzer et al., 1999). The representativeness heuristic is often used to make judgments about whether a target object belongs to a given class. According to this heuristic, people make these judgments by using easy-to-access information about the degree to which the target object resembles a prototypical instance of the class. Anchoring and adjustment similarly refers to using easy-to-access information. This heuristic states that decision makers will form judgments by first anchoring to a salient and accessible value and then adjusting their evaluations from this value.

The affect associated with an alternative also serves as another prominent cue that is easy to evaluate (Finucane, Alhakami, Slovic, & Johnson, 2000; Monin, 2003; Monin & Oppenheimer, 2005; Slovic, Finucane, Peters, & MacGregor, 2002). According to affect-based heuristics, people often base judgments about an object on emotional evaluations of that object. This compiled feeling results from the negative and positive aspects of the object, and this feeling is easy to access. For example, affect can be used as a cue for evaluating the risks and benefits of a prospect (Slovic et al., 2002). If decision makers like a prospect, then when they are asked to determine the risks and benefits of the prospect they judge the risks to be low and the benefits to be high; the opposite pattern occurs when decision makers do not like a prospect. Similarly, the *outrage heuristic* (Kahneman & Frederick, 2002) states that people consider the outrageousness of crimes when determining retribution and punishment. According to this heuristic, people might want to punish robbery of a child more than the robbery of an adult, even if the crimes were legally indistinguishable.

Evidence for the use of easy-to-access cues also appears in a number of domain-specific heuristics that rely on domain-based facilitation of retrieval. For example, it is typically assumed that heuristic processing of arguments relies on cues that are associated with message validity (see, e.g., Maheswaran & Chaiken, 1991; Ratneshwar & Chaiken, 1991). As these cues become associated with high-quality messages, the task of judging message quality might prime the associated cues. Therefore, when judging message validity it may be easier to retrieve or access such associated cues, and using these cues would reduce the effort related to retrieving more difficult-to-access cues, such as argument quality.

Simplifying the Weighting Principles for Cues

When simplifying weighting principles, decision makers might use heuristics that ignore cue-validity information, or the predictive quality of each cue. Typically, more valid cues are weighted more heavily; however, by using nonvalidity based cue selection, decision makers inherently simplify cue weighting principles because they do not have to judge the predictive accuracy of each cue (for a discussion, see Shah & Oppenheimer, 2007). For example, the *equal weighting*, or *tallying*, *heuristic* (Dawes, 1979; Payne et al., 1993) is virtually identical to the weighted additive model, except that it gives each cue an equal weight. The *majority of confirming dimensions heuristic* (Russo & Dosher, 1983) similarly applies equal weights to every cue value. According to this heuristic, decision makers compare two alternatives at a time, and they retain the alternative that is superior on the majority of cues; no one cue is weighted more heavily than another. Furthermore, Gigerenzer et al. (1999) have posited the *Minimalist heuristic*, in which decision makers will randomly choose a cue until they find one that discriminates between alternatives. Additionally, there is the *Take the Last heuristic* (Gigerenzer et al., 1999), which suggests that decision makers use the cue that has most recently discriminated between alternatives. Without having to decide on different weights for each cue, decision makers reduce cognitive effort.

Integrating Less Information

When decision makers reduce effort by integrating less information across multiple attributes, they often do not form an overall impression of an alternative (Payne et al., 1993). The heuristic for choice that best exemplifies the use of this principle is the *satisficing heuristic* (Simon, 1955, 1956, 1990). Although this heuristic uses numerous cues, it does not integrate the information from all of these cues to form an overall impression of an alternative's utility. To make a choice, decision makers set cutoff levels for each cue and then select the first alternative in their search that surpasses their cutoff for each cue. That is, the chosen alternative is simply "good enough," but its overall utility is not assessed. Similarly, the *domran heuristic* (Hogarth & Karelaia, 2005b) does not require decision makers to integrate information across multiple cues. The domran heuristic eliminates alternatives that are dominated by at least one other alternative. Because each cue is evaluated independently, there is no need to integrate information across cues or to form an overall impression of an alternative before it is eliminated. Indeed, all noncompensatory heuristics (i.e., heuristics that do not make trade-offs between cues) reduce effort by integrating less information or even by not integrating information at all.

Of course, when a heuristic uses only one cue, decision makers avoid integrating multiple pieces of information as a necessary side-effect. Heuristics that use only one cue include the Take the Best (Gigerenzer et al., 1999), the lexicographic (Fishburn, 1967, 1974) and the elimination by aspects (Tversky, 1972) heuristics. Although these one-cue heuristics might make it seem as though examining fewer cues and integrating less information are identical ways of reducing effort, heuristics such as satisficing show how these principles are discriminable. These one-cue heuristics therefore represent only a subset of heuristics that integrate less information.

This principle may also help explain effort-reduction underlying response mode compatibility effects (Lichtenstein & Slovic, 1971). For example, consider a choice between two lotteries: One lottery offers a high payoff but with a low probability of winning; the other lottery offers a high probability of winning but with a low payoff. When presented with these gambles, participants' preferences will depend on how they are asked to indicate such preferences. When asked to choose, participants will more often choose the high-probability gamble. However, when asked to bid on each gamble, participants will often offer a higher price for the high-payoff gamble (indicating greater preference). It seems that in the case of choice, it is easier to anchor the preference on probability of winning. However, in the case of pricing, it is easier to anchor the preference on the payoffs. That is, rather than integrating the payoffs and probabilities, participants primarily use the information that requires the least mental transformation to answer the experimental question. As it may be more effortful to integrate across modalities than within modalities, participants reduce effort by integrating less information across modalities.

Examining Fewer Alternatives

Heuristics that examine or compare fewer alternatives are particularly suited for reducing the effort associated with making choices. Heuristics of this type can work in three ways. First, decision makers can use heuristics that limit the number of alternatives that are compared simultaneously. For example, the aforementioned majority of confirming dimensions heuristic (Russo & Dosher, 1983) makes use of pairwise comparisons, where an alternative from each pair is retained until only one alternative remains. Pairwise comparisons significantly reduce the number of alternatives that must be kept in working memory at once, which reduces the demand on cognitive resources. Pairwise comparisons underlie other heuristics, such as the *elimination by least attractive aspect heuristic*—which removes the alternative with the lowest overall cue value—and the *choice by most attractive aspect heuristic*—which retains the alternative with the highest overall cue value (Svenson, 1979).

