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An agenda (either implicit or imposed) is a set of constraints on the order of selecting or eliminating choice alternatives. It can be "top down," "bottom up" (as a tournament), or more general. The author's analytic results identify which probabilistic choice rules are affected by agendas and when they are affected. The results also illustrate how agendas might be used to enhance target products. Examples and behavioral hypotheses are provided and the implications of the results for marketing management are discussed.

Agendas and Consumer Choice

Agendas influence choice. For example, academic hiring decisions are sometimes made with an agenda of sequential decisions. If many good candidates apply for a junior faculty position and we do not wish to interview them all, we may first decide on a subfield, say information processing, and then search within that subfield. We base our decision on subfields on our prior experience, which tells us what to expect from candidates who choose to enter that subfield. Contrast this "top-down" sequential decision (subfield, then candidate within subfield) with a "bottom-up" sequential decision that might be used if we could interview all potentially good candidates. For example, if there are relatively few candidates, we may interview them all, decide who is the best "model builder," who is the best "consumer behavioralist," and who is the best "managerial analyst." We then would contrast the best with the best, taking into consideration all of the candidates' characteristics as well as their fields of interest. One interesting question is whether (and how) our sequential decision process influences the outcome.

Constraints on the order of selecting or eliminating alternatives also may affect choices made by individual customers or consumers. Consider the industrial sales presentation in which a target product is compared with a competitor against which it performs particularly well, rather than with the market as a whole (see, e.g., Newton 1981). Product comparisons are also common in advertising. In one recent example, Pitney-Bowes compared its copiers with those of Savin and Xerox, Savin compared its copiers with those of Xerox, and Xerox used advertising to discourage such comparisons.

The effect of a sales or advertising campaign is not identical to the effect of the sequential decision process used by hiring committees. Sales presentations and advertising can influence the decision process, but cannot set it. Furthermore, whether or not the consumer actually follows the suggested decision process is an empirical question. Finally, an agenda effect may be only one of many outcomes of a sales or advertising campaign. Nonetheless, there are similarities and it would be useful to know whether sequential decision processes influence consumer choice. Such knowledge would help us analyze and design communication strategies that appear to influence such decision processes.

There are a myriad of other interesting, relevant situations in which individual consumers are faced with constrained decision processes. New products often are designed on the basis of analyses suggesting which competitive products consumers will consider in their decision processes (see review by Day, Shocker, and Srivastava 1979). In shopping behavior a consumer limits his or her set of product options by choosing one particular shopping center; supermarkets use displays to set one brand away from others; package goods manufacturers often use similar packaging (compare Colgate with

Close-Up toothpaste) or distinct packaging; and some advertisements mention competitive products whereas others do not. Some of these strategies are planned, some are dictated by environmental constraints, and some are serendipitous. In each case the sequence of decisions among products is potentially influenced and in each case the modification of the decision sequence may or may not affect choice outcomes.

We can understand better the marketing management implications of modifying decision sequences by studying how, in theory, such constraints can influence decisions. In this article we draw on recent developments in mathematical psychology and explore how agendas, that is, imposed or implicit constraints on choices, influence consumers' probabilities of choice.[1] We analyze such agendas with probabilistic models of consumer choice that are documented, empirically tested, and influential in marketing thought. We derive from these models a series of mathematical implications of the influence of agendas on consumer choice.

We begin with a review of the consumer behavior models, then define agendas and speculate on when consumers will follow implicit agendas. Next, three theorems indicate which probabilistic choice rules are affected by agendas and on which aspect structures. This mathematical structure is applied to illustrate how agendas might be used to influence consumer choice. We close by illustrating how agendas can violate two commonly accepted axioms of consumer choice behavior.

PROBABILISTIC MODELS OF CONSUMER CHOICE BEHAVIOR

Our review is by necessity concise and limited to probabilistic models. Readers desiring greater detail are referred to Luce (1959, 1977), Tversky (1972a,b), and particularly Tversky and Sattath (1979). For alternative paradigms, see Cortsjens and Gautschi (1983).

We use the lowercase English letters t, v, w, x, y, and z to denote choice object (e.g., automobiles, restaurants, and televisions). We use uppercase English letters, A, B, C, . . ., to denote sets of choice objects (e.g., $A = \{x,y,z\}$). The total finite set of all choice objects being studied is denoted by T and the null set is denoted by $\emptyset$.

Let $P(x|A)$ denote the probability that object x is chosen when the choice set is A. Naturally we assume $P(x|A) \geq 0$ and the sum of all $P(x|A)$ for all x in A is equal to 1.0.

We describe choice objects as a collection of aspects. For example, an automobile may be described by aspects

such as "sporty," "high mpg," "sedan," "front wheel drive," and "Chevrolet." An aspect is a binary descriptor of a choice object (e.g., "sedan") in the sense that a choice object either has the aspect or it does not. We use lowercase Greek letters, α, β, γ, . . ., to denote aspects. For continuous attributes such as mpg, we define ranges. For example, an automobile with the attribute of 30 mpg or more would have the aspect "high mpg." An aspect in this analysis can be a collection of more elementary aspects (e.g., "high mpg, front wheel drive, sporty, and red") or it can be that which is unique to a choice object (e.g., "Honda Accordness") or to a set of choice objects.

Let $x' = \{\alpha,\beta,\ldots\}$ be the set of aspects associated with choice alternative x. For any set of choice alternatives, A, let A' be the set of aspects that belong to at least one alternative in A (i.e., $A' = \{\alpha|\alpha \in x'$ for some $x \in A\}$). For any aspect, α, and set of choice alternatives, A, let A_α denote the set of all choice alternatives in A that have aspect α (i.e., $A_\alpha = \{x|x \in A, \alpha \in x'\}$). Note that A' is a set of aspects and A_α is a set of choice objects. For example, if $A = \{$Honda Civic, Honda Accord, Chevrolet Chevette, Chevrolet Citation$\}$, then $A' = \{$"compact," "front wheel drive," "Honda," "Chevrolet," . . .$\}$. If $\alpha = $ "Honda," then $A_\alpha = \{$Honda Civic, Honda Accord$\}$.

Constant Ratio Model (CRM)

Perhaps the most commonly used probabilistic choice model in marketing is the constant ratio model (see Batsell and Lodish 1981; Bell, Keeney, and Little 1975; Hauser and Urban 1977; Jeuland, Bass, and Wright 1980; Luce 1959, 1977; McFadden 1980; Nakanishi and Cooper 1974; Pessemier 1977; Punj and Staelin 1978; Silk and Urban 1978). The basic assumption underlying the CRM is that the ratio of (nonzero) choice probabilities for two objects is independent of the choice set. Mathematically, $P(x|A)/P(y|A) = P(x|B)/P(y|B)$ for all A and B such that the probabilities are nonzero. One can easily show (e.g., Luce 1977) that CRM implies there exist scale values, $u(x)$, for the objects, x, such that

$$(1) \qquad P(x|A) = \frac{u(x)}{\sum_{y \in A} u(y)}$$

where $y \in A$ denotes all objects, y, contained in choice set A. The simplicity of equation 1 has led to its wide acceptance and in many situations it approximates behavior very well (e.g., see Urban and Katz 1983).

However, several authors (Debreu 1960; Luce and Suppes 1965; Restle 1961; Rumelhart and Greeno 1971; Tversky 1972b) have presented conceptual and empirical evidence that CRM fails to account for the similarity among choice objects. For example, if two automobiles, say a Honda Accord and a Buick Skyhawk, were equally likely to be chosen, CRM would imply that the addition of a third automobile, say another Honda Accord with

a minor variation, would make all three automobiles equally likely. The probability share of a Honda Accord would be raised artificially from 50% to 67%.

