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Draft (5.0): begun: Jan. 2005

Printed: Wednesday, August 24, 2005

A Cognitive Model of Political and Economic Choice Bearing on the Underpinnings of Prospect Theory[a]

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Suggested Running Head: A Cognitive Model of Political and Economic Choice

a. **Acknowledgments:** We are very grateful for the hospitality shown to us at the University of California, Berkeley, where the Department of Political Science let us enjoy our sabbatical working on this problem. Our conceptualization of the problem, and this paper, were enriched by the comments of Eleanor Rosch. Three other faculty members were especially helpful in developing our understanding of the subject while we were at Berkeley: Steven Palmer in the Department of Cognitive Sciences, and Matthew Rabin and Jordi Brandts in Economics. We are of course also thankful for the financial support of the Social Sciences and Humanities Research Council of Canada, the National Science Foundation (grant #01523490), and the Universities of Maryland and Manitoba for their continued support. Finally, both Roberta Frohlich and Barbara Oppenheimer severely and appropriately criticized preliminary drafts in a kind and constructive manner. Versions of this paper were presented at the 16emes Journées-économie Appliquée à Lyon, France, June 4, 1999 and at the Public Choice Center of George Mason University, Fairfax Virginia, on October 14, 1999. In Lyon, the comments of Professor Levy-Garboua were most helpful. We benefitted richly also from the comments by Roger Congleton, Bryan Caplan, and David Levy. In May, 2003 the paper was presented at a conference on aggregating preferences in Silver Spring, Maryland. Tom Wallsten gave us very useful comments at that time. A revised version of the paper, which included the experimental results was presented at the Meetings of the Public Choice Society, in New Orleans, March, 2005.

Abstract

Over the past 20 years psychologists have found anomalies which challenge standard rational choice theory and have important implications for political and economic theorists. We sketch a cognitive model of choice which offers a theoretical consolidation of the inductively based behavioral theory (prospect theory) which has dominated the recent literature. The model introduces the concepts of multiple representations, vividness and salience; and shows how these interact to modify Tversky and Kahneman's value function. We show how this model provides a cognitive substructure for elements of prospect theory while differing in some of its predictions. We present experimental data which is supportive of the extended cognitive model and discuss some of the implications of this model for political and economic choice.

Keywords: Prospect Theory, framing, decisions, vividness, salience, loss aversion

A Cognitive Model of Political and Economic Choice

Bearing on the Underpinnings of Prospect Theory

For the past fifty years a growing proportion of the theoretical work in political science and economics has dealt with how a rational individual chooses and how those choices determine group outcomes. (Mueller, 1989; Arrow, 1963; Sen 1970). As the theoretical edifice grew taller, examining the foundations became more important. Over time, problems in the foundations were noted and the list of anomalies in individual choice behavior has grown. Some of the most striking anomalies show that an individual's choice can depend on aspects of the environment which, theoretically, should make no difference. By now, lists of anomalies have been published in psychology, economics, political science, and other social sciences (Kahneman and Tversky, 1979, Rabin, 1998; Quattrone and Tversky, 1988; Grether and Plott, 1979; Simon, 1986; Tversky and Kahneman, 1986; Tversky, Slovic and Kahneman, 1990; as well as Shafir and Tversky, 1994).

Despite these problems most theoretical works regarding individual choice in political science and economics continue to be built upon the problematic behavioral assumptions used in micro-economics, and its cousin: game theory. The relative lack of concern about the underpinnings of the decision process in political science and economics has hindered the development of a more inclusive theoretical model of choice: one which could deal with the anomalies which threaten the standard choice model. The notable exception is the work of Kahneman and Tversky (1979), whose prospect theory constitutes the core of what we refer to below as the "Behavioral Model of Choice".[1]

1/ Bendor (1995), and less ambitiously, Machina (1987) offer attempts to change the classic model.

In a recent article, McDermott (2001) laid out the details of Tversky's insights and detailed the broad implications of his ideas for Political Science. She notes (p. 18) in passing, that ". . . one of the oft-noted criticisms of the applicability of prospect theory . . . is its failure to delineate some of the underlying mechanisms of framing effects, which remain one of its central theoretical suppositions." Relying on a few fundamental findings and conjectures regarding the psychology of cognition, here we sketch a plausible "underlying mechanism" that explains many framing effects. The theory we put forward may partially serve to integrate the economic and behavioral approaches. In doing this we claim no leaps of originality. Rather, we stitch together the claims of the psychologists to support many of their findings and provide a possible explanation for a number of the anomalies. Yet our construct leaves some scope for the rational choice theorists by identifying domains where the rational choice models are likely to hold sway. We identify and provide empirical tests of situations where predictions from our model diverge from those prospect theory.

A Behavioral Theory and Anomalies of Choice

A sampling of some major anomalies gives a sense of the breadth of their attack on the standard model. The gain-loss anomaly: (Kahneman and Tversky, 1979) shows how decisions are sensitive to the framing of the choices as either over gains or losses. The endowment effect (Kahneman, Knetsch, and Thaler, 1990), shows valuations to be sensitive to the ownership status of goods. Other anomalous choices are identified in the Allais' Paradox, (Allais 1990, [1953]); and Tversky and Kahneman (1986, p. s265+) find certainty, and pseudo-certainty effects in association with the framing and weighting of chance events. Information processing anomalies have also been demonstrated to be a function of framing. Shafir, (1993). Simonson and Tversky (1992) show choices to be dependent on "irrelevant alternatives" - alternatives which should not affect choices in the standard model. In 1981, Tversky and Kahneman, demonstrated a discount anomaly: the

attractiveness of a fixed monetary discount on merchandise is dependent on the size of the purchase. In addition, a substantial literature exists regarding individuals' inconsistencies regarding time preferences both in economics and psychology (Rabin 1998, p. 39). Together, these (and other) anomalies pose a major threat to the standard model.

Prospect theory, (Kahneman and Tversky, 1979), which attempts to explain these anomalies, consists of two basic assumptions. One posits a valuation function which describes how individuals assign values to prospects around a status quo point (this property is reflected in **Figure 2**, on page 9, below). The operative properties of that function are: concavity above the status quo point, convexity below that point, and a steeper slope of the valuation function below the status quo than above it. The description of risky decisions is facilitated by a second assumption which characterizes how individuals factor probabilities into their evaluations of risky alternatives. The important aspects of that function are non-well-behavedness around probabilities of 0 and 1, and non-linearity of the function.[2] These formal properties of prospect theory explain many of the anomalous behaviors referred to above; indeed, the theory was used speculatively to discover some of them.