Second, heuristics of this type might reduce effort by gradually paring down the number of alternatives in the set. For example, Tversky's (1972) elimination by aspects heuristic and other lexicographic heuristics initially include all alternatives but rule out alternatives that fall below a minimum threshold for a particular cue. As more cues are evaluated, fewer alternatives will remain in the set of available options. Because the cues of only a limited number of alternatives are thoroughly searched, these processes will reduce effort compared with a process that examines all cues for all alternatives.

Heuristics that examine fewer alternatives might also reduce effort by immediately eliminating some alternatives from the overall set of available alternatives. Suppose you are searching for a new cell phone provider, for example. Although you might know of many companies, you might just consider the first two providers that come to mind. In this way, other providers have quickly been eliminated from the decision set. Once you have narrowed your decision set, you may want to consider other cues, such as coverage area, number of calling minutes, price, and so forth.

The *equality heuristic* (Messick, 1993) might serve as a more concrete example of this effort-reduction principle. This heuristic aids decision makers in dividing goods among different parties. This heuristic dictates that the decision-making process ought to yield an equilibrium outcome in which each individual possesses an equal share of the overall utility. Take the simple example of dividing $100 between two people. The divider has the possibility of giving $1 to the other person and retaining $99, or giving $2 and keeping $98, and so on. If each of these division scenarios represents an alternative, then decision makers using the equality heuristic will immediately discard the alternatives that stray greatly from a $50–$50 distribution. Alternatives closer to the equilibrium outcome may receive closer investigation, however. Ultimately, this heuristic specifies a limited range of acceptable outcomes, even though there exist additional mathematically plausible outcomes in the set of alternatives. Indeed, such behavior occurs in situations that tend to promote heuristic processing. When people are placed under greater cognitive load, they will divide goods amongst themselves and others according to this equality heuristic. When cognitive load is decreased, people will adjust their division to optimize their gain (Roch, Lane, Samuelson, Allison, & Dent, 2000).

Another heuristic that makes use of this effort-reduction principle is the *do-no-harm heuristic* for policy reform (Baron, 1993, 1994; Baron & Jurney, 1993). Through this heuristic, decision makers first rule out any policy change that would infringe upon the rights of a group. After this initial step, the heuristic then requires decision makers to continue using cues, such as fairness, when deciding on policy changes.

It is worth noting that it is unclear whether the do-no-harm heuristic and equality heuristic actually reduce effort by reducing the number of alternatives or whether they might do so by simplifying cue weighting. It is possible that the do-no-harm heuristic immediately eliminates alternatives that impose harm on a person. However, it is also possible that this heuristic simply places more weight on a cue about whether a policy imposes harm. Similarly, the equality heuristic might consist of only examining distribution outcomes within a specific range. Or one could say that the equality heuristic uses a weighting function that simply places great weight on whether the distribution outcome is near equilibrium. This confusion is precisely why we hope that researchers will begin to define their heuristics algorithmically and in terms of how they reduce effort. Greater specificity when describing new heuristics can mitigate the difficulty in diagnosing how they operate. Indeed, careful descriptions of heuristics can shift the identification of these cognitive mechanisms from a seemingly arbitrary exercise to a scientific process.

These Principles Are Separable

It is important to note that the five effort-reduction principles discussed above are all qualitatively different from one another. As such, the components of this framework can reduce effort individually or collectively. For instance, a heuristic might not noticeably reduce the number of cues used but might instead use numerous easy-to-access cues. Other heuristics might reduce the difficulty associated with storing cue values without using simpler weighting principles. Such is the case with the *weighted pros heuristic* (Huber, 1979), which is virtually identical to the majority of confirming dimensions heuristic but requires decision makers to assign different weights to cues.

Some heuristics might also use easy-to-access cues in conjunction with other effort-reduction principles. Consider anchoring and adjustment, which uses easy-to-access cues and reduces the number of alternatives. According to this heuristic, people formulate quantitative estimates by starting with an arbitrary value that was presented recently. This arbitrary number serves as a numeric cue that is easy to access given its recent presentation. The second part of this heuristic states that people insufficiently adjust from this value to formulate their final judgment. Decision makers with knowledge about an item use this information to establish a range of values that might be acceptable final judgments (to understand this process, see Mussweiler & Strack, 1999). As soon as a value within this range is reached, the adjustment ceases. This range of acceptable values essentially establishes an outcome set with a reduced number of alternatives, akin to the equality heuristic's putative principle.

The lexicographic heuristic also serves as evidence for the independence of these principles. According to this heuristic, decision makers reduce effort by examining fewer cues and by not integrating information; however, they might not simplify cue weighting (or search order). Similarly, heuristics that simplify cue weighting (e.g., the equal weighting heuristic) do not necessarily require decision makers to also use easy-to-access cues. Finally, although satisficing does not integrate information across cues, it may require decision makers to establish cutoff levels for every cue.

By examining each heuristic in terms of effort-reduction, we can compare and contrast heuristics by a common standard. This framework does not necessarily dismiss any heuristics that are discussed in the literature today, but instead it offers a more rigorous understanding of what it means for a process to be a heuristic. This framework also requires heuristics to be more precisely defined so that they can be compared along these common dimensions of effort-reduction. The catalogue of heuristics covered in this article appears in Table 1, with each heuristic's putative effort-reduction principles noted. In constructing this table, we consulted the articles referenced to best glean how the authors' definitions of the heuristic might be captured by an effort-reduction model. As the table shows, these effort-reduction principles are separable and can either co-occur or operate individually. Because many of the heuristics noted in the table are not commonly discussed in terms of effort-reduction, it might be the case that authors intended for their heuristics to be interpreted differently. Or, it may be that some proposed heuristics do not reduce the effort associated with a task, in which case it seems that they may not truly be heuristics. The assignment of effort-reduction principles in the table is an attempt to show how current and future heuristics can be more rigorously defined so as to highlight the overlap and distinctions between heuristics.

Additionally, we can now use this framework to extend current heuristic theories and to refocus research on how decision makers can engage in less effortful processing. In the next section, we outline current heuristic theories, noting how the effort-reduction framework can direct more deliberate exploration of these existing frameworks.