Elimination by Aspects (EBA)

In response to these criticisms, Tversky (1972a,b) proposed a model called "elimination by aspects" which postulates that consumers choose among objects on the basis of the aspects of the objects, not the objects *per se*. This assumption is analogous to the economic models of Lancaster (1971) and his colleagues and to the multiattributed models in marketing as reviewed by Wilkie and Pessemier (1973).

EBA postulates that a consumer chooses among all *aspects* in the offered set, A', with probability proportional to the scale value of the aspect. The consumer then eliminates all choice objects not having the chosen aspect and continues choosing aspects and eliminating objects until one choice object is left.

If an italicized Greek letter, α, represents the scale value of an aspect, α, EBA is given mathematically by the following recursive equation.

$$(2) \qquad P(x|A) = \sum_{\alpha \in x'} \frac{\alpha}{\sum_{\beta \in A'} \beta} \cdot P(x|A_\alpha)$$

It is easy to show that any aspect common to all alternatives in a choice set (e.g., the aspect "automobile") does not affect choice probabilities and therefore will be discarded (see Tversky 1972a,b). Tversky demonstrates that EBA overcomes the conceptual criticisms of CRM and he demonstrates the empirical validity of the model for explaining choices among dot patterns, gambles, and test score profiles.

EBA is a generalization of CRM because equation 2 reduces to equation 1, with $u(x) = \sum_{\alpha \in x'} \alpha$, when choice objects do not share aspects. Note that EBA does not imply a fixed sequential decision process. Rather, it implies that the consumer probabilistically selects aspects for consideration and, hence, EBA is a randomized sequential decision process.

EBA is conceptually elegant, but it has not been applied widely in marketing because a fully specified EBA model would require a large number of parameters. If there were n products and an aspect for every possible subset, a fully specified EBA model would require $2^n - 2$ aspects. For example, for the 160 automobile brands now on the market, EBA would require approximately 1.5×10^{48} aspects. At the other extreme is CRM, which requires only as many scale values as there are choice objects.

Preference Trees

Tversky and Sattath (1979) investigate a practical alternative that requires fewer parameters than a fully specified EBA yet can represent more complex behavior than is modeled by CRM. They examine an intermediate level of aspect set complexity known as preference trees. Figure 1 is an example preference tree.

A preference tree is a hierarchical aspect structure that has no overlap among the branches. For example, in Figure 1 there are Japanese and American automobiles. The Japanese automobiles are subdivided into Hondas and Toyotas and the American automobiles are subdivided into Buicks and Chevrolets. The addition of an American Honda, say if consumers considered Hondas built in the United States as American, would introduce overlap and upset the tree structure. (See Tversky and Sattath 1979 for a formal definition of preference trees.)

A preference tree structure greatly restricts the complexity of the interrelationships among aspects. The $2^n - 2$ possible aspects are limited to at most $2n - 2$ aspects corresponding to the maximal number of links in a tree with n terminal nodes. For example, in a choice set with 10 objects, the number of aspects possible is reduced from 1022 to 18. Thus, preference trees represent a compromise between the generality of unrestricted EBA and the limitations of the CRM.

Hierarchical Elimination Model (HEM)

Neither CRM nor EBA is a sequential decision rule. Preference trees are aspect structures, not decision rules. However, empirical evidence suggests that consumers make explicit, hierarchical decisions (see, among others, Bettman 1979; Haines 1974; Payne 1976).

In 1979, Tversky and Sattath introduced the hierarchical elimination model (HEM) to represent cognitive processing on a preference tree as a hierarchical series of choice points. The idea is that the consumer sequentially compares sets of objects defined by branches in the preference tree. For example, in Figure 1 he first decides between Japanese and American automobiles, then, if he selects Japanese, he chooses between Honda and Toyota, and finally, if he selects Honda, he chooses between Civic and Accord. The choice between branches is proportional to the sum of the measures of the aspects in each branch. For example, if α = Japanese, β = American, γ = Honda, δ = Toyota, μ = Buick, λ = Chevrolet, ξ = Civic, and η = Accord, the probability of the consumer choosing the Japanese branch is

Figure 1
EXAMPLE PREFERENCE TREE FOR AUTOMOBILES
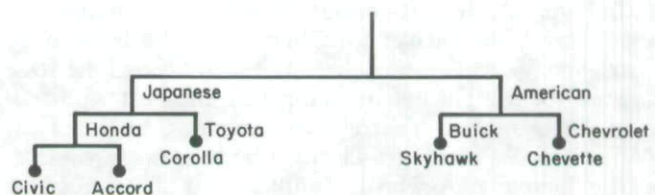
(3) $P(\text{Japanese}|T) = \dfrac{\alpha + \gamma + \delta + \xi + \eta}{(\alpha + \gamma + \delta + \xi + \eta) + (\beta + \mu + \lambda)}$.

The overall probability is the product of the sequential conditional probabilities: $P(\text{Civic}|T) = P(\text{Civic}|\text{Honda})*P(\text{Honda}|\text{Japanese})*P(\text{Japanese}|T)$.

Tversky and Sattath (1979) demonstrate that HEM resolves the conceptual criticisms of CRM. They demonstrate the empirical validity of the model with applications to choices among celebrities, political parties, academic disciplines, and shades of grey. However, to date, HEM has been defined only for preference trees.

We now define agendas, indicate how our definition affects the decision rules of CRM, EBA, and HEM, and propose a behavioral hypothesis to predict when consumers will use implicit agendas.

AGENDAS

If the aspect structure is a preference tree and the consumer follows HEM, we can think of the choice process as following a sequence of constraints. For the automobile example, the consumer chooses first between Japanese and American automobiles, then between Honda and Toyota, and then the Civic from among Hondas.

In many situations, however, the aspect structure is not a preference tree and/or the sequence of decisions does not match the aspect structure. For example, the set of televisions is not a preference tree if the consumer considers both black-and-white and color portables as well as both black-and-white and color consoles. Even if the aspect structure is a tree, external constraints may force a sequential process that does not follow the tree. Consider the automobile owner who is constrained in a choice of service stations because the automobile requires diesel fuel.

Even if no constraints are imposed, a consumer may wish to make choices sequentially. Consider restaurant choice in an unfamiliar city. We often simplify our decisions by first choosing price range, say high, medium, or low, and then style, say French, Italian, German, American, Chinese, or Lithuanian. Such a choice process can be viewed as a set of (internally imposed) constraints.

We define an agenda as a sequence of constraints. In particular, an agenda is a tree of objects such that at any node, the consumer must choose among those branches exiting that node. We label the nodes to indicate the order in which they are processed. An agenda can be top down as in the example of restaurant choice in an unfamiliar city (i.e., price range then nationality) or it can be bottom up as illustrated in Figure 2.

In Figure 2, we first choose the best restaurant in each class, say Yantze River for Chinese, Cory's for American, and Versailles for other. We then choose the restaurant for a night out by comparing the best with the best, in this case, Yantze River versus Cory's versus Versailles. Such an agenda might be used by a resident of Lexington, MA who is familiar with all six restau-

Figure 2
BOTTOM-UP AGENDA FOR RESTAURANT CHOICES IN LEXINGTON, MA
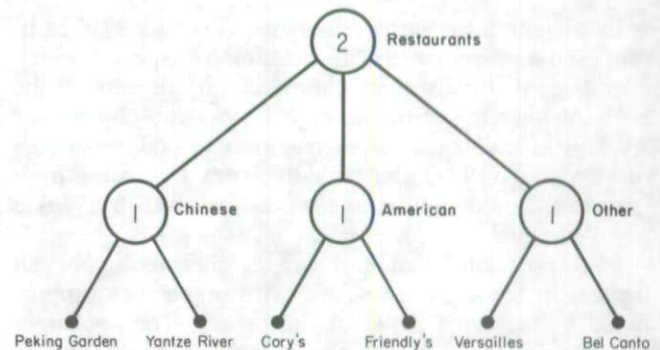
rants. In contrast, a tourist unfamiliar with Lexington may process this tree with a top-down agenda. Notice that the processing sequence is a logical constraint, not necessarily a temporal constraint, in the sense that all "1" nodes do not need to be processed simultaneously. We only require that all "1" nodes be processed prior to any "2" nodes.