Taken together, the elements of the behavioral model may make sense of a number of observed anomalies. But as a set, these theoretical constructs and assumptions ". . . do not form a unified theory, comparable to the rational theory of choice." (Shafir and Tversky, 1995, p. 97). They do not provide an underlying coherent view of how individuals confront and make decisions. The theory is not based on an examination of what is happening, cognitively in the individuals, and hence the findings cannot be deduced from a single model. In addition, the model is, itself, not anomaly free. Many people are often risk-taking regarding gains. Every lottery ticket bought and every bet placed

2/ These two properties imply first that choices will be very sensitive to the status quo point and to which side of the status quo point they lie. Small perturbations to that point can create the anomalies at the heart of many of the behavioral arguments. Second, the non-well-behavedness of probability evaluations around 0 and 1 means that when a very sure bet for x is expressed as a very unlikely bet for not x, we also can get anomalous behavior.

at a casino is particularly striking because the individuals are choosing 'bad gambles' - instances of risk-taking for gain with objective expectations of reward lower than the price. This behavior can only be explained by invoking the "misbehavior, or undefined nature" of the probability weighting function at its endpoints. From a falsification point of view, this is problematic regarding the epistemological status of Prospect Theory.

While we are not in a position to present a fully developed model, we sketch a tentative cognitive model that attempts to define the cognitive mechanisms underlying Kahneman and Tversky's valuation function. Hence our sketch may serve to illuminate whence these diverse behaviors may spring. We also show that some of the anomalies explained by prospect theory can be reconciled via a simplified model and provide experimental data on situations which discriminate between the predictions of prospect theory and our reinterpretation.

Cognition and a Model of Choice

Making Sense of Choice

The behavioral model is structured around carefully observed and replicable, behavior. But it does not rely, *explicitly*, on the findings of how individuals put together a cognitive picture, or understanding, of their environment. We now sketch a perspective integrated with some the cognitive process underlying decisions.

How do individuals cope with their environments? They use prior experience to make sense of the sensory input. They form expectations regarding how their welfare is likely to be affected by their choices, and, *in context*, choose[3] the alternatives that they believe will best promote their welfare. This perspective preserves the maximizing imperative of the rational choice model, although only in

3/ Most behavior, even most selection behavior of alternatives, is not strictly choice. Rather, it is by habit, or learned (i.e. simple internalized rule following). These pose different problems, and we note this, to indicate this is not the problem focused on by any of the arguments being considered here.

a localized fashion, and dispenses with the assumption of fixed preferences. It posits preferences that are dependent on the individual's understanding of the world as the individual encounters the world with new sensory inputs. Hence, we borrow from the behavioral model the notion that those preferences may be a function of how situations are framed (or interpreted). But, we add conjectures about individual perception so as to explain how preferences vary as a function of the individual's encountering of the environment. We go on to show that our view can illuminate additional empirical problems regarding political choice. Moreover, the approach can address some of the normative questions about group welfare that bedevil political philosophy (see Frohlich and Oppenheimer, 1999). Finally, we show that the rational choice model is a special case of this more general argument. Specifically, when certain contextual parameters are held constant, the behavior posited by the rational choice model conforms to the behavior anticipated in the more general model. Hence, many general predictions of behavior are likely to conform to the rational choice model.

The model we propose shares some aspects of the earlier models. Decisions are purposive or consequentialist: individuals make decisions to optimize the outcome for themselves. Hence, choice will be dependent on the value an individual places on any alternative x , $w(x)$. But our characterization of the choice situation differs considerably from that of the standard model.

Our understanding of decisions begins with an individual trying to make sense of an *environment*. The individual receives sensory input regarding the environment, and translates this input into a meaningful mental picture, or model, of the environment. Then to make a choice, the individual compares the consequences of choosing one way rather than other ways. To do all this, the person must organize the sensory information she receives.

More specifically, the brain organizes the sensory input into some *representation* of the environment. The representation of a choice situation will include a representation of the current state encountered as well as choices available in that representation as well as the expected implications of the various choices. In addition, the representation must contain evaluative components regarding the alternatives available. The evoked representation thus defines the situation for the individual; it is all that the individual has as a mental picture.

Since our understanding comes, in large measure, from experienced events, they contain the individual's biographical imprint. The understanding is tied to memories of past encounters encapsulated in a deep repertoire of available representations. For an individual to survive and thrive, her choices must satisfactorily anticipate her expected welfare and this must reflect, to a degree what is likely to happen in the situations. To do this she must have some implicit theories of how the world works in different classes of situations. So there must be something about the processing of the sensory inputs that selects a representation used for understanding the sensory data. That is, there must be a selection of at least one of the representations for use in the individual's thought process.

The Multiple Representation Problem:

Theoretically, individuals could call up more than one representation when confronting a given environment. Clearly, the evocation of different representations would generate different alternatives and/or valuations, and conceivably lead to different choices. To an outside observer this would look like preference reversals or inconsistencies. We now can delineate our task as explaining, "How can we explain a person's choices if, when confronting a given environment, she can have multiple representations, each of which is associated with different understandings and values?" The possibility of more than one representation for a given encounter with the

environment, is one reason framing effects may affect choices and can be evoked so easily. We now elaborate on this process to develop our theoretical perspective.

The existence of multiple representations of a situation raises a number of distinct questions. How many different representations can we attend to at any time? What determines which representation is called forth or evoked? How do we correct or update a representation?

Figure 1 about here

Careful studies of perception indicate that the mental representation of a perceived object at any instant appears to be unique even though we may be aware of the possible ambiguity of any given representation. Consider the Necker cube in **Figure 1** (Gaetz et al.). You probably see the cube in one of two ways: with the front face pointing up and to the left of the page or, with the front face pointing down and to the right. But only one of those representations is apparent at any one time. This is so, even though you may be able to see the ambiguity of the design and even be able to switch willfully between representations. We can be aware that multiple representations are possible but can perceive them only seriatim. As we will actively use this finding in our arguments, we underline its role by restating it as a formal conjecture:

Conjecture 1: An individual can, potentially, have multiple representations of a given choice situation, but can attend to only one representation at any given time.

Given multiple possibilities, how can a particular representation take over our attention? With the Necker Cube it is probably stochastic. In more complex situations where very different representations are possible some underlying factors may give the edge to one representation over another. Recent or repeated prior use of a representation or specific cues linked to particular representations may play roles in advantaging one representation over another. How these might

interact to explain which representation is evoked and how that can affect decisions is a potentially complex story which we begin to tell here.