Extending Current Heuristic Theories

Previous research on heuristics has typically identified a subset of the effort-reduction principles set forth in the current framework. Some approaches have subtly implied the presence of such principles, whereas other approaches have more directly described a small number of principles. For example, Hogarth and Karelaia (2005a, 2005b, 2007; Karelaia, 2006) have conducted a series of experiments, wherein they study the accuracy of various heuristics across different task environments (a topic beyond the scope of the current article). As part of this work, they describe features that can be used to predict which heuristics will be suited to these environments. They note that these features simplify the computations involved in the weighted additive rule and therefore this approach touches on concepts related to the current framework. Although they do not discuss heuristics primarily in terms of effort-reduction, Hogarth and Karelaia do identify features that are related to the principles of examining fewer cues and integrating less information. To some degree, they also discuss simpler weighting principles as another source of effort-reduction. However, this work's focus was noticeably different from the current approach and concentrated on a subset of effort-reduction principles and a limited set of heuristics. Nevertheless, frameworks such as Hogarth and Karelaia's have provided the necessary beginnings of the comprehensive effort-reduction framework that is set forth in this article. We discuss other related approaches in this section.

Dual-Process Models of Attitude Change and Persuasion

One branch of heuristic theory today entails a dual-process view of judgment and decision making (Chaiken, 1980; Eagly & Chaiken, 1993; Petty & Cacioppo, 1986).[2] According to these theories, there are two styles of reasoning. System 1 takes shortcuts to process information quickly, and System 2 deliberately processes information.

Early dual-process models relevant to judgment and decision making emerged from the literature on attitude change (Chaiken, 1980; Eagly & Chaiken, 1993; Petty & Cacioppo, 1986). These models offer insight into the *what* and *when* of heuristic processing. According to these models, systematic processing uses information that is more central to a persuasive message. On the other hand, heuristic processing uses cues that are peripheral to the message but perhaps related to the source of the message (e.g., a speaker or writer). These peripheral cues are typically associated with persuasive messages through rules developed from experience and observation (Chaiken, 1980). Therefore, a speaker's expertise might be weighted heavily by heuristic processing in determining message quality. This would occur because people are aware that experts are often right, and so they might choose to use the expertise cue, rather than the actual content of the message, for their judgment. Heuristic processing occurs when a person has less capacity or motivation to do well in task or is less involved in the task (Giner-Sorolla & Chaiken, 1997).

In addition to outlining what cues are used by heuristic processing and when this processing occurs, these dual-process models also assume that heuristic processing requires less effort (Ratneshwar & Chaiken, 1991). However, these models do not rigorously outline *how* heuristics reduce effort. As discussed above, these heuristics are often described as using cues that are related to

[2] There is some discussion in the field over whether dual-process views most accurately capture human judgment and decision making. Some researchers have argued that analytic and intuitive processing may not rely on separate systems (Kruglanski, Fishbach, Erb, Pierro, & Mannetti, 2004). This theoretical question is orthogonal to the effort-reduction framework. We posit that the effort-reduction principles outlined above underlie judgment and choice heuristics, regardless of whether these heuristics are used by System 1, System 2, or a single, continuous system that can operate both analytically and intuitively.

Table 1
Effort-Reduction Principles Underlying Heuristics

Heuristic	Examines fewer cues	Reduces difficulty associated with retrieving/storing cue values	Simplifies weighting principles for cues	Integrates less information	Examines fewer alternatives
Anchoring and adjustment (Tversky & Kahneman, 1974)		Easy to access			Eliminates alternatives
Audience response (Axsom et al., 1987)		Easy to access			
Availability (Tversky & Kahneman, 1973, 1974)	X	Easy to access		X	
Brand name (Maheswaran et al., 1992)		Easy to access			
Categorization by Elimination (Gigerenzer et al., 1999)	X			X	Paring down
Choice by most attractive aspect (Svenson, 1979)			X	X	Fewer compared simultaneously
CONF (Karelaia, 2006)	X			X	
Consensus (Giner-Sorolla & Chaiken, 1997)		Easy to access			
Country of origin (Chang, 2004)		Easy to access			
Deterministic elimination by aspects (Hogarth & Karelaia, 2005b)	X			X	Paring down
Discount percentage (Darke et al., 1995)		Easy to access			
Distinctiveness (Schacter et al., 2001)		Easy to access			
Domran (Hogarth & Karelaia, 2005b)			X	X	
Do-no-harm (Baron & Jurney, 1993)					Eliminates alternatives
Effort (Kruger et al., 2004)		Easy to access			
Elimination by aspects (Tversky, 1972)	X			X	Paring down
Elimination by least attractive aspect (Svenson, 1979)			X	X	Fewer compared simultaneously
Endorsement (Forchand et al., 2004)		Easy to access			
Equal weighting (Dawes, 1979)			X		
Equality (Messick, 1993; Roch et al., 2000)					Eliminates alternatives
Expertise (Ratneshwar & Chaiken, 1991)		Easy to access			
Fluency (Whittlesea & Leboe, 2003)		Easy to access			
Idiosyncratic fit (Kivetz & Simonson, 2003)	X	Easy to access			
Lexicographic (Fishburn, 1967, 1974)	X			X	Paring down
Lexicographic semi-order (Tversky, 1969)	X			X	Paring down
Likeability (Chaiken, 1980)		Easy to access			

Table 1 (*continued*)

Heuristic	Examines fewer cues	Reduces difficulty associated with retrieving/storing cue values	Simplifies weighting principles for cues	Integrates less information	Examines fewer alternatives
Majority of confirming dimensions (Russo & Dosher, 1983)		Simple omparisons	X		
Minimalist (Gigerenzer et al., 1999)	X		X	X	Paring down
Outrage (Kahneman & Frederick, 2002)	X	Easy to access	X		
Peak-end (Kahneman et al., 1993)	X		X		
Price (Mitra, 1995)		Easy to access			
Priority (Brandstätter et al., 2006)	X			X	Paring down
QuickEst (Gigerenzer et al., 1999)	X			X	
Recognition (Gigerenzer & Goldstein, 1996)	X	Easy to access	X		
Representativeness (Tversky & Kahneman, 1974)	X	Easy to access		X	
Satisficing (Simon, 1955, 1956, 1990)			X	X	
Single variable (Hogarth & Karelaia, 2005a, 2007)	X			X	
Scarcity (Brannon & Brock, 2001)		Easy to access			
Take the Best (Gigerenzer et al., 1999)	X			X	Paring down
Take the Last (Gigerenzer et al., 1999)	X	Easy to access	X	X	Paring down
Warm glow (Monin, 2003)	X	Easy to access		X	
Weighted pros (Huber, 1979)		Simple comparisons			