We also allow agendas to be mixed. For example, a consumer may process all bottom nodes, then the top node, and finally the intermediate nodes.

We denote agendas by uppercase script letters, $\mathcal{A}$, $\mathcal{B}$, $\mathcal{C}$, ..., and represent them by labeled diagrams such as Figure 2. For top-down agendas we use a superscript star ($\mathcal{A}^*$), and for bottom-up agendas we use a subscript star ($\mathcal{A}_*$). When an agenda is either all top down or all bottom up we can represent the agenda more simply by nested sets. For example, $\{\{x,y\},\{v,w\}\}^*$ indicates we first choose between $\{x,y\}$ and $\{v,w\}$ and then within either $\{x,y\}$ or $\{v,w\}$. Alternatively, $\{\{x,y\},\{v,w\}\}_*$ indicates we first choose between x and y and between v and w, then compare the best with the best, say x with v.

Elimination by Aspects (EBA) and Agendas.

Suppose a consumer uses EBA whenever he is presented a set of choice objects, but we constrain him to follow an agenda from the top down. For example, suppose that T is partitioned into A and B and we force the consumer to choose first between A and B and then within A or B. Following Tversky and Sattath (1979), we assume that the probability of choosing A from T equals the sum of the probabilities of choosing any object in A from T. In our example, such a combination of constraints and EBA says simply

(4) $$P(x|\mathcal{A}) = P(x|A)P(A|T)$$

where:

$$P(A|T) = \sum_{y \in A} P(y|T)$$

and $P(x|A)$ and $P(y|T)$ are given by EBA. (We can clearly generalize equation 4 to more than one intermediate level.)

Generalized Elimination Model (GEM)

To analyze aspect structures that are not preference trees and agendas that do match aspect structures, we must extend HEM to general hierarchies. In particular, we must address the impact of aspects that are shared among branches.

In preference trees no aspects are shared among branches; thus one obvious generalization is to define the measure of a branch as equal to the sum of all aspects that are unique to that branch. Such a generalization postulates that only differences matter and is thus similar in spirit to EBA.

However, it is also reasonable to posit that shared aspects do affect choices among branches. For example, suppose branch A had a red Chevy sedan and a blue Honda hatchback whereas branch B had a red Chevy hatchback and a red Honda sedan. The two branches would share the aspects "Chevy," "Honda," "hatchback," "sedan," and "red" but only branch A would have the aspect "blue." Thus, on the basis of unique aspects only, branch A would dominate branch B. Such dominance is unrealistic if we believe the aspects of color are less important than the aspects of manufacturer and body style. An alternative postulate is to define the measure of a branch as equal to the sum of all aspects on that branch, including shared aspects.

The two postulates span the range of hypotheses on how to generalize HEM to arbitrary aspect structures. *A priori* both are reasonable. We leave the selection of postulates as an empirical question by defining a parameterized model that includes both postulates as special cases. Furthermore, this model reduces to HEM for all values of the parameter when the aspect structure is a preference tree.

In particular, the generalized elimination model (GEM) is defined as a sequential elimination model (as HEM) in which consumers process the choice set from the top down according to an agenda, A^*, in which the probability of choosing a branch at any stage is proportional to its measure. Furthermore, the measure of a branch is equal to the sum of all unique measures plus θ times the sum of all shared measures where $0 \leq \theta \leq 1$.

For example, if $A^* = \{\{x,y\},\{v,w\}\}^*$, $x' = \{\alpha_1,\beta_1\}$, $y' = \{\alpha_1,\beta_2\}$, $v' = \{\alpha_2,\beta_1\}$, and $w' = \{\alpha_2,\beta_2\}$,

(5) $P(x|A^*) = P(x|\{x,y\})P(\{x,y\}|T)$

$$= \left(\frac{\beta_1}{\beta_1 + \beta_2}\right)\left(\frac{\alpha_1 + \theta(\beta_1 + \beta_2)}{[\alpha_1 + \theta(\beta_1 + \beta_2)] + [\alpha_2 + \theta(\beta_1 + \beta_2)]}\right).$$

We investigate the implications of shared aspects (θ) in a subsequent section.

Bottom-Up Agendas

In a bottom-up agenda, we represent a choice set by its best choice object, a processing rule often advocated

by economists (e.g., Blackorby, Primont, and Russell 1975). Processing proceeds much as an athletic team proceeds through a tournament. For example, for the agenda $A_* = \{\{x,y\},\{v,w\}\}_*$, we compute $P(x|A_*)$ with equation 6.

(6) $P(x|A_*) = P(x|\{x,y\})[P(x|\{x,v\})P(v|\{v,w\})$

$$+ P(x|\{x,w\})P(w|\{v,w\})]$$

We analyze the implication of bottom-up agendas in subsequent sections. For now, suffice it to say that bottom-up agendas do affect choice and do so differently than top-down agendas.

Behavioral Hypotheses—Familiarity

In many cases agendas are imposed externally by managerial action. However, in some cases they may be the result of self-imposed simplifications in cognitive processing. We now set forth empirically testable initial hypotheses as to when self-imposed agendas are likely to be used by consumers. Though our analytic results in subsequent sections do not depend explicitly on the validity of these hypotheses, the hypotheses do serve to motivate and interpret self-imposed agendas.

Top-down versus bottom-up agendas. In our motivation of agendas we imply that consumers familiar with restaurants in a city would use a bottom-up agenda comparing the best with the best whereas tourists unfamiliar with the restaurants would use a top-down agenda screening restaurants by category. Similarly, if we are hiring faculty candidates at the junior level, we may be likely to use a top-down decision process because even after a campus interview we are uncertain how productive the candidate will be. At the senior level we have much better information on research and teaching productivity and may be more likely to use a bottom-up process whereby we compare, say, the best available model builder with the best available consumer behavioralist.

In each of these anecdotes, the key variable is familiarity. In general, we posit that:

> When one is very familiar with objects or search cost is low, and uncertainty is low, a bottom-up agenda will be favored. When one is unfamiliar with the choice objects and search cost is high, or uncertainty is high, a top-down agenda will be favored.

One implication of the familiarity hypothesis is that lack of information will lead an individual to a top-down choice process and could conceivably lead one to eliminate an optimal choice object early in the hierarchy. For example, suppose the "best" junior faculty candidate is not in the area we choose.

Search cost is a relative measure. For high cost consumer durable goods (or high cost industrial goods) we expect consumers (customers) to be willing to incur greater search cost than they would for less expensive, more frequently purchased goods, Thus, one implication of the familiarity hypothesis is that bottom-up agendas will be

more prevalent for high cost items.

EBA versus GEM. GEM computes representative measures to summarize the attractiveness of a branch. Constrained EBA sums the probabilities of the individual items. We expect representative measures to be used more often when detailed information about the objects in unknown, uncertain, or difficult to obtain. We posit that:

> For constrained top-down agendas, GEM will be the operant rule when detailed information is not available, whereas EBA will be favored when detailed information is available.