Attention:

If choosing involves the processing and weighing of information, first information must be received from the environment. Any model of the mental processing of choice must begin with the individual's receipt of information.

Sensory input about the elements of the environment are processed continually (and mainly sub-consciously) as the individual scans the environment and continually encounters the environment anew. Given limited information processing capabilities, she pays attention to only some of the details or elements encountered. What she attends to in this complex mix of stimuli is not easy to predict. Those elements recognized in the environment form the basis of a representation of the situation, fashioned by the individual. This occurs prior to, or while, the objects compete for the attention of the individual.

Given a representation of a situation, the elements are associated with alternatives which hold an expected relationship to her welfare.[4] The individual then chooses in a manner that optimizes her welfare, given that understanding. Continually optimizing relative to her continually unfolding understanding of the environment, the individual behaves in a sort of locally optimizing or satisficing fashion. But this is not to say that the individual makes myopic choices by neglecting longer term consequences and potentially leading to suboptimal results. Rather it implies that the optimization is *relative to the then current representation based on the available information.*

4/ More specifically an individual j attends to representations of elements $\{e_1 . . . e_n\}$ of her environment, E, within an ongoing representation which she has of E: $r(E) = \{r(e_1), . . ., r(e_n)\}$ of the elements in the environment and their relationships. These elements are interpreted via a representation of a situation. The alternatives s_i. in the situation have, associated with them, different expected levels of welfare, or value : $w(s_i[\, r(e|E)])$. The welfare from the alternatives in E will be understood in terms of the representation of the situation. Below we discuss how vividness and salience can affect the perceived welfare associated with the alternatives. .

Paying attention involves focusing the mind on particular details of the environment. What causes some aspects of the environment rather than others to capture the individual's attention and how can attention shift? Although an individual may be able to attend to a small number of different things more or less simultaneously, in general, an individual's ability to attend simultaneously to stimuli is severely limited. Competition for attention comes from stimuli emanating both from the external environment and from her internal world. An individual's attention shifts, at any time, on the basis of processing the sensory and internally generated inputs. This processing results in more or less frequent reevaluations of the environment, and updating of the representation of it. Capture of attention seems to take place via a winner take all process.[5] The process has been modeled as one based on thresholds (Taylor, 1996; Shizgal, 1997) involving filtering continual updates of sub-conscious sensory information, and implies an ongoing adjustment of threshold values.

A Cognitive Model of Choice

We conjecture two properties of any encounter help determine what will be attended to and hence as affecting which values or preferences will surface. The first property is the *salience* of the elements in a choice situation. By this we mean the degree to which an element is linked to possible changes in the welfare of the decision maker. Aspects that are believed to be associated with a greater potential for changing or maintaining welfare are referred to as more salient to the decision maker. Salience of the choice situation may be thought of as the range of welfare associated with the alternatives in the representation evoked. Salience operates to determine attention. Higher

5/ Algebraically, the individual understands her environment, and its elements, via a compound representation r(E). The representation includes an assignment of a potential for changing her welfare to the elements in E. Thus, each element *e*, has associated with it a salience. The salience of an element $\mathsf{F}(e) = w_{max}(s_i[r(e|E)]) - w_{min}(s_i[r(e|E)])$, where w_{max} and w_{min} represent the maximum and minimum evoked values of the alternatives $w(s_i)$ in the representation evoked by e in E. In other words, paying attention to e, $s_i[r(e|E)]$, establishes a threshold which any item has to beat in order to displace e from one's attention.

salience implies higher stakes in the choice and hence a higher demand for attention. The second property of a representation playing a role in choice is the *vividness* of the encounter. Vividness is the amount and quality of the sensory details from the encountered environment. Below, we posit reciprocal relationships between the vividness and salience of objects in an encounter and argue that vividness and salience interact with one another and affect the value attached to the alternatives in the representation.

How do these properties determine what is attended to? Given attention's 'winner-take-all' nature, to displace something else to which one is attending, the new focus of attention must have a higher claim. Attention shifts on the basis of 'what catches the eye'[6] as well as the importance, or *salience*, of the object for the individual. The importance of the objects are inseparably nested in the representation. Damasio (1999, 163-64) describes the process whereby the values associated with previously perceived objects are stored:

> . . .(T)he memory of .. (an) object has been stored in a dispositional form. Dispositions are records which are dormant and implicit rather than active and explicit, as images are. Those dispositional memories of an object that was once actually perceived include not only records of the sensory aspects of the object . . . but also records of the motor adjustments that necessarily accompanied the gathering of the sensory signals; moreover the memories also contain records of the obligate emotional reaction to the object. As a consequence, when we recall an object, . . . we recall not just sensory characteristics of an actual object but the past reactions of the organism to that object.

6/ We seem to be genetically programmed to attend to certain stimuli. Changes, especially those which involve quick movements (especially towards one) and flashing lights seem to capture our attention before we are able to identify the object responsible for the input. Unfortunately, designers of internet ads are aware of this phenomenon.

Based on Damasio's observation, each remembered (i.e. recognized) object has a number of 'emotional reaction' tags associated with it, one of which is called up in any encounter, presumably as a function of the context of other stimuli in that encounter since objects are usually experienced in a context. That context evokes a particular representation with its associated choices (alternatives), outcomes and valuations associated with those outcomes.

The representation which is evoked when we encounter the environment defines the situation one is in. The stakes associated with a particular object (and hence its salience) will depend on the situation defined by that representation. A knife in the kitchen at dinner time will have a different salience than a knife coming through a shower curtain. In an encounter, the salience one attributes to an object is determined by the context provided by the representation - the situation - as the individual sees it. A new encounter draws on the past experiences which have set an object's average affect to determine its salience in that encounter.[7]

Although an encounter yields an initial salience for an item, the salience is frequently update as the individual gathers sensory input. Changes in the salience of an object leads to a change in the threshold that governs what is attended to. So, for example, consider a deer grazing in a field with sheep. At first the deer may be startled by the bleating of a sheep and pay attention to it. After all, this could be a warning of a "predator attack." But over time, the deer re-evaluates the meaning of the noise in a rough updating fashion and pays less and less attention to the sounds: its salience being diminished by the reevaluation (see Palmer, 1999, Chapter 11). So the initial salience does not

7/ The salience of an object in a given representation parallels a phenomenon in quantum mechanics. The "average affect" of an object is the probabilistically weighted average of the affect associated with all stored previous encounters with the object. The evocation of the object within a single representation assigns one of those values (or a mix of them) to the object. The parallel with quantum mechanics is to the collapse of the wave function of a fundamental particle when the particle is observed. Each particle can be defined by its wave function, which is a probabilistic distribution of likely position and momentum. Observation selects one of the possible states for the particle, just as the observation of an object evokes a single representation which assigns the object it a specific salience.

determine whether attention will continue to be paid to an object. Rather ongoing stimuli may lead to different representations that affect the salience of the object.