Note. This table is based on how the heuristics are described in the cited articles. Evidence for their use (or simulations of the heuristics) can be found in the cited articles as well. Where appropriate, we verbally identify the subtype of effort-reduction. Further research based on this framework may reveal that different principles in the framework underlie the heuristics.

simple rules for judgment. Although this idea begins to define a heuristic in terms of effort-reduction, it has proven somewhat vague and has thus resulted in researchers describing the many domain-specific heuristics discussed earlier in the article, which are at their core quite similar. For example, the brand name heuristic (Maheswaran et al., 1992) and country of origin heuristic (Chang, 2004) are highly related, and they are also similar to other heuristics in which positively valenced information affects human judgment. Although these proposed heuristics are useful for describing domain-specific behavior, it is easy to see that there can be an infinite number of such heuristics (or at least, as many heuristics as there are cues for judgment in the world). Consequently, using our approach to effort-reduction can offer a domain-general approach to understanding how heuristics operate and what heuristics are likely within a given environment.

Although heuristic processing for persuasive messages was not originally discussed in terms of the current framework, this does not preclude it from being incorporated into the study of effort-reduction. In fact, given that these models often mention that heuristic processing saves effort, the current framework can complement these dual-process models by enabling them to explain *how* they reduce effort. For example, as the heuristics are currently defined in the persuasion literature, they appear to all make use of the second effort-reduction principle in the current framework, using cues that are easy to access. Yet the effort-reduction framework also outlines other ways in which effort might be reduced. Ideally, the additional principles from the current framework could motivate future research to explore different types of heuristic processing when judging the persuasiveness of a message.

Currently, empirical tests of many persuasion heuristics make it difficult to properly identify which, if any, heuristic principle is working to reduce effort. For instance, one cannot be certain that a heuristic is drastically reducing the number of cues that are examined if studies only include a few key pieces of information, such as a speaker's message and a cue about the speaker's expertise. If an experimental design already reduces the number of cues available to the participant, there will be a floor effect when testing cue-reduction principles. Indeed, some dual-process theorists even say that message cues and peripheral cues are used in conjunction (Ratneshwar & Chaiken, 1991) but that systematic processing attenuates the effect of peripheral cues. If this is the case, then this suggests that what has been called heuristic processing might just be behavior that shifts the weights applied to each cue, with peripheral cues being weighted more heavily. Yet it is also hard to tell whether this change in weighting is simpler (and therefore effort-reducing) or whether it is only indicative of misweighting or overweighting certain information without any effort-reduction. Using the effort-reduction framework, we can say that the most likely candidate for effort-reduction in heuristic processing in this field is that certain cues are used because they are easier to access when forming a given judgment. This does appear to be what authors suggest when they discuss how peripheral cues are related to simple judgment rules. As such, the current framework can identify the common effort-reduction principle that is likely (but not certain) to underlie the heuristics commonly discussed in the persuasion literature. Furthermore, the effort-reduction framework can help researchers determine the appropriate experimental empirical manipulations to determine whether a process is heuristic.

Dual-Process Models and Attribute Substitution

Kahneman and Frederick (2002) have posited attribute substitution as a means to reduce effort. According to this hypothesis, people will use cues that are easier to access when formulating a judgment. For instance, if you ask someone "How many dates did you have last month?" and then ask them "How happy are you with your life in general?" the answers are highly correlated (p. 53). The authors have asserted that people substitute the information about how many dates that they have had for the information about how happy they are. In a sense, people are answering a different question. The authors have extended the attribute substitution hypothesis to account for base-rate neglect in the classic Linda problem (Tversky & Kahneman, 1974). According to this problem, people will judge the likelihood that Linda is both a feminist and a bank teller to be greater than the likelihood that she is either a feminist or a bank teller. Kahneman and Frederick have argued that people do not use base rates when judging the likelihood that Linda is a feminist bank teller. Instead, people answer a different question: How representative is Linda of a feminist bank teller? People then substitute representativeness for their answer and exhibit base-rate neglect. Thus, the authors have taken care to specify *how* certain heuristics reduce effort. They ultimately argue that decision makers reduce effort by using cues whose values are easier to access than other cues.

Although this work does begin to describe effort-reduction principles, the current effort-reduction framework can outline more basic effort-reduction principles. This different level of analysis permits researchers to further dissect heuristics into components that are responsible for reducing effort.

We can highlight multiple effort-reduction principles within attribute substitution. By using easy-to-access cues, attribute substitution reduces effort by addressing the second demand of the weighted additive model. Furthermore, attribute substitution presumes that heuristic processes reduce effort by reducing the number of cues. In the case of representativeness, attribute substitution largely discards the base rate cues. People have been shown to use base rates under various circumstances (for a review, see Koehler, 1996), such as when people have direct experience with base rates (Manis, Dovalina, Avis, & Cardoze, 1980), when individuating information is less diagnostic (Ginossar & Trope, 1980), or when information is presented in frequency formats (Gigerenzer & Hoffrage, 1995). To account for this wide body of research, Kahneman and Frederick (2002) have posited that systematic, not heuristic, processes make use of base rate information. They have argued that manipulations, such as using frequency formats, to correct base-rate neglect affect "the corrective operations of System 2, not the intuitive operations of System 1" (p. 69). In other words, they have posited that base rates and representativeness cannot be combined in a heuristic manner. Through this implicit assumption, Kahneman and Frederick have addressed the first demand of the weighted additive model—that people must examine all cues. Thus, we can use an effort-reduction approach to make explicit the assumptions of Kahneman and Frederick's effort-reduction model. Their effort-reduction model relies on reducing the number of cues used and using a cue that is also easy to access. The current framework also builds on this subset of effort-reduction principles by describing how decision makers might confront the three other demands of a weighted additive model.