In analyzing the familiarity hypothesis, it is important to recognize that both GEM and EBA are paramorphic models of cognitive processing. GEM does not necessarily imply that an individual uses the postulated arithmetic rule to compute the measures of each branch, but rather that the arithmetic rule will provide a good estimate of the measure he or she will attach to each branch. Thus, according to the familiarity hypothesis, an individual will assign measures to branches on the basis of limited familiarity. These measures will be similar to what we, as analysts, compute by the GEM rules.

SOME GENERAL IMPLICATIONS

In this section we use our definitions and the probabilistic models of consumer choice to investigate some general properties of agendas. In particular, we show which of the probabilistic choice rules can and cannot be affected by agendas, identify those aspect structures for which compatible agendas do and do not affect choice, and show an interesting equivalence in outcomes between two apparently very different choice rules. These results generalize theorems by Tversky and Sattath (1979).

Invariance

Consider the aspect structure $x' = \{\alpha_1, \beta_1\}$, $y' = \{\alpha_1, \beta_2\}$, $v' = \{\alpha_2, \beta_1\}$, $w' = \{\alpha_2, \beta_2\}$, and consider the agenda $\mathcal{A}^* = \{\{x,w\},\{y,v\}\}^*$. Using $\alpha_1 = .251$, $\alpha_2 = .249$, $\beta_1 = .499$, $\beta_2 = .001$, $\theta = 1$, and the choice rules of the preceding section, we compute (see Appendix for details)

(7a) $P(w|T) = \alpha_2\beta_2/[(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)] = .001$

(7b) $P(w|\mathcal{A}^*, \text{EBA}) = (\alpha_2 + \beta_2)(\alpha_1\beta_1 + \alpha_2\beta_2)$

$$/[(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)] = .125$$

(7c) $P(w|\mathcal{A}^*, \text{GEM}) = (1/2)(\alpha_2 + \beta_2) = .125$.

This example illustrates that agendas can influence choice for both EBA and GEM($\theta = 1$). Furthermore, the influence is dramatic. We might wonder whether there is any choice rule for which choice probabilities are not affected by agendas. We call such unaffected choice rules "invariant."

It is easy to see that for top-down agendas, a cognitive processing model is invariant if and only if $P(x|T) =$

$P(x|A)P(A|T)$ for any A whenever A is a subset of T and $P(x|T)$ is nonzero. However, this condition is Luce's (1959) choice axiom which is the defining property of CRM. Thus, for top-down agendas, CRM is the only invariant probabilistic choice model.

Consider the bottom-up agenda, $\mathcal{B}_* = \{\{x,y\},\{v,w\}\}_*$. Applying CRM to each pair gives us

$$P(x|\mathcal{B}_*) = \left(\frac{u(x)}{u(x) + u(y)}\right) \cdot \left[\left(\frac{u(x)}{u(x) + u(v)}\right) \cdot \left(\frac{u(v)}{u(v) + u(w)}\right)\right. $$
$$\left. + \left(\frac{u(x)}{u(x) + u(w)}\right) \cdot \left(\frac{u(w)}{u(v) + u(w)}\right)\right]$$

which does not reduce to the CRM of

$$P(x|T) = \frac{u(x)}{u(x) + u(y) + u(v) + u(w)}.$$

Thus, not even CRM is invariant with respect to bottom-up agendas. Because EBA and GEM are equivalent to CRM when there is no overlap among the aspect sets, this example is sufficient to show that CRM, EBA, and GEM can be affected by bottom-up agendas. To date, we know of no decision rules that are invariant with respect to bottom-up agendas.

We state this result as a theorem because it is important conceptually even if it is easy to prove mathematically.

> *Theorem 1 (invariance):* The constant ratio model is the only probabilistic choice model invariant with respect to top-down agendas. In contrast, each of the decision rules, CRM, EBA, and GEM, can be affected by bottom-up agendas.

Theorem 1 is encouraging. Agendas do affect choice. We should be able to identify at least some agendas that affect choice in scientifically interesting and managerially useful ways.

Theorem 1 has an additional benefit because it provides a means to test whether CRM is a reasonable description of behavior. If no top-down agendas can be found to affect choice, CRM is not eliminated as a decision rule. If any top-down agenda affects choice, CRM cannot be the decision rule.

Compatibility

Only CRM is unaffected by all top-down agendas, but theorem 1 does not imply that all agendas affect choice outcomes. For example, an agenda that matches, or at least does not disrupt, a GEM hierarchy will not affect GEM choice probabilities. What about EBA? Intuitively, because EBA is a random-access processing rule, we expect agendas to influence EBA probabilities.

However, some agendas do not affect EBA probabilities. Consider the aspect structure used to compute equations 7. This aspect structure is generated with a factorial design on the aspects, that is, a choice alternative has either α_1 or α_2 and either β_1 or β_2. This time

consider the agenda $\mathcal{C}^* = \{\{x,y\},\{v,w\}\}^*$ that is "compatible" with the aspect structure and compute the constrained EBA probability.

$$(8) \quad P(w|\mathcal{C}^*, \text{EBA}) = P(w|\{v,w\})[P(v|T) + P(w|T)]$$

$$= \left(\frac{\beta_2}{\beta_1 + \beta_2}\right) \cdot \left[\alpha_2\left(\frac{\beta_1}{\beta_1 + \beta_2}\right)\right.$$

$$+ \beta_1\left(\frac{\alpha_2}{\alpha_1 + \alpha_2}\right) + \alpha_2\left(\frac{\beta_2}{\beta_1 + \beta_2}\right)$$

$$\left. + \beta_2\left(\frac{\alpha_1}{\alpha_1 + \alpha_2}\right)\right]$$

$$= \alpha_2\beta_2/[(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)] = .001$$

Equations 7a and 8 give the same results! As it turns out, this result generalizes.

Following Tversky and Sattath (1979), we deem two preference trees compatible if and only if there exists a third tree defined on the same choice objects that is a refinement of both. For example, $\{\{\{x,y\},z\},\{t,v,w\}\}$ and $\{\{x,y,z\},\{\{t,v\},w\}\}$ are compatible because $\{\{\{x,y\},z\},\{\{t,v\},w\}\}$ refines both agendas. In contrast, $\{\{x,w\},\{y,v\}\}$ is not compatible with $\{\{x,y\},\{v,w\}\}$ because there is no tree that refines both these agendas. Note that the degenerate tree, $\{x,y,v,w,...\}$, implied by CRM is compatible with all trees on T. For factorial structures, an agenda is compatible if each branch of the agenda corresponds to dividing the factorial structure on the (factorial) groups of aspects.

Tversky and Sattath (1979) have shown that, in general, constrained top-down agendas do not affect EBA choice probabilities if the aspect structure is a preference tree and the agenda is compatible with the preference tree. We show in a supplemental appendix[2] that this result also holds if the aspect structure is a factorial structure (FS) and the agenda is compatible with the factorial structure.

We also show the more surprising result that compatible preference trees and compatible factorial structures *are the only* agendas that do not affect choice probabilities. Except for specific choices of aspect measures,[3] all other agendas affect EBA choice probabilities. Even fractional factorial agendas will affect choice. Formally,

Theorem 2 (compatibility): For an arbitrarily chosen set of aspect measures, a constrained top-down agenda, $\mathcal{A}^*$,

has no effect on a family of EBA choice probabilities, $P(x|T)$ for all $x \in T$, if and only if either (1) the aspect structure forms a preference tree and $\mathcal{A}^*$ is compatible with the tree or (2) the aspect structure forms a factorial structure and $\mathcal{A}^*$ is compatible with the factorial structure.