Relationships between Vividness Salience and Evoked Affect:

So salience is central in determining attention, but attention is only the first step in the choice process. Given a representation, how does an individual come to place an estimate on the importance of an item for her welfare stream? As noted above, the mechanism usually depends on the individual's past experience.[8] The associations and memories we have with objects and their contexts determine their valuations. Situations contain attributes that relate to our memories and experiences. Any encounter with an object or situation will occur with some degree of vividness and the more vivid the encounter, the more vivid the representation.[9]

Frequent and recent use ease the evocation of representations. There is likely to be an indirect link, via familiarity, between salience of aspects of a situation and the vividness of the stored memories of related elements. For example, waiting at the airport as people come off a plane, I may notice each of the individuals and have a vivid (i.e. detailed) representation of them in short term memory as they pass by. But my brother is more salient to me than mere strangers, and so the representation of my brother, whom I have not seen for a year, is likely to be more vivid, and more recallable when recalled in any but the shortest term. Objects of great salience have caught one's attention at previous times. Because they can affect one's welfare significantly they are likely to be stored with more detail. And repeated encounters with the same object increase the details with which the representation of the object is stored in memory. Thus, the components of the

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8/ Why only usually? Because it appears that we have some tastes, such as appetites for sweets and aversions for snakes, which may be genetically passed on.

9/ Note vividness is used in two contexts here: An encounter is more vivid, the more sensory detail it contains (as noted above). But a representation, which is a mental construct can also be more or less vivid, by having more or fewer sensory details or aspects.

environment that have strong ties to our experience are more salient, and more vividly recallable. It follows:

Conjecture 2: Representations involving components which have higher salience due to past experience are likely to have been stored more vividly and hence, give rise to more vivid representations.

In other words, the salience of an object, due to *past* encounters, determines, in part, the vividness of its representation when evoked.

When we encounter an object, myriad sensory inputs such as smells, sounds and other details of the environment enter into the representation and its selection. These can activate links to other representations, which can modify the value of the outcomes linked to the object in the representation without changing one's basic understanding of the situation.[10] A given representation, supported by a given level of sensory input, yields one value for each of the alternatives s_i in the representation at any time. That value will be referred to as the *evoked value* $w^*(s_i)$ of the outcome, since it is dependent upon the particular representation which has been evoked. This process operates through the mechanism implicit in Damasio's description. The stored "emotional reaction" to an outcome is likely tied to various types of sensory data received in past encounters with the outcomes associated with the object. So the more vivid an encounter, i.e. the more aspects of object are represented in the representation, the more links one would expect to find to the stored "emotional reaction" and the larger is the potential expected evoked value, w^*.[11] Put simply, the vividness of an encounter can modify the evoked values associated with the

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10/ A discussion of interlinked representations can be found in Edelman, 1992.

11/ Why potential? Because the differing signals can conflict rather than reenforce one another. See also Nisbett & Ross, 1980 where, on p. 45, vividness is characterized as follows: "Information may be described as vivid, that is, as likely to attract and hold our attention and to excite the imagination to the extent that it is (a) emotionally interesting, (b) concrete and imagery-provoking, and (c) proximate in a sensory, temporal, or spatial way."

outcomes in the representation of that encounter. For example, a black and white photo of the dishes in a prix fixe meal at Chez Pannise will be less vivid than a color picture, than a movie panning over the dishes, than a visit to the restaurant where we see and smell the prepared dishes close up and in three dimensions.

Since different aspects of an alternative may have different vividness, the more vivid attributes will disproportionately determine the evoked value of the alternative in the representation. In sum, vividness is intimately tied to evoked value. This can be restated as a conjecture:

Conjecture 3: The more vivid the encounter of the situation, *ceteris paribus*, the greater the evoked value of the alternatives in the representation.

That is, vividness affects the slopes of the two segments of the value function in prospect theory. Increasing vividness could be expected to make both segments of the value function steeper.

These two conjectures lead to a number of implications. Conjecture 3 implies that choice situations confronted in real life and in full detail will lead to representations with greater vividness and hence greater evoked value than those presented by others either verbally or in written form. So real life encounters will lead individuals to place higher valuations on outcomes than equivalent situations presented by second-hand frames such as verbal or written descriptions.[12]

Although, many of the representations that gain our attention are induced by real life encounters, we can call forth hypothetical or "imagined" states, often related to stored memories or our imagination. Define any such representations as hypothetical states. Real life encounters usually involve a broad array of sensory inputs and can be checked in multiple modalities. Confirmatory *real time* updates of a representation also reenforce the vividness of the representation. Nisbett and Ross (1980, p. 50) note that information obtained firsthand through one's own sensory

12/ Of course, such a report or depiction may be designed explicitly to be vivid (as in novels or movies viz. the battle scenes in Saving Private Ryan) and hence designed to overcome this.

apparatus is more vivid and more likely to exert an impact on one's judgments and inferences than information obtained verbally from a secondhand or thirdhand source. Thus, if we are making a judgement about an object or stimulus, its degree of vividness will be one of the factors likely to affect our judgment about that object or stimulus. Because most hypothetical states accessed via memory are both less vivid and are not subject to the same sort of updating as are live encounters, we deduce from our initial conjectures that:

Implication 1: Outcomes in representations based on hypothetical situations will have less vividness and evoked value than those elements in representations of the same situation encountered live.

In our waking hours, we live with a continuous flow of sensory inputs. Much of the environment remains virtually constant, while some aspects are subject to noticeable or major change. Based on our ongoing inputs, we develop more or less continual reference to representations of many of these aspects of our lives. This gives us representations of where we stand at the moment which are, for the main, robustly tested and well understood. It also means that many aspects of the status quo are continually attended to and as a result of updating are firmly tied to our picture as to how we can protect and improve our welfare. It follows that:

Implication 2: At any given moment, elements of the status quo are experienced more vividly and so representations of objects in them will have greater vividness and evoked value than representations evoked by comparable hypothetical situations.[13]

13/ Of course, some hypothetical states consist of recalls of traumatic or euphoric events of substantial salience. Therefore, in making comparisons of hypothetical and live representations we must invoke a ceteris paribus condition regarding salience by the use of the word "comparable".