The Adaptive Decision Making Framework

The current framework also complements existing work on effort-reduction. Such work was notably undertaken by Payne et al. (1993), who developed a taxonomy of heuristics by classifying strategies according to six binary features. First, heuristics might or might not lead decision makers to form an impression of each alternative. Second, heuristics can be compensatory or noncompensatory. Third, heuristics can broadly use all information or ignore some information. Fourth, heuristics can lead decision makers to engage in quantitative or qualitative reasoning. Fifth, heuristics can result in consistent or selective processing. Finally, heuristics might use attribute-based or alternative-based approaches.

In some regards, the current effort-reduction approach is similar to this taxonomy. For example, the effort-reduction framework explains that some heuristics, such as satisficing (Simon, 1955, 1956, 1990), reduce effort by not integrating information to form an overall evaluation of an alternative. This principle is analogous to Payne et al.'s (1993) distinction between forming and not forming impressions of alternatives.

However, the current approach differs from the adaptive decision making framework in several critical ways. First, this effort-reduction approach is not restricted to a binary classification system, which allows for finer distinctions between heuristics than is possible using the adaptive decision making framework alone. This difference is most salient when we consider the distinction between compensatory and noncompensatory heuristics. Compensatory heuristics consider multiple cues and allow for decision makers to make trade-offs between cues. Noncompensatory heuristics consider one cue at a time and do not make trade-offs between cues. This feature is clearly related to effort-reduction, and the current framework maintains this feature but can subdivide it into two effort-reduction principles: examining fewer cues and integrating less information. A noncompensatory heuristic would be one that typically reduces the number of cues to one, whereas a compensatory heuristic would use multiple cues. Additionally, a noncompensatory heuristic would not integrate information, whereas a compensatory heuristic would integrate all information.

The effort-reduction framework extends this classification system, allowing for a graded effort-reduction, as opposed to an all-or-nothing reduction by switching from compensatory to noncompensatory strategies. The principle of examining fewer cues can help explain how the idiosyncratic fit heuristic (Kivetz & Simonson, 2003) reduces effort, for example. This heuristic is compensatory, but it uses just two cues (individual effort and the effort required of others to complete the requirements of consumer loyalty programs) in an extremely simple manner so as to reduce effort.

The current effort-reduction framework can also be used to similarly subdivide the feature of whether a heuristic considers all information. The two most obvious ways of ignoring information involve examining fewer cues or examining fewer alternatives. However, people can also use simple weighting functions to ignore information. Simpler weighting procedures, such as equal weighting or random weighting, can reduce effort by ignoring the information pertaining to cue validities/importance. Additionally, decision makers can use simple comparisons (greater than, less than, equal to), thereby ignoring the magnitude of differences between cues, such as in the weighted pros heuristic (Huber, 1979). Simple comparisons and simpler weighting were not explicitly discussed by Payne et al. (1993) but were instead encompassed under the broader feature of quantitative versus qualitative reasoning. The current framework can therefore highlight the importance of these principles as unique ways to reduce effort.

Yet in some ways, Payne et al.'s (1993) framework provides insight into heuristic processing that would be lost when using an effort-reduction framework alone. For example, the feature of consistent versus selective processing describes how heuristics can process the same information for each alternative (i.e., consistent) or they can engage in variable processing (i.e., selective). The current framework does not help in identifying a subset of effort-reduction principles that would perfectly discriminate between the two parts of this feature.

The distinction between alternative-based and attribute-based heuristics also escapes simple classification in terms of effort-reduction. Decision makers using alternative-based heuristics proceed by examining multiple attributes for a single alternative before moving on to a new alternative. Decision makers using attribute-based heuristics proceed by evaluating multiple alternatives along a single attribute before moving on to a new attribute. The current framework neglects this distinction, and our proposed effort-reduction principles could often be applied to heuristics of either sort. For example, decision makers could examine fewer cues regardless of whether they are using alternative based or attribute based strategies. In the former case, they could simply not consider certain cues when forming an evaluation of the alternative. In the latter case, they could reach a decision after comparing the alternatives on a small subset of the cues. In this way, Payne et al.'s (1993) approach can identify distinctions that would be overlooked using solely an effort-reduction approach. As such, the current framework and the adaptive decision making approach complement each other. Each can individually improve our understanding of heuristics, and jointly they make up an exceptionally powerful tool.

The Fast-and-Frugal Framework

The fast-and-frugal heuristics framework (Gigerenzer et al., 1999) has also examined how heuristics reduce effort, particularly in the domain of inference (but for a fast-and-frugal approach to choice, see the priority heuristic; Brandstätter et al., 2006). Typically fast-and-frugal heuristics for inference are built upon a three-stage model. First, heuristics specify principles to guide search for cues in some fashion (e.g., in order of validity or randomly). Second, heuristics include rules for when decision makers should stop searching for information. Third, cues are processed and a judgment or inference is made. The fast-and-frugal approach ultimately defines a heuristic as an algorithm that specifies a guiding principle for each of these three stages. Although this definition noticeably differs from our definition of a heuristic in terms of effort-reduction, the fast-and-frugal approach does discuss some ways in which heuristics reduce effort.

The fast-and-frugal framework most directly describes how heuristics reduce effort in the rules for stopping search and making a decision. Gigerenzer et al. (1999) have noted that stopping rules are necessary because it is psychologically implausible for cue-search to be exhaustive. Given this, many of the more widely discussed fast-and-frugal heuristics stop searching for information as soon as a single discriminating cue is found (e.g., the recognition, Take the Best, Take the Last, and Minimalist heuristics). This is analogous to the current framework's principle of examining fewer cues. Note that heuristics that use multiple cues (e.g., *Quick-Est* or *Categorization by Elimination*; Gigerenzer et al., 1999) will still help decision makers form a judgment based on a subset of relevant information. Further, the vast majority of fast-and-frugal heuristics are noncompensatory and therefore do not integrate information, saving the decision maker the difficult task of making trade-offs between cues.

Fast-and-frugal heuristics must also specify search principles, but the ways in which these principles reduce effort have not been examined in detail. Instead, the fast-and-frugal program has focused on how these search rules are differentially suited to various task environments, which largely concerns the accuracy of the heuristics. The current framework can complement this approach because in addition to varying in accuracy in different environments, search principles can vary in how they reduce effort.