The detailed proof of theorem 2 is long and complex. Basically, we first show that EBA is algebraically equivalent to a hierarchical rule for preference trees and factorial structures and only for preference trees and factorial structures. We then show that a compatible agenda does not upset the hierarchical nature of the calculation.

Theorem 2 is both interesting and useful. Factorial structures occur often in marketing. For example, applications of conjoint analysis in marketing rely heavily on factorial designs for data collection (see review by Green and Srinivasan 1978). Similarly, factorial experimental designs are used to investigate consumer behavior theories (see Sternthal and Craig 1982). Some markets naturally evolve as factorial designs as line extensions are introduced to fill every market niche.

Consider a television market that is a factorial structure with aspects "console" versus "portable" and "color" versus "black and white." For EBA, theorem 2 implies that an advertising campaign will have no effect if it attempts to influence consumers to make decisions according to "portable" versus "console." Nor will a "color" versus "black and white" campaign have an effect. However, a campaign encouraging the comparison of "color consoles" with "black-and-white portables" will affect choice probabilities. Theorem 2 also cautions behavioral researchers seeking to test agenda effects to avoid experiments on compatible factorial structures.

To date, we know of no aspect structures that are not affected by bottom-up agendas.

Equivalence

Define x', y', v', w', and $\mathcal{C}^*$ as before. Now calculate the constrained GEM ($\theta = 0$) probability for choosing w.

$$(9) \quad P(w|\mathcal{C}^*, \text{GEM}, \theta = 0) = \alpha_2\beta_2/[(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)]$$

Though the procedure by which we calculate the choice probability is dramatically different, we obtain the same answer. This is true despite the fact that GEM and EBA are very different hypotheses about how a consumer processes information to make a choice. GEM is an explicit, sequential, top-down decision process whereas EBA is a random-access elimination process.

$\mathcal{C}^*$ is defined on a compatible factorial structure. It turns out that this result generalizes to all factorial structures and, as shown by Tversky and Sattath (1979), to preference trees. However, the result holds for no other structure.[4] Furthermore, the result does not hold when

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[2] The appendix is available from the author. Alternatively, request Working Paper #1747-86, "Proofs of Theorems and Other Results: Appendix to Agendas and Consumer Choice," from the Sloan School of Management, MIT, Cambridge, MA 02139.

[3] We can always find degenerate cases in which $P(x|T) = P(x|\mathcal{A}^*)$ for some choice of aspect measures. For compatible pretrees and FS's and only for compatible pretrees and FS's, $P(x|T) = P(x|\mathcal{A}^*)$ for all choices of nonzero aspect measures. Define compatibility for nontree/nonfactorial when, for each split due to the agenda, there is a set of aspects contained in each branch that are contained in no other branch in the split.

[4] Except, of course, for specific choices of aspect measures. We seek the result that holds for arbitrarily chosen aspect measures.

shared aspects are considered, that is, when θ is not zero. Formally,

> *Theorem 3 (equivalence):* For an arbitrarily chosen set of aspect measures, the generalized elimination model and elimination by aspects yield equivalent choice probabilities if and only if (1) the aspect structure is a preference tree or (2) the aspect structure is a factorial structure, $\theta = 0$, and the hierarchy associated with GEM is compatible with the preference tree or factorial structure.

An immediate corollary of theorem 3 is that GEM(0) probabilities are independent of the order in which aspect partitions are processed. (For $\theta \neq 0$, the order can be shown to matter.) Thus, if a researcher uses a compatible factorial structure experiment to investigate hierarchies and the consumer(s) is using GEM(0) or EBA, the researcher will not be able to identify the order of aspect processing or the decision rule the consumer is using by simply observing the choice outcomes. However, the researcher may be able to identify orderings or decision rules by other means such as verbal protocols or response time.

Furthermore, in a market that has evolved fully to a factorial structure, say some automobile submarkets, managerial actions to influence agendas will not depend on the specific cognitive processing hierarchy as long as EBA or a compatible GEM(0) applies.

At this point it worth digressing to recognize that the definition of aspects may be only an approximation. For example, Urban, Johnson, and Hauser (1984) represent the instant coffee market as a factorial structure of "caffeinated" versus "decaffeinated" and "freeze dried" versus "regular." However, Taster's Choice may have a different color label than Folger's, and that color may matter in consumer choice. By analyzing the instant coffee market as a factorial structure we are assuming that the specified features (aspects) dominate the features we do not model explicitly. The validity of such assumptions can only be determined empirically, but by making such assumptions we can isolate and study agenda effects, recognizing that in application we might have to include other effects in our analysis.

We turn now to an analysis of agendas that do affect choice probabilities.

STRATEGIC IMPLICATIONS ON FACTORIAL STRUCTURES

In general, agendas affect choice, but theorems 1, 2, and 3 suggest that the effect depends on the type of agenda, the aspect structure, the decision rule, and the measures of the aspects. To a marketing manager seeking to improve the probability that his or her product is chosen, these are very important questions. For example, the manager who wants to design an advertising campaign to influence consumer agendas, that is, influence to which competitive products his or her product is compared, will want to evaluate the likely directional effect of the campaign. If the directional effect depends

only on the aspect structure, not on the specific measures of the aspects, so much the better.

In this section we illustrate the strategic implications of agendas on 2×2 factorial structures. Such factorial structures serve to illuminate more general results, but are easy to visualize and do not obscure the intuitive understanding of agenda effects.

We begin with dissimilar groupings, a class of top-down agendas that enhance a lesser target object. We then illustrate bottom-up agendas that enhance greater objects. Finally, we explore the comparative implications of EBA and GEM and the effects due to shared aspects. Throughout this development, we use the factorial aspect structure notation of $x' = \{\alpha_1, \beta_1\}$, $y' = \{\alpha_1, \beta_2\}$, $v' = \{\alpha_2, \beta_1\}$, and $w' = \{\alpha_2, \beta_2\}$.

Enhancement of a Lesser Object

Marketing folk wisdom suggests that it is always effective for a low market share product to force a comparison between itself and a high market share product. For example, in many advertisements a cola is compared with Coca-Cola. A similar phenomenon appears to have occurred in the Pitney-Bowes/Savin/Xerox example. However, many automobile manufacturers compare themselves with the low share, but prestige, products of BMW and Mercedes.

Consider the agenda, $\mathcal{A}^* = \{\{x,w\},\{y,v\}\}^*$, and suppose we choose the aspects such that $\alpha_1 > \alpha_2$ and $\beta_1 > \beta_2$. That is, we choose the aspects such that the least preferred object, w, is compared with the most preferred[5] object, x. For example, if $\alpha_1 = .03$, $\alpha_2 = .01$, $\beta_1 = .81$, and $\beta_2 = .15$, then $P(w|\mathcal{A}^*) = .08$ and $P(w|T) = .04$. The folk wisdom appears to be true for this example.

However, for the folk wisdom to be true for other choice objects in T, the condition that y has a lower unconstrained probability than v should be sufficient to ensure that the probability of choosing y is enhanced by the agenda $\mathcal{A}^*$. In this example, $P(y|T) = .12$ which is less than $P(v|T) = .21$, but the agenda $\mathcal{A}^*$ actually hurts y, that is, $P(y|\mathcal{A}^*) = .09$. Thus, we have an example in which it is not effective strategically to compare a low share product with a higher share product.

Fortunately, we can identify an interpretable condition in which an agenda is effective independent of the specific aspect measures. In particular, if we group the object, w, in a top-down agenda with that object, x, to which w is maximally dissimilar but inferior, the agenda will enhance the probability that w will be chosen. This result holds independent of the specific aspect measures as long as $\alpha_1 > \alpha_2$ and $\beta_1 > \beta_2$. We state the result for a 2×2 factorial structure, but in the supplemental appendix we show it generalizes for an ℓ-level factorial structure and for more aspects.