This leads us to conjecture that in general the vividness of representations of situations decrease as they diverge from the status quo. *Ceteris paribus*, a situation some distance away from the status quo along any dimension, be it quantity, time, or whatever, will be represented more vividly than a similar situation placed further along that given dimension. Nevertheless, exceptions to this general rule are certainly to be found. For example, certain dramatic possibilities, such as winning the big lottery, may have been often imagined and rehearsed and so may have very vivid details associated with them because of their particular salience. They constitute extremely salient outcomes, with life-altering possibilities. To the extent that a number of such "prominent" situations of high vividness fall along any dimension, one might expect the value function to be steeper in representations involving such highly vivid and salient outcomes. Notwithstanding that, we posit that, in general:

Conjecture 4: Representations of situations at a further distance from the status quo are evoked with lower vividness.

Figure 2 about here

Our conjectures, taken together provide us with a cognitive explanation for the value function of prospect theory. We run through the details of how the shapes of the curves can be derived from the conjectures and then identify points of similarity and divergence between our model and theirs.

Why There Is Decreasing Marginal Valuations of Changes from the Status Quo:

Consider how an individual might evaluate possible changes from the status quo. Imagine two possible gains from the status quo: sq + , and sq + 2, . Each will have associated with it an evoked

value, *w**. To evaluate these two alternatives we must compare their *evoked value: w* as a function of their vividness: v.*[14]

The change from sq to (sq + ,) will be more easy to imagine than will be a similar change from (sq+ ,) to (sq+2 ,).[15] The former is a change from the immediately experienced status quo and a hypothetical situation, the latter the difference between two hypothetical situations. So this latter change will have lower vividness than the former and will have lower evoked value.

In general the evoked value, *w**, will be monotonically decreasing in , at a diminishing rate (i.e. with a negative first derivative) and a monotonically increasing function of vividness. Hence decreased marginal evoked valuation follows from decreased vividness as one moves further from the status quo. In a sense, each , is 'discounted' more by this decreasing of vividness. Vividness decreases monotonically with distance on each side of the status quo as one moves along any single dimension of change. This leads to marginally decreasing evoked value or decreasing marginal valuations in both directions. This can be seen, visually, in **Figure 2** which is simply a representation of Kahneman and Tversky's valuation function.

Were this the entire story, gains and losses would be similar. After all, we have introduced nothing to say that *w**(,) is different in moves in either direction from status quo. But, our conjectures imply that the function is asymmetric around the status quo.

Why Preventing a Loss Is Valued More than Getting an Equally Large Gain:

14/ This is a special case of the more general formulation above. See footnote 4. In each case here we keep , (and hence F) constant.

15/ We say "ceteris paribus' because some alternates far from the status quo, such as a big lottery win, or the destruction of your house by fire or flood may present vividly because they are easily imaginable for a number of reasons (including experience - perhaps vicarious - with disasters or large windfall gains). It should be understood that we are not asserting this rule of decreasing marginal valuations as a substitute or replacement for the generalization in economics of decreasing marginal returns and valuations.

Figure 2 depicts valuations of losses as being different from valuations in gains. Since we have a more vivid tapping of the status quo than we do of a hypothetical state any element in our current inventory is likely to be encountered vividly. Consider contrasting the loss of an item x from the status quo with some value $w(x)$ and the potential gain of an object y with an equivalent value $w(y)$. Since x is encountered *live* it is more vividly represented than y, which is encountered as a hypothetical. It follows from our argument above that the absolute value of the evoked value of x, $w^*(x)$, is greater than the absolute value of the evoked affect of y, $w^*(y)$. Hence, the loss (*evoked value*) of any item from the status quo would be greater than the gain of an equivalently valued item.

Figure 3 about here

This argument explains why individuals would be risk averse with regard to gains, and yet risk takers with regard to losses. With marginal valuations of changes decreasing in either direction from the status quo, a gamble, such as one of losing 2, with a probability of ½ is not as bad as losing , for sure (see **Figure 3**). And with gains, the reverse will be true: gaining 2, with a chance of ½ is not as good as gaining , for sure.

This asymmetry is consistent with the model of Tversky and Kahneman. Rabin (1998) gives a hint at the relative size of the asymmetry. As he puts it (p. 14), "people value modest losses roughly twice as much as equal-sized gains."

The consequences of these last two arguments (decreasing marginal valuations around the status quo and losses being more vividly experienced than gains) leads to statistically observed evaluation functions as in the graph. In any case, this would help explain the experimentally observed finding

that losses are felt more intensely than gains.[16] Put simply, losses are of real things experienced *vividly,* while potental gains are of hypotheticals, experienced less vividly.

This asymmetry has been noticed and capitalized upon in the political and economic arena. It has long been noted that individuals react much less strongly to income tax deducted at source than they do to having to pay a large lump sum payment from received wages at tax time. Politicians in virtually all democratic societies deduct income tax at source. The "loss" is then of what we have called a hypothetical: money you never really got your hands on. A similar comment can be made of the problem faced by unions who must often fight to have membership based on an opting out basis if they are to survive.

Cues and Frames:

To understand how one representation may dominate another in the individual's perception, we introduce the concepts of *cues* and *frames*. Frames are the stimuli that lead the individual to call up one from a set of possible representations. Hence, a frame can be understood as the particular subset of aspects of a situation which grabs one's attention and directs it, selectively, to evoke a particular type of representation. A frame generates a characteristic response to a subset of the aspects or stimuli in an encounter and can consist of a particular verbal description, or a depiction, of a situation. Often (as in experiments) the frame is constructed and communicated by others.

In the rational choice model, informationally equivalent frames (i.e. one's with the same information about alternatives and consequences) should lead to the same decision. In that model, preferences are fixed and based solely on consequences. In that model if F and F' are

16/ If most of the time species have found themselves in fragile ecological niches where their survival as individuals was marginal so that losses would be costly indeed, it would follow that evolutionarily we should be programed to weigh losses more heavily than equivalent gains. Note also the likely extension of this dislike for losses to our simian relatives who can be caught in a monkey trap by putting a desired object in a trap which allows an empty fist in but does not allow a full fist out! One of the authors recently was surprised to see his newest grand niece (23 months) engage in just such determined holding behavior with a plastic toy.

informationally equivalent frames, then the choices made in the situation depicted by those two frames are expected to be the same. However, a shift in representation, generated by the descriptive (semantic) difference between informationally equivalent frames can create anomalies and hence the problem for the rational choice model (see the discussion of invariance and depiction in Shafir and Tversky, 1995). Different frames may evoke representations that involve both different evaluations and different choices. Framing is the mechanism that can lead to behavior anomalous with the rational choice model.