The benefits of combining the fast-and-frugal framework with the effort-reduction approach can be seen when highlighting the differences between the Take the Best and Minimalist heuristics (Gigerenzer et al., 1999). According to the fast-and-frugal approach, these heuristics only differ in that Take the Best searches cues according to validity, whereas the Minimalist heuristic searches cues randomly. It is noted that people with more information about the environment might use the validity-based strategy, whereas more naïve decision makers might search cues randomly (Gigerenzer et al., 1999). However, a strong body of evidence suggests that learning and *using* cue validities is difficult to accomplish accurately (Evans, Clibbens, Cattani, Harris, & Dennis, 2003; Goodie & Crooks, 2004; Himmelfarb, 1970; Permut, 1973; Peterson & Pitz, 1985; Tversky & Kahneman, 1974). Therefore, when these two heuristics are viewed through the lens of the current framework, it appears that the Minimalist heuristic would make use of an additional effort-reducing principle, one analogous to simplifying weighting principles (where searching cues randomly would be easier than searching cues in order of their validity).[3] Combining the fast-and-frugal emphasis on ecological validity and fit to the task environment with the current approach's focus on reducing cognitive effort could yield insight into when different search rules are adopted.

The effort-reduction approach can also clarify a number of implicit assumptions about how particular heuristics proposed within the fast-and-frugal framework operate. Consider the recognition heuristic (Gigerenzer et al., 1999). In this heuristic, fast-and-frugal researchers have identified recognition of an item as a particularly easy-to-access cue, similar to the availability heuristic (Tversky & Kahneman, 1973). Fast-and-frugal researchers have also proposed a fluency heuristic (Hertwig & Herzog, 2007) that also makes use of an easy-to-access clue: fluency. Yet, although the fast-and-frugal approach has focused on the use of recognition and fluency as separate and unique processes, we would describe them as specific instantiations of the more general principle of using easy-to-access cues.

The fast-and-frugal approach certainly provides the beginnings of an effort-reduction framework. In discussing stopping and decision rules, the fast-and-frugal approach touches on principles that the current framework shares. However, the effort-reduction framework specifies principles—such as using easy-to-access cues and simpler weighting strategies—that, although evident in specific heuristics proposed by fast-and-frugal researchers, have not been explored formally. Additionally, although the fast-and-frugal program has discussed heuristics that pare down alternatives, it has not directly assessed heuristics that immediately eliminate alternatives from the decision set (though such an idea seems to be implied by Gigerenzer et al., 1999). As such, the current framework suggests new avenues for fast-and-frugal researchers to explore and complements and extends the three-stage model. It is also worth noting that although the fast-and-frugal approach offers great specificity in describing a particular set of heuristics, the current framework can provide the added benefit of describing the effort-reduction underlying components of a number of heuristics that fall outside the scope of the fast-and-frugal analysis.

Just as the effort-reduction framework extends current heuristic theories, it also reframes the research methods that one could use in studying heuristic processing. In the next section, we briefly discuss how various existing methods can be used to test for the effort-reduction principles specified in this article.

Types of Methods in Heuristics Research

Researchers primarily seek three types of evidence when studying heuristics in judgment and decision making. First, researchers use computer simulations to investigate the effort and expected accuracy of heuristics. Second, researchers study what information is sought and used on a moment-to-moment basis to arrive at a decision. Third, researchers examine how people's behavioral outcomes match patterns that are indicative of certain strategies. Much has already been accomplished in using these techniques. In this section, we focus on how researchers can use existing methods, in conjunction with the organizing principles of the current framework, to gain a deeper understanding of the effort-reduction mechanisms underlying heuristics.[4]

When conducting computer simulations, one way to quantify cognitive effort is to consider decision processes in terms of what Payne et al. (1993) call elementary information processes (EIPs). EIPs can account for the effort associated with processes, such as reading information, comparing alternatives on a cue, and so forth. By counting the number of EIPs involved in a decision process, researchers can compare the effort involved in various processes. Accordingly, the weighted additive rule has been shown to use more EIPs than do most of the widely discussed processes that reduce effort (Payne et al., 1993).

We can combine this methodology with the current framework to make predictions about how certain heuristics will behave in various conditions. Consider a heuristic H. Let the function $H(a)$ represent the number of EIPs used by H when there are a alternatives available in the decision set. We can use the slope of this function to quantify the increase in effort for each additional alternative in the decision set. As H examines fewer alternatives in a set, the slope for $H(a)$ decreases. Similarly, let $H(c)$ represent the number of EIPs used by H when there are c cues available per alternative. As H examines fewer cues per alternative, the slope for $H(c)$ should decrease.

We can apply this to the effort-reduction framework directly by quantifying how much effort is saved by a given effort-reduction principle in particular. By comparing the slope of $H(a)$ to the slope of $H(c)$, we can understand whether a heuristic saves more effort by reducing the number of alternatives or the number of cues. If $\Delta H(c) < \Delta H(a)$, then we can say that this heuristic probably saves more effort through the latter principle. If $\Delta H(a) < \Delta H(c)$, then we can say that this heuristic probably saves more effort through the former principle.[5] Furthermore, this research method can be used to determine whether multiple effort-reduction principles work together in an additive manner or whether there is an interaction between certain types of effort-reduction principles.

Although computer simulations are useful, they cannot prove whether people actually use a given heuristic. As complements, process tracing and outcome analysis provide strong empirical assessments of effort-reduction. *Process tracing* refers to observing how people search for information before making a judgment or decision. By tracking how participants search through information, researchers can determine which types of decision processes

[3] Note that because both of these heuristics stop searching for information as soon as a discriminating cue is found (and because the decision is based on this discriminating cue), searching for a cue earlier essentially gives it more weight in the final decision (Brandstätter et al., 2006). For example, consider inference or choice between two alternatives—A and B—supposing cue x favors option A, whereas cue y favors option B. If cue x is searched before cue y, then the decision will essentially depend on cue x—and vice versa if cue y is searched first.