> *Result 1 (dissimilar grouping):* For the 2×2 factorial structure the top-down agenda, $\mathcal{A}^* = \{\{x,w\},\{y,v\}\}^*$, en-

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[5] Here we loosely interpret "preference" as the EBA probability.

hances the EBA probability that the least preferred object, w, is chosen and diminishes the EBA probability that the most preferred object, x, is chosen. That is, $P(w|\mathcal{A}^*) > P(w|T)$ and $P(x|T) > P(x|\mathcal{A}^*)$.

For example, a campaign that encourages comparisons between black-and-white portable televisions and color console televisions will always be effective for black-and-white portables as long as "color" > "black and white" and "console" > "portable."

We show in the supplemental appendix (result 1.1) that the result holds even if some additional aspects are common to the two dissimilar objects. Thus, a manager introducing a copier, w, which is "just as good as a Xerox" on some aspects and (probabilistically) weaker on all other aspects, say the image of the brand names, could increase w's market share if consumers could be encouraged to compare w with only a Xerox. We recognize, of course, that such a campaign might be effective for other reasons, such as the comparison giving the lesser copier, w, a quality image. Result 1 suggests that the agenda effect reinforces such image effects.

Enhancement of a Greater Object

Anyone familiar with sports tournaments (e.g., tennis, basketball, soccer) knows that "seeding," the selection of the tournament agenda, affects the probabilities of the outcomes. Common belief is that the "right" seeding will lead to the best teams finishing well and worst teams being eliminated early. The "wrong" seeding leads to upset victories.

According to our familiarity hypothesis, we believe consumers tend to use bottom-up agendas when they are familiar with the objects. Our intuitive belief might be that bottom-up agendas are "good" decision rules. That is, they lead to "better" choices in the sense that choice objects with better aspects (higher aspect measures) are more likely to be chosen and "poorer" choice objects (lower aspect measures) are more likely to be eliminated.

In this section we illustrate that such intuition is reasonable; some bottom-up agendas alter choice probabilities to favor choice objects with better aspects. However, just as in sports tournaments, this phenomenon is operant only with the "right" agenda. The "wrong" agenda can be counterproductive and lead to "upsets."

To illustrate the effect of bottom-up agendas, consider the three possible pairing agendas on a 2×2 factorial structure. Following our convention and without loss of generality, we assume $\alpha_1 > \alpha_2$ and $\beta_1 > \beta_2$. The first agenda, $\mathcal{A}_* = \{\{x,v\},\{y,w\}\}_*$, makes the first comparisons with respect to products that differ only on α_1 and α_2. The second agenda, $\mathcal{B}_* = \{\{x,y\},\{v,w\}\}_*$, makes the first comparisons with respect to β_1 and β_2. Finally, the third agenda, $\mathcal{C}_* = \{\{x,w\},\{y,v\}\}_*$, is analogous to top-down dissimilar groupings in that it "seeds" the best product against the worst and the two middle products against each other. Finally, without loss of generality,

assume that $\{\alpha_1,\alpha_2\}$ is the more important aspect pair, that is, $\alpha_1/(\alpha_1 + \alpha_2) > \beta_1/(\beta_1 + \beta_2)$. These assumptions ensure that the EBA ordering is $P(x|T) > P(y|T) > P(v|T) > P(w|T)$.

We first examine the agendas, $\mathcal{A}_*$ and $\mathcal{B}_*$, that are compatible with the factorial structure. Intuitively, we expect the agenda $\mathcal{A}_*$, which encourages first the "easy" comparison (α_1 vs. α_2), to enhance the "good" products, x and y. We expect $\mathcal{B}_*$ to do just the opposite and enhance "upsets," v and w. This turns out to be the case. In particular,

Result 2 (bottom-up agendas): For compatible bottom-up agendas, $\mathcal{A}_*$ and $\mathcal{B}_*$, on a 2×2 factorial structure where $P(x|T) > P(y|T) > P(v|T) > P(w|T)$, doing the easy comparison first (α_1 vs. α_2) enhances objects with already higher probability and doing the difficult comparison first (β_1 vs. β_2) enhances objects with lower probability. That is,

(1) $\quad P(x|\mathcal{A}_*) > P(x|T) > P(x|\mathcal{B}_*),$

(2) $\quad P(y|\mathcal{A}_*) > P(y|T) > P(y|\mathcal{B}_*),$

(3) $\quad P(v|\mathcal{B}_*) > P(v|T) > P(v|\mathcal{A}_*),$

(4) $\quad P(w|\mathcal{B}_*) > P(w|T) > P(w|\mathcal{A}_*).$

To illustrate this bottom-up agenda effect in another way, let us consider the concept of entropy, $H(\mathcal{D})$, for an agenda, $\mathcal{D}$. $H(\mathcal{D}) = -[P(x|\mathcal{D})\ln P(x|\mathcal{D}) + P(y|\mathcal{D})\ln P(y|\mathcal{D}) + P(v|\mathcal{D})\ln P(v|\mathcal{D}) + P(w|\mathcal{D})\ln P(w|\mathcal{D})]$. Entropy measures the uncertainty of the system. High entropy means that the agenda tells us little about choice outcomes. (Entropy is maximized when all choice objects are equally likely to be chosen.) Reductions in entropy can be considered information and should be favored by consumers. See Gallagher (1968) for the general theory and Hauser (1978) for marketing interpretations.

Because $\mathcal{A}_*$ makes probabilities more extreme, that is, closer to 1.0 or 0.0, we expect it to decrease entropy relative to EBA. Similarly, we expect $\mathcal{B}_*$ to increase entropy. Formally,

Result 2.1 (entropy): According to the conditions of result 2, performing the easy comparisons first decreases entropy and performing the difficult comparisons first increases entropy. That is,

$$H(\mathcal{A}_*) < H(T) < H(\mathcal{B}_*).$$

By analogy to sports tournament "seedings," we expect that a bottom-up dissimilar grouping, that is, first matching the "best" product, $x' = \{\alpha_1,\beta_1\}$, with the "worst" product, $w' = \{\alpha_2,\beta_2\}$, would maximize the probability of choosing the "best" object.

As it turns out, the dissimilar grouping agenda, $\mathcal{C}_*$, may or may not enhance x relative to unconstrained choice. However, $\mathcal{C}_*$ never enhances x more than the best compatible agenda, $\mathcal{A}_*$ (see supplemental appendix, result 2.2). This may seem counterintuitive, but it does make good intuitive sense. The first comparison in the

best compatible agenda, say x versus v, is made with respect to the most favorable aspect, in this case α_1 versus α_2. The first dissimilar grouping comparison, x versus w, is made with respect to both aspect pairs, α_1 versus α_2 and β_1 versus β_2. Thus, though $\beta_1 > \beta_2$, the comparison with respect to β_1 versus β_2 dilutes the strength of α_1 versus α_2. According to EBA, x is more likely to be chosen over v than over w. It is not surprising, therefore, that the best compatible agenda is better than the dissimilar agenda. Furthermore, in the supplemental appendix we note that $\mathscr{C}_*$ may actually do worse than unconstrained choice if $\beta_1\beta_2 > \alpha_1\alpha_2$.

In summary, our analyses of bottom-up agendas suggest that marketing managers with superior quality products can enhance the probability that their product is chosen if they encourage consumers to use bottom-up processing strategies and make the easy comparisons first. Result 2.1 also suggests that the consumer who wants to improve his or her decision making with implicit agendas should use a bottom-up agenda and make "easy" comparisons first.