How do frames evoke different representations? Some frames may contain identifiable components or aspects that are effective in invoking a particular type of representation. These aspects or parts will be referred to as "cues." So sets of cues constitute frames. There will likely be significant variance across individuals as to what will act as cues since those aspects are a result of the past experiences of the individual. Nevertheless, we presume that there may be enough uniformity across wide swaths of human experience that some stimuli will act relatively homogeneously as generic cues. The notions of "loss" as opposed to "gain" seem to be cues of this latter type and may invoke characteristically different representations. Indeed, there may be a variety of commonplace contexts which have characteristic representations associated with them. Market interactions may have characteristic representations and cues such as the words "buy" or "sell" may call up a market representation. Hence, a cue such as "buying", embedded in the frame of an experimental presentation of a situation, is likely to be effective in evoking a market oriented representation. (Roth, 1995).

With these conjectures in mind, we can begin to show how the model we propose covers many of the anomalies addressed by prospect theory, how it differs from that theory, and how we propose to perform critical tests between the two theories.

Covering Some of the Anomalies and Differences from Prospect Theory

Our model justifies, or explains, an equivalent of prospect theory's 'valuation function.' It does not, however, provide a justification of their probability weighting function.[17] If we presume that as well, the enhanced cognitive model presented here "explains" all of the anomalies to the standard economic model that are explained by prospect theory. But our model furnishes additional insight and explanations of some anomalies not well covered by prospect theory. We sketch these similarities and differences and then outline possible tests of our differences with prospect theory.

Some Anomalies Covered by Both Theories

Preference reversal anomalies equally well covered by both prospect theory and our theory. The framing of pairs of gambles as losses or gains obviously relies on our shared value function for explanation. Similarly the Allais Paradox (Allais, 1990 [1953]) and the certainty and pseudo certainty effects which Kahneman and Tversky derived from the Allais Paradox (Tversky and Kahneman, 1986).

Then there are a few anomalies that have 'more complete' explanations with our model. For example, there are only nuances of difference between the way the discount anomaly, (Tversky and Kahneman , 1981) is explained by the two models. The cognitive model suggests that a decision could be made based upon a representation in which one imagines oneself at different levels of the value function than the status quo. This explains why a $5 discount on a $15 item may have more evoked value v^* than a $5 discount on a $150 item. Prospect theory requires an assumption that individuals always evaluate choices from the status quo, but sometimes have difficulty readjusting their status quo points, and really decide on other portions of the value function. And the

17/ We might, however, note in passing that the ill behavedness (undefinability) of the probability weighting function at *very low* or *very high* probabilities may have a loose explanation linked to our model. As a species and as individuals, we simply do not have a great deal of salient experience with *very low* or *very high* probability events. Hence, those sorts of situations are not easily (consistently?) represented in our cognitive representations.

endowment effect is certainly explained by the curvature of the valuation function, but our model offers a reason for the difference in the curvature at the status quo: the increased vividness of that which we literally possess.

Other anomalies, such as the information processing anomaly, Shafir (1993) and Shafir and Tversky (1995), and the effect of irrelevant alternatives anomaly, Simonson and Tversky, (1992) are explained somewhat differently by our two models. Shafir and Tversky (1995) note inconsistency in a pair of choices "awarding"or denying" custody of a child, this violates "procedural invariance" and can be explained by the compatibility of the features of the parents compared to the instructions. While we would not disagree with that characterization, from our perspective these results can be accounted for by the nature of the representations called up by the differing instructions. The words "award" and "deny" in the different instructions act as cues which call up representations based on different underlying scenarios and hence with different evoked values attached to the attributes of the parents. The "award" condition evokes a representation in which positive attributes are more vivid and hence have a higher evoked value in the evaluation. The "deny" condition does the same for negative attributes.

Our perspective also casts some light on why subjects show increased willingness to choose a Cross pen rather than take $6 when a cheaper pen is introduced as an irrelevant alternative (Simonson and Tversky, 1992). Again we rely on the vividness of the representation evoked by the two situations and its effect on evoked value as well as the evocation of possibly different representations based on different underlying conditions and cues. When a subject is faced with a choice between a Cross pen and $6 the representation called up arguably has the pen and the money represented with equal vividness. The choice is between the Cross pen (which can be evaluated in terms of its usefulness in a number of hypothetical situations) and $6 which can also be evaluated in

terms of its alternative uses. When, in the alternative treatment, two pens are presented as options, two of the three alternatives are pens and "pens" as a category are more vividly represented than in the other treatment. "Pens" are represented by two representatives of differing quality, with the vividness now underlying the salience of quality of pens. It is as if the representation is skewed to the notion, "Oh! We're looking at the quality of pens!"[18]

Time Preferences and Weakness of Will:

The vividness of an encounter and the attendant higher evoked value can be used to explain both inconsistent time preferences and weakness of the will. Rabin (1998, p 39) gives an example of how an individual, on a given day, may be willing to postpone a 10 hour aversive task for a day at the cost of an additional hour's work the next day in order to enjoy today's pleasures. Yet the same individual, asked whether she would rather do the task for 10 hours a few months from now or for 11 hours a few months plus one day from now would opt for the former. From our perspective this is explicable in terms of the relative vividness of the status quo and the indeterminate future. We have argued that the status quo, (the here and now), is more vivid, hence represented more strongly, and hence valued more highly than an equivalent state in the future. Vividness falls off along any dimension of hypothetical evaluation - including time. This step flows naturally from the assumptions of the cognitive model but not so easily from prospect theory.

In a choice involving two time periods, the cognitive model gives us leverage. Consider today's decision: the loss of current pleasures loom large. This loss is at the steep part of the loss curve, just to the left of the status quo. The gain from doing the work today is the hypothetical pleasurable activity of an additional hour's free time a day from now. It is presumably less vivid, and so has a

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18/ This conjecture is testable via a modification of their experiment which introduces into the pen/$6 choice, another money alternative - say $3. If our characterization is correct, we would expect lower numbers of subjects to choose the pen in that treatment.

lower evoked value. Under a variety of reasonable valuations it may well fail to outweigh the loss that would be suffered by foregoing today's pleasures. Of course there is nothing absolute about this. It is all a matter of the relative value of today's pleasure versus tomorrow's cost. Were the price of the delay an additional day of work, today's pleasure might not outweigh and the task might be performed. The outcome turns on the relative steepness of the loss as a function of time, the difference in the costs of procrastination and the relative steepness of the gain function.