[4] Payne et al. (1993) and Gigerenzer et al. (1999) identified methods for assessing the accuracy of heuristics, which are useful for describing when heuristics will be used. These methods can be directly translated to assessing the accuracy of our effort-reduction principles as well. Currently, we are interested in applying this framework to describing *how* decision makers reduce effort. As such, the matters of accuracy and when individual effort-reduction principles are used are beyond the scope of this article.

[5] Alternatively, a multivariable function $H(a,c)$ may better describe the effort involved in a decision rule according to the number of alternatives and cues in a decision set. If this were the case, then the partial derivatives of each variable could be used to evaluate the effort-reduction associated with alternatives and cues individually. For simplicity, however, we use separate linear functions in our discussion.

are being used. The basics of using process tracing to study judgment and decision making have been widely discussed elsewhere (for reviews, see Payne et al., 1993; Rieskamp & Hoffrage, 1999; Svenson, 1979; Wedell & Senter, 1997).

Process tracing is especially useful for studying whether decision makers are examining fewer cues or alternatives. For example, if decision makers are reducing effort by comparing just two alternatives at a time, then they might examine all the attributes for these two alternatives first. Moreover, if decision makers stop searching alternatives on the right side of the screen, researchers can presume that these decision makers are using a heuristic that immediately eliminates alternatives from the decision set according to spatial position. This pattern might similarly limit the number of cues that decision makers search if they are using a cue-reduction heuristic. Participants who use cue-reduction heuristics might also search numerous alternatives according to only one cue.

Processing tracing might also provide insight into whether participants are reducing effort by using easy-to-access cues. If participants typically search alternatives for one cue, and they spend a shorter amount of time on this cue yet weight it heavily in forming a judgment, then this suggests that the cue is easier to access and integrate into their judgment formation. However, because participants can easily lookup cues in a process tracing environment, they need not always retrieve cues from memory. As such, process tracing still remains a relatively weak method for determining which cues are easier to access. Therefore, to fully understand heuristics in terms of effort-reduction, we cannot solely rely on process tracing.

Process tracing is considerably more powerful when used in conjunction with outcome analysis. When examining outcomes, researchers establish a set of alternatives and cues that yield different choices according to different heuristics. By analyzing the frequency with which participants arrive at a given outcome, researchers can make inferences about which heuristics are being used. For this technique to work, however, outcomes must be separable (Rieskamp & Hoffrage, 1999); a single outcome cannot be accounted for by multiple heuristics. This type of analysis might be useful for studying whether people are examining fewer cues or alternatives, for instance. Researchers might have one group of participants make judgments or choices with a limited set of cues (or alternatives), whereas other groups view different levels of expanded sets. If the decisions differ and reaction times significantly increase with different levels of expansion, then it is less likely that participants are examining fewer cues (or alternatives).

To determine whether people are using easier-to-access cues, Kahneman and Frederick (2002) offer a different type of outcome-oriented analysis called the *heuristic elicitation method*. They used this method to test whether representativeness was driving base-rate neglect in the classic Linda problem. In this design, some participants provide judgments for the target criterion, whereas others provide judgments for cues, such as representativeness, that might be easier to access. If attribute substitution occurs, then the two judgments should be highly correlated. Participants were asked to rate how much Linda resembled the typical worker in a certain field (e.g., psychiatric social worker, bank teller, bank teller active in the feminist movement)—a possibly easy-to-access cue—and how likely she was to be such a worker—the target criterion. The correlation between the two rankings was .99, which provides some support for the idea that representativeness drives the probability judgments. However, as when using other forms of outcome analysis, researchers must take care to ensure that cues, such as representativeness, are separable from other cues that might be driving the effect.

Given that heuristics ought to reduce effort, one should expect the use of heuristics to increase with cognitive load. Using the methods described above in conjunction with cognitive load will allow researchers to understand which heuristics are particularly effective in reducing demands on cognitive capacity. Furthermore, it is of interest to know whether multiple effort-reduction strategies are used as load increases, or whether any given effort-reduction principle becomes single-handedly more prominent under significant load.

Discussion

The goal of this article has been to motivate a renewed focus on how heuristics reduce effort. A framework of effort-reduction might serve as a formal foundation for more rigorous analysis of heuristics. The word "heuristic" should not mean "curious behavior" or "suboptimal choice." Instead, the word "heuristic" ought to signal to readers that a decision process is reducing the effort associated with a task and that readers should expect to hear more about *how* that process is reducing effort.

The current framework of effort-reduction makes intuitive sense given that much of the work on heuristics has been done to understand how people respond to bounded rationality (Simon, 1955, 1956, 1990). Complex, optimal judgment and decision-making strategies typically demand a large amount of cognitive capacity and effort. In this article, we have for numerous reasons focused on the weighted additive model as a complex rule. For instance, this rule is commonly used as the normative principle for judgment and choice (Gigerenzer et al., 1999; Payne et al., 1993). Additionally, this rule is closely related to normative rules for evaluating expected value and expected utility (Keeney & Raiffa, 1976). Furthermore, this rule typically requires the most effort from decision makers and results in the most accurate choices or judgments (Payne et al., 1993).

The weighted additive rule and other optimal strategies place five demands on people: to consider all available cues, to retrieve cue values accurately, to weight cues properly, to integrate information for each alternative, and to examine all alternatives. We therefore believe that people confront limited cognitive resources by addressing these five demands. They can reduce the effort associated with any of these five demands individually or collectively.

With this effort-reduction framework in mind, we can finally begin to understand what a heuristic *is not*. A heuristic is not, for example, a set of guidelines for reaching a goal unless these guidelines reduce effort compared with an optimal model, such as the weighted additive model. Consider trying to beat a chess master who has memorized many of the common patterns observed during the course of a match. A novice might adopt the following strategy: "Remove many pieces from the board to avoid making recognizable mistakes." Although this guideline will beget a curious and observable behavioral trend, it does not necessarily reduce effort, as it can be quite difficult to take many pieces from a chess master.

Furthermore, heuristics are not merely curious representations of a problem, even if these representations are commonplace. If decision makers are asked to administer a penalty to a corrupt corporation, then it is not necessarily a heuristic to use the information such as long term projections about the economic impact, which would require substantive arithmetic. It saves effort, however, to access the information pertaining to how outrageous the corruption seems, as this is an affect-based heuristic that is easy to assess on a personal level (Kahneman & Frederick, 2002) and thus reduces effort through the second principle in the effort-reduction framework. Both are interesting ways of representing the question: "How much should we penalize this company?" Yet only one representation significantly decreases the effort associated with the task.