Shared Aspects and Processing Rules

Results 1 and 2 suggest when and how a marketing manager can use agenda effects to the advantage of a product. We can also imagine situations in which an advertising or salesforce presentation can influence consumers to use one or another processing strategy. For example, Tversky (1972a,b) suggests several advertising strategies consistent with EBA.

In this section we focus on the relative strategic effect of alternative processing rules, in particular EBA and GEM. For ease of exposition and without loss of generality, we label the first comparison in GEM with α_1 and α_2. That is, $\mathscr{A}^* = \{\{x,y\},\{v,w\}\}^*$.

For example, let $\alpha_1 = \beta_1 = .4$ and $\alpha_2 = \beta_2 = .1$; then by theorem 3 we know that the EBA and GEM(0) probabilities are equal because the GEM hierarchy is compatible with the aspect structure. What happens as θ increases? Calculating, we obtain

$$P(x|\mathscr{A}^*) = .64 \quad \text{for } \theta = 0,$$
$$P(x|\mathscr{A}^*) = .52 \quad \text{for } \theta = 1/2,$$
$$P(x|\mathscr{A}^*) = .48 \quad \text{for } \theta = 1.$$

Thus, it appears that the more the consumer considers the shared aspects, β_1 and β_2, the lower the likelihood that the "best" product, x, is chosen. As it turns out, for all 2×2 factorial structures, shared aspects are detrimental to the products that are better on the first comparison, x and y, and enhance the products that are worse on the first comparison, v and w. Formally,

> *Result 3 (shared objects):* For a 2×2 factorial structure with the first comparison made with respect to α_1 and α_2, and for $\alpha_1 > \alpha_2$, shared aspects in hierarchical processing, that is, GEM(θ), enhance those objects which contain the weaker aspect (α_2) and are detrimental to those

objects which contain the stronger aspect (α_1). The effect increases as the importance of the shared objects increases, that is, as θ increases.

This result is illustrated in Figure 3. By the equivalence theorem, the GEM and EBA probabilities start the same at $\theta = 0$, but as θ increases, the choice probability increases (decreases)[6] whenever the choice object contains α_2 (α_1), assuming $\alpha_1 > \alpha_2$.

Thus, the manager of the product x, where $x = \{\alpha_1,\beta_1\}$, should discourage the consideration of shared aspects whereas the manager of product w, where $w' = \{\alpha_2,\beta_2\}$, should encourage the consideration of shared aspects. Managers of "mixed" products, $y' = \{\alpha_1,\beta_2\}$ and $v' = \{\alpha_2,\beta_1\}$, may or may not wish to encourage shared aspects, depending on whether the α's or the β's are considered first.

Summary

Agendas and processing rules do affect choice probabilities. By understanding their effects, the marketing manager can begin to generate strategies with which to increase market share. Having explored some of these effects and illustrated our results on 2×2 factorial structures, we leave extensions and generalizations to future research.

DOMINANCE AND REGULARITY

We close our article by showing that agendas can cause two commonly assumed axioms of probabilistic choice theory to be violated. Furthermore, we illustrate that such violations are reasonable and should be expected. The following examples are important because the two axioms generally are assumed to be logical requirements of probabilistic choice models and hence underlie most of the commonly applied models in marketing.

Consider the following four vacations.

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[6]The curvature is as drawn. Second-order conditions are negative for objects containing α_2 and positive for objects containing α_1.

Figure 3
THE EFFECT OF SHARED ASPECTS ON CHOICE PROBABILITIES (θ MEASURES THE IMPORTANCE OF SHARED ASPECTS)
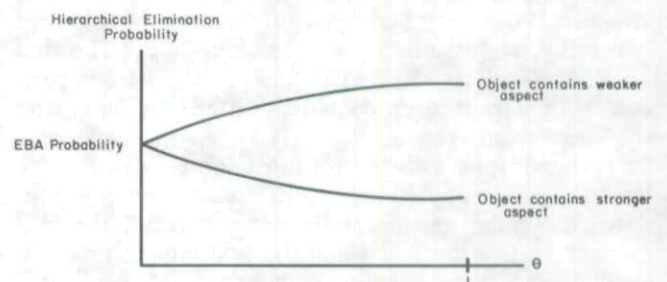
x: Japan via Japan Air Lines (JAL) with free drinks on the plane
y: Japan via Northwest Orient (NW)
v: Japan via Japan Air Lines
w: Hong Kong via Northwest Orient

If a person were choosing from the set $\{x,y,v,w\}$, vacation x dominates vacation v and, hence, we would expect that no rational consumer would choose vacation v. Indeed, with a random access rule such as EBA, the probability that v is chosen is zero.

Such is not the case with agendas. Consider the top-down agenda, $\{\{x,y\},\{v,w\}\}^*$, in Figure 4. Because the right branch, $\{v,w\}$, has unique aspects it will have a nonzero probability of being chosen. Furthermore, v has a nonzero probability of being selected from the branch. Thus, dominance is violated because a dominated object, v, has a nonzero probability of being chosen.

This violation of dominance makes good sense if in January a consumer must choose a tour company and in June must choose which of two tours to take. A rational consumer might choose the $\{v,w\}$ tour company to keep his options open and maintain maximum variety. He then would choose vacation v if in June he decides he would really rather go to Japan than to Hong Kong. He may even feel that the sacrifice of free drinks is well worth the chance to delay his decision on which country to visit. (Such a decision is analogous to the decisions made by business travelers who avoid "supersaver" fares in favor of more flexible regular fares.)

Depending on the aspect measures, we can make this effect as strong as we like. For example, suppose $\alpha_1 =$ Japan, $\alpha_2 =$ Hong Kong, $\beta_1 =$ JAL, $\beta_2 =$ NW, $\gamma =$ free drinks, $\alpha_1 = .94$, $\alpha_2 = .05$, $\beta_1 = .008$, $\beta_2 = .001$, and $\gamma = .001$. With these aspect measures we increase the probability of choosing v from $P(v|T) = .00$ without an agenda to $P(v|\mathcal{A}^*) = .93$ with an agenda.

Agendas also can cause consumers to violate regularity. That is, the probability of choosing an object, say v, can be enhanced by the addition of another object, say w, to the choice set. Consider again the two tour companies. Suppose the first company still offers the two

Figure 4
ILLUSTRATIVE AGENDA IN WHICH A DOMINATED CHOICE OBJECT MIGHT BE CHOSEN

x: Japan via JAL with drinks.
y: Japan via NW
v: Japan via JAL
w: Hong Kong via NW

Japan vacations, $\{x,y\}$, but the second company only offers the one Japan vacation, v. Now both variety and the fact that x dominates v favor the first tour company. Thus, as expected, even with GEM(0), $P(v|\{\{x,y\},v\}^*) = 0$. However, as shown before, if the second tour company adds the option of the Hong Kong flight, the second tour company is favored and $P(v|\{\{x,y\},\{v,w\}\}^*) = .93$. This violation of regularity makes good intuitive sense because the addition of w to the repertoire of the second tour company clearly enhances its desirability.

These intuitive examples suggest that builders of probabilistic models should think carefully about dominance and regularity as fundamental axioms of consumer behavior. For empirical evidence that regularity can be violated, see Huber, Payne, and Puto (1982). However, we note that their experiments appear to exploit perceptual effects, not agenda effects.

DISCUSSION, SUGGESTED EXPERIMENTS, AND EXTENSIONS

Consumer choice behavior is complex. Any attempt to study it requires tradeoffs between full complexity (i.e., modeling *all* phenomena we can postulate) and parsimony (i.e., focusing on specific phenomena to understand their role in complex decision making). In this article we focus on specific phenomena, agendas, and how they influence choice probabilities.