However, when one contrasts this decision with a similar decision with alternatives several months hence, the force of vividness in reversing preferences is clear. One's activities several months hence are neither determinate nor vivid. There is virtually no difference in one's conception of what one might forego 90 versus 91 days hence in the way of pleasurable activities. In terms of the value function expressed over time, the curve is very flat. Hence it makes perfect sense, today, to agree to do the task 90 rather than 91 days hence to save an hour's labor. There is no loss commensurate with today's pleasure that one can envision 90 days hence.

The previous example, characterized as inconsistent time preferences, can be seen as an example of weakness of the will. The vividness of the encounter with the seductive immediacy of objects of desire plays a major role in an individual's decision to succumb to temptation. To use the classical example, Ulysses, before he encounter's the Sirens, has a relatively weak representation of their charms, relying as it does, on second hand accounts. Yet he can imagine a contingency in which, under a more vivid representation: hearing their call and seeing them, he might choose to be seduced. His preferences are a function of the vividness of the encounter. He is, in that sense, in exactly the same situation as the dieter who knows that eating the first peanut will change the evoked value of the peanut eating experience and probably make it impossible to stop at one.

The four conjectures enunciated above, along with some ancillary hypotheses, can be used to develop the sketch, promised above, of a cognitive model of decision making.

Figure 4[19] summarizes the process of choosing we have sketched. An individual receives sensory input from an encounter. The individual's representation of the situation is in part determined by cues and frames. The salience and vividness of various aspects of the encounter help determine the evoked representation and the evoked value of the alternatives. The representation embodies the evoked values and yields weights w_i associated with alternatives s_i. Based on those values the individual chooses the alternative of highest value.[20]

Test implications

If the model we are proposing were to coincide in its predictions with those of prospect theory, the cognitive model would add no empirical content to the explanations of prospect theory even though we would be offering an explanation of its value function. But there are some testable differences between prospect theory and the cognitive model. It follows directly from Conjecture 3 that two presentations of a choice to an individual, one less vivid that the other, should lead to different levels of evoked value. Thus the two presentations might yield different choices. Prospect theory is mute on this point. Below we describe a series of experiments that distinguish between the theories. The experiments also gave us a chance to clarify the relationship between vividness and salience.

Experiments Testing Prospect Theory vs the Cognitive Model

19/ We are indebted to Robert Folger and Linda Skitka for the their development of this graphic interpretation of the problem.

20/ Of course, a choice represents a conscious decision. Other actions are undertaken by individuals with little or no conscious attention being paid to the choice. But the representations which may underlie the actors decisions regrading the actions are not necessarily consciously thought about (although, individuals may at times make special efforts to manipulate this foundational aspect of their choices).

To test for the effects of vividness on the value function, two experiments were run with students who were recruited at the Asper School of Business at the University of Manitoba. The experiments each had two treatments which varied with regard to the vividness of the choices presented. The vividness pertained to the objects with which the subjects were endowed and which they could sell back to the experimenter. In the first experiment, the endowment was a coffee mug. In the second, the object was a digital camera. Those two objects varied in their salience

In the vivid treatment involving the mugs, 71 students were given a coffee mug and asked to write down the minimum amount for which they would be willing to sell it back to the experimenter. In the non-vivid treatment, 80 students were given a voucher for the same mug with a color photo of the mug on it while a representative mug was placed at the front of the room. In both conditions the maximum acceptable sale price was set at $12. Subjects were told to record their minimum price for selling the mug back to the experimenter with the knowledge that whether or not the sale took place would be determined by a roll of two dice. If the number rolled exceeded the selling price, the subject would sell the mug back at the price they had written down. If not, they kept the mug. The hypothesis was that those subjects who had the mug in hand would experience it more vividly (touch, three-dimensionality, etc.), and would therefore have higher evoked values. They would therefore set higher reserve prices for the mugs than those who merely had color photo vouchers. We were wrong! There was no statistically significant difference in the reserve prices set by subjects in the vivid treatment (with a mean offer price of $9.14) and the non-vivid treatment (with a mean offer price of $9.90; $t = 1.699$; P [one tailed, but in the wrong direction] = 0.091).[21]

This seemingly falsifying result was discouraging: it led us to place the theory on the shelf until a year ago, when one of the authors of this paper, Najam Saqib, then a Doctoral student, came upon

21/ Indeed, the marginally insignificant result was in the wrong direction.

our draft paper and proposed an alternative explanation for our data. He noted that our mugs experiment involved very low stakes, and that accepted cognitive models in the field of marketing posit that when consumers (subjects) confront a purchasing decision which is not involving, (roughly translated into low salience in our parlance) they do not process the situation with high cognitive elaboration (Kisielius and Sternthal, 1986).

Kisielius and Sternthal attempt to explain the variable effect vividness has on attitudes. They conjecture that the variablity comes from 'available-valence.' Building on findings of others (for example Taylor and Thompson, 1982, show that vividness need add neither to persuasiveness nor to impact), Kisielius and Sternthal conjecture that vividness is mediated by memory. How does vividness impact attitudes? The value judgements are formed by memory operations (p. 420) that depend on the degree of favorable available information (related to our concept of salience) in memory: specifically, how tied a concept is to multiple associative paths in memory. Saquib conjectured that this interaction may have explained the lack of effect of the vividness treatment and proposed a complementary experiment with objects of higher value or salience (we then used digital cameras).

On this basis, we fleshed out our conjectured relationship between vividness and salience and proposed:

> *Conjecture 5*: that the vividness effects of an object or outcome on judgement is likely to be more robust if an individual is highly concerned about the product or stimulus, i.e. if the object is more salient.

Our proposition, while not exactly same as explanation given by Kisielius and Sternthal and Thompson and Taylor (1982), is very close to the ideas they propose. When individuals are considering highly salient decisions under vivid conditions, they are likely to elaborate more

extensively upon the given information than in low vividness situations. But the same would not hold under conditions of low salience. Thus, we propose that vividness affects evoked value and choice variably as a function of salience. In the low salience condition, we expect weaker vividness effects, because individuals do not elaborate extensively upon the given information. From considerations such as these, we predicted that in a choice situation involving objects of higher salience, subjects' valuations in the low vividness conditions would be lower than they would be in the high vividness condition.