Heuristics are also not cues in and of themselves. This is a point that often seems obscured in the literature. Simply preferring or overweighting a cue across situations is not in itself a heuristic. To be part of a heuristic process, these preferred or overweighted cues might be easier to access or they might be used to the exclusion of other cues. Consider consumers' bargain-hunting behaviors. When deciding whether to stop bargain hunting for a low-cost product, decision makers have been found to consider the percentage discount of a product (Darke, Freedman, & Chaiken, 1995). In this study, more people opted to continue bargain hunting for a product when they were offered a 10% discount than when they were offered a 30% discount. Darke et al. (1995) argued that "the percentage discount allows the buyer to estimate when further search is warranted," and they have explained this in terms of heuristic processing (p. 585). The authors seem to assert that the discount percentage provides easy-to-access information for decision makers who are deciding whether to continue bargain hunting. However, the researchers ought to consider whether it is a *discount percentage heuristic* per se or whether the experimental environment simply made discount percentage an easy-to-access cue. In this sense, the experimental environment may have indeed elicited heuristic behavior. Yet discount percentage might not be the only heuristic or cue that accounts for these behavioral findings. The more precise heuristic principle would be that participants are using easy-to-access information for deciding whether to continue bargain hunting. There may then be numerous cues that help decision makers estimate whether further bargain hunting is warranted. For instance, the "length of sale" might also be a useful cue for deciding whether to continue bargain hunting. A brief sale might signal a better bargain than a lengthier sale. We would not jump to call this a "length of sale" heuristic, however, because cues are not heuristics themselves—the true heuristic is the underlying method or strategy that selects easy-to-access cues. We must take care to identify the true heuristics at work, instead of pinning down experimental artifacts or domain-specific behaviors as heuristics. In the same vein, a specific emotion is not a heuristic. Instead, affect in general is serving as an easy-to-access cue, and the heuristic principle is choosing to use easy-to-access cues (Finucane et al., 2000; Frederick, 2002; Kahneman & Frederick, 2002; Monin, 2003; Monin & Oppeneheimer, 2005; Slovic et al., 2002).

All of this is to say that not all unexpected, curious, suboptimal, or irrational behaviors are the result of heuristic behaviors. Although these behavioral patterns are interesting and worthy of investigation, they are not necessarily heuristic behaviors. Heuristics may sometimes appear as optimal or suboptimal, expected or surprising, but they should foremost share the common goal of reducing the effort associated with a task.

The current framework can help researchers to properly examine their heuristics for effort-reduction. Consider the testing of heuristics that are used in one-reason decision making, such as the recognition heuristic (Gigerenzer et al., 1999). Proponents of the recognition heuristic argue that it reduces cognitive effort in two ways: it is an easily retrievable cue and it is the only cue used for decision making. The first claim has found much supporting evidence, particularly given that it is highly similar to the availability heuristic and other fluency-based heuristics (Tversky & Kahneman, 1974). The second claim, however, has received much criticism because recognition is often confounded with other cues such as knowledge, thereby making it difficult to determine how many cues are truly being used (Oppenheimer, 2003; Richter & Späth, 2006). These fast-and-frugal heuristics therefore make use of one of the proposed effort-reduction principles— easy-to-access cues— but the point that they reduce the number of cues used to just one cue has been called into question. Even though the heuristics are defined to use just one cue, the feasibility of this approach must be studied further. In this way, the effort-reduction framework may help researchers define heuristics more accurately and to test for different effort-reduction principles more precisely.

The *how* of effort-reduction presents the next challenge for those who research heuristics. Computer simulations, process tracing, and outcome analyses have been used to describe what people do when making decisions and when people adopt certain strategies. Now, these experimental methods must be used to answer how people are reducing effort. Future research will need to develop new methods to investigate how people reduce effort. For instance, researchers can turn to reaction time analyses to compare how quickly people can access certain cues. This might provide a measurement for the effort associated with cue-value retrieval. Researchers might also return to the literature on EIPs (Payne et al., 1993). Perhaps reducing the number of alternatives typically leads people to use fewer EIPs than does reducing the number of cues. Or perhaps there are interactions between the five types of effort-reduction principles. With a new framework for studying effort-reduction, researchers can ultimately return to the existing methods for quantifying effort while also working to establish new methods.

Although examining effort-reduction is an important step toward a proper understanding of heuristics, it is not sufficient by itself. The current framework also raises several questions. For instance, why are some cues easier to access than others? The answer to such a question lies beyond the scope of this current framework. Yet, answering this question will go a long way in defining heuristic behavior and predicting when it affects decision making.

We must also pay careful attention to *when* a heuristic is used, as well as how often a heuristic is used. If attribute substitution (Kahneman & Frederick, 2002) and one-reason decision making (Gigerenzer et al., 1999) govern some behavior, then we can seek out when they do so while also admitting their limits (B. R. Newell & Shanks, 2003; Oppenheimer, 2003; Richter & Späth, 2006). We can theoretically construct an infinite number of behaviors that will reduce effort (and these behaviors *would* be heuristics), but these exercises are useless if we cannot show that people actually engage in these behaviors. Some work on effort-reduction has sought to identify when heuristics will be used. For example, Gigerenzer et al. (1999) have hypothesized that heuristics will be used to fit the environmental structure. Additionally, research on the accuracy of heuristics (Gigerenzer et al., 1999; Payne et al., 1993) can help identify heuristics that produce better choices or inferences, and this research can highlight heuristics that are more likely to occur. For, if a heuristic is not accurate, it will probably not be used for very long.

The framework presented in this article serves as a new way to revive the discussion on how heuristics reduce the effort associated with tasks. It demonstrates that the question "What is a heuristic?" has not been fully answered because we have often failed to address the question "How do heuristics reduce effort?" Simply observing a behavior in certain task environments and calling it a heuristic is no longer sufficient. We must probe deeper to understand whether proposed heuristics are simply artifacts of an experimental environment or if they represent a broader system of effort-reduction. We should no longer expect the word "heuristic" to do the theoretical work for us.

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