Our contributions are fourfold. First, we define agendas, extend current probabilistic choice models to general aspect structures, and posit behavioral rules to predict when consumers will use implicit agendas. These definitions and hypotheses enable us to study agenda effects within the established paradigms of mathematical psychology and provide a framework for future testing, elaboration, and modification.

Second, we prove three general theorems that relate agendas to the probabilistic choice models (CRM, EBA, and GEM). In particular, CRM, and only CRM, is unaffected by all agendas. EBA is unaffected by compatible factorial structures and preference trees and only by those aspect structures. EBA and GEM(0) yield equivalent predictions if and only if the aspect structure is a factorial structure or a preference tree. These theorems are important because they identify the special invariance properties of CRM and because they identify the special nature of EBA and GEM on preference trees and factorial structures.

Third, we illustrate how marketing managers can use agendas to influence consumers. In particular, our results suggest that:

—managers with a lesser product should encourage consumers to use a top-down agenda grouping "dissimilar" products,
—managers with a greater product should encourage consumers to use a bottom-up agenda making the "easy" comparisons first,
—managers with a strong aspect should encourage consumers to use a random access rule (EBA),
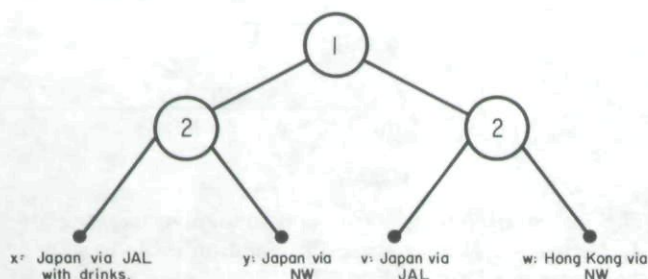
—if consumers do use a hierarchical rule, managers with a strong aspect should encourage consumers *not* to consider shared aspects,

—managers with an aspect that is the weaker of a pair of aspects should encourage consumers to use a hierarchical rule, consider that pair first, and place high weight on the shared aspects, and

—consumers who wish to increase the likelihood that they will choose the "best" product should use a bottom-up agenda and make the "easy" comparison first.

These results on 2×2 factorial structures are indicative of marketing strategies that might use agenda effects to enhance scales.

Our fourth contribution is to demonstrate that two commonly assumed axioms of probabilistic choice can be violated because of agenda effects. Furthermore, such violations are plausible and suggest feasible managerial strategies.

We have developed our theory from a few simple hypotheses. Future research may test our derived implications. By constraining choice and inducing either topdown or bottom-up processing, the clever experimenter can test the empirical implications of our theorems. Alternatively, one can test the familiarity hypotheses by manipulating familiarity and inferring the operant choice rule and implicit agenda through its implied effect on choice probabilities (see Tversky and Sattath 1979 for some pioneering experiments on preference trees). Another empirical direction is testing the relationship of GEM and generalized extreme value (GEV) models (see discussion by McFadden 1980 and Tversky and Sattath 1979).

It is also possible to generalize our analyses. For example, EBA and GEM can be given aggregate interpretations as proportions of consumers (see Tversky and Sattath 1979, p. 552–4). Another generalization would simplify measurement by defining CRM, EBA, and GEM for intensity measures, such as constant sum preference comparisons, rather than choice probabilities (see Torgerson 1958 and Hauser and Shugan 1980 for relevant axioms). One also can generalize the definition of an agenda to a directed graph rather than a tree structure.

Finally, we point out a key limitation of the analysis. All of our theorems and results apply for individual choice probabilities. In many marketing situations consumers differ in the choice rules they use, the aspects by which they define choice alternatives, the importances they place on aspects, and the implicit agendas they choose to follow. Because heterogeneous CRM consumers do not imply an aggregate CRM process, we expect heterogeneity will be an issue in our analyses as well. Segmentation or the aggregate interpretation may be the best means to address this dilemma.

APPENDIX
EXAMPLE CALCULATIONS

This appendix illustrates the probabilistic choice models by providing the detailed calculations for equation 7. We

assume here $x' = \{\alpha_1, \beta_1\}$, $y' = \{\alpha_1, \beta_2\}$, $v' = \{\alpha_2, \beta_1\}$, $w' = \{\alpha_2, \beta_2\}$, and $\mathcal{A}^* = \{\{x,w\},\{y,v\}\}^*$. Without loss of generality we assume $\alpha_1 + \alpha_2 + \beta_1 + \beta_2 = 1$. For notational simplicity we drop italics for aspect measures when such usage is clear from context.

The proofs for the formal theorems and results are available in a 15-page, unpublished supplemental appendix available from the author. Alternatively, request Working Paper #1747-86, "Proofs of Theorems and Other Results: Appendix to Agendas and Consumer Choice," from the Sloan School of Management, MIT, Cambridge, MA 02139.

Elimination by Aspects (Unconstrained)

$$P(w|T) = \alpha_2{}^*P(w|\{v,w\}) + \beta_2{}^*P(w|\{y,w\})$$

$$= \alpha_2\beta_2/(\beta_1 + \beta_2) + \beta_2\alpha_2/(\alpha_1 + \alpha_2)$$

$$= \alpha_2\beta_2/[(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)]$$

The last step collects terms and recognizes $\alpha_1 + \alpha_2 + \beta_1 + \beta_2 = 1$.

Elimination by Aspects (Constrained to Agenda)

$$P(w|\mathcal{A}^*, \text{EBA}) = P(w|\{x,w\})^*[P(x|T) + P(w|T)]$$

where $P(x|T)$ and $P(w|T)$ are calculated with unconstrained EBA. Thus,

$$P(w|\mathcal{A}^*, \text{EBA}) = \left(\frac{\alpha_2 + \beta_2}{(\alpha_1 + \alpha_2 + \beta_1 + \beta_2)}\right)$$

$$\cdot \left(\frac{\alpha_1\beta_1}{(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)} + \frac{\alpha_2\beta_2}{(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)}\right)$$

$$= (\alpha_2 + \beta_2)(\alpha_1\beta_1 + \alpha_2\beta_2)/[(\alpha_1 + \alpha_2)(\beta_1 + \beta_2)].$$

The last step collects terms and recognizes $\alpha_1 + \alpha_2 + \beta_1 + \beta_2 = 1$.

Generalized Elimination Model (Constrained to Agenda)

$$P(w|\mathcal{A}^*,\text{GEM},\theta = 1) = P(w|\{x,w\})P(\{x,w\}|T)$$

$$= \left(\frac{\alpha_2 + \beta_2}{\alpha_1 + \beta_1 + \alpha_2 + \beta_2}\right)$$

$$\cdot \left(\frac{m(\{x,w\})}{m(\{x,w\}) + m(\{y,v\})}\right)$$

$$= \left(\frac{\alpha_2 + \beta_2}{\alpha_1 + \beta_1 + \alpha_2 + \beta_2}\right)$$

$$\cdot \left(\frac{\alpha_1 + \beta_1 + \alpha_2 + \beta_2}{(\alpha_1 + \beta_1 + \alpha_2 + \beta_2) + (\alpha_1 + \beta_2 + \alpha_2 + \beta_1)}\right)$$

$$= (1/2)(\alpha_2 + \beta_2)$$

The last step collects terms and recognizes $\alpha_1 + \alpha_2 + \beta_1 + \beta_2 = 1$. Here we use the notation $m(A)$ to denote the measure of set A. For GEM($\theta = 1$) the measure of

a choice set is equal to the sum of the measures of all of the aspects associated with the choice alternatives in that set. We exclude, of course, any aspect that is shared by all of the choice alternatives in the sets being considered.

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