Accordingly, we ran new high salience experiments involving digital cameras. In which subjects were placed in either a low or high salience treatment. In the low vividness treatment, forty-five subjects, in groups of five, were presented with a manual for the camera and were told that there was a 5% chance that they would win the camera in a random draw. They were asked what minimum price they would be willing to sell the digital camera if they were one of the winners of the camera. A representative camera was placed at the front of the room. In the high vividness treatment, the same number of subjects, again in groups of five, were each given an actual camera to hold and manipulate for a few minutes prior to making their decision. In this experiment, the data supported the hypothesis that vividness, in a situation of high salience, would affect valuation. On average subjects in the vivid condition for the digital camera demanded a significantly higher selling price (with a mean offer price of $196.62 versus a mean offer price of $175.13 in the less vivid condition: $t = 2.18$; p [one tailed] $< .02$). This stands in contrast to the experiment the coffee mugs. So, it appears that salience and vividness interact in a manner foreshadowed but not completely articulated in Conjecture 2. Vividness does matter. It can increase the slope of the value curve, but its impact is attenuated in low salience decision situations.

Discussion

We view the cognitive model sketched here as providing some underpinnings to the pioneering work of Tversky and Kahneman, and offering some amendments to that theory. The model facilitates the explanation of a number of the anomalies identified elsewhere and previously only explained via a wide range of ad hoc hypotheses.

The value function we use is, in most instances, identical to theirs although we both extend it to time, and place and put a different interpretation on it. However, it appears that each individual may operate with more than one value function: the particular shape evoked being a function of both the vividness of the aspects in the encounter and the salience of the alternatives present in the representation. Vividness and salience play central roles in our model although they are absent in prospect theory. They operate through our hypothesized possibility of multiple representations of single situations. The possibility of multiple representations also furnishes some texture to the intuitive notions of cues and framing enunciated by Tversky and Kahneman in their presentation of prospect theory.

It should also be noted, however, that these relationships are also consistent with findings in the anomalies of time discounting. More proximate (temporal) gains and losses are conjectured, by us, to evoke more vivid representations and hence more asymmetry in valuations in gains and losses, while more distant temporal ones should reflect less asymmetry. Loewenstein and Prelec (1992) enumerate a number of anomalies to the standard model empirically observed and reported by different scholars. The anomaly, referred to as *common difference effect* by Loewenstein and Prelec, violates the constant discounting assumption of the standard model. The authors argue that preferences between two delayed outcomes often switch when both delays are incremented by a given constant amount, whereas, the standard model assumes that preferences in this case do not switch. Loewenstein and Prelec quote an example from Thaler (1981) to support their argument. "A

person might prefer one apple today to two apples tomorrow, but at the same time prefer two apples in 51 days to one apple in 50 days." Rabin (1998) calls it *Time-Variant Preference*. This anomaly observing time variant preference implies that the discount rates should decrease with time delay over which they are estimated, rather than stay constant as assumed by the standard model. Our model explains this anomaly.

The theory itself, at this point, is obviously preliminary and in need of some refinement and additional testing. But it does offer some possible refinements of prospect theory and, in doing so, evokes two general implications regarding classical rational choice and political theory.

First, the standard rationality choice model, simple, elegant and decisive, is not liable to be replaced with a generally applicable theory that is as simple and manipulable. If the argument is right, the rational choice model will predict choice behavior well whenever the chooser attends to the problem using a single representation of the choice situation because no other representations compete for attention. Under those circumstances the causal model descriptive of the consequences of choice and the values attached to those consequences remain constant because of their appearance in a single representation. In oft repeated routine market interactions, for example, we would expect relatively consistent behavior. This is in keeping with a substantial body of experimental evidence in economics concerning behavior in markets (Roth 1995). It would also reflect our understanding of choice in legislatures by professional politicians, etc. where standard rational choice models have performed brilliantly. On the other hand, choice behavior by actors in new and unfamiliar markets and other less used and internalized contexts may not be as stable.

Second, the *normative* power of the traditional model is called into question by the psychological discoveries of framing and preference instability. In the standard model, individuals' stable and consistent preferences are plausibly posited to be an appropriate basis for evaluating their welfare.

But suppose, as seems apparent, that individuals have non-unique preferences in the sense that different preferences over the same choices can be evoked by different framings. Then one particular preference cannot have the strong normative claim that is usually attributed to preferences. It cannot be argued to be a stable 'reflection of the welfare of the individual.' Democratic theory, post Arrow and Downs has centered around the 'aggregation' function of elections and voting. Much has been made of the quality or lack thereof of this aggregation (e.g. see Mackie, 2003). Similarly, most of welfare economics and public policy evaluation calls for some sort of aggregation of individual preferences. But given our caveat that there are multiple preferences, simple aggregating of expressed preferences would no longer need constitute the best measure of aggregate welfare. The normative justification of Paretian optima, democratic results, and utilitarian analyses, become suspect and a deeper analysis of group welfare is required. Democratic procedures and institutions, for example, must be judged not only in terms of how they aggregate preferences, but which preferences they evoke or privilege to aggregate.

Finally, given our affiliation with the discipline of Political Science, perhaps a word is in order regarding the implications of how the model might broaden the scope of Public Choice in politics. There has always been a substantial quarter of resistence among traditional political scientists to the perceived incursion of Public Choice into the realm of political analysis. A frequently heard criticism is that the traditional economic behavioral assumptions are too simple, and/or wrong, and/or inappropriate in politics. Many claim they do not allow for a nuanced analysis of many of the micro-phenomena that can conceivably loom large in political decisions. We would argue that the richer texture of our model may possibly allow for the analysis and understanding of some political phenomena not easily amenable to a traditional Public Choice analysis.

For example, consider the phenomenon of who is the victor in an American Presidential primary election. A straightforward Public Choice analysis of a contest between two candidates in which Candidate A received 48% of the votes and B received 52% would state that the winner was B. But, if B were a frontrunner, and A were considered a very longshot in the primary, the media and the public would not necessarily draw that conclusion. We would argue that citizens evaluating candidates do so on the basis of some sort of status quo expectation level. Results are judged relative to that internalized status quo. Failure to meet or exceed it is viewed as failure. The same is often true of stock earning expectations. Politicians, spin-doctors, and public relations executives know it, and attempt to establish an appropriate set of expectations. A model which allows for more cognitive complexity may be able to capture some of the phenomena not previously amenable to analysis. But a good deal of careful refinement and testing will be needed before we can tell whether a model such as this one will be able to support such explanations.

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Figure 1

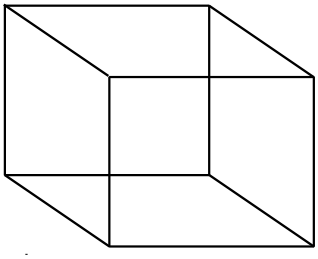

Figure 1: A Necker Cube, which can be perceived as seen from either above, or from below, but not both simultaneously.

Figure 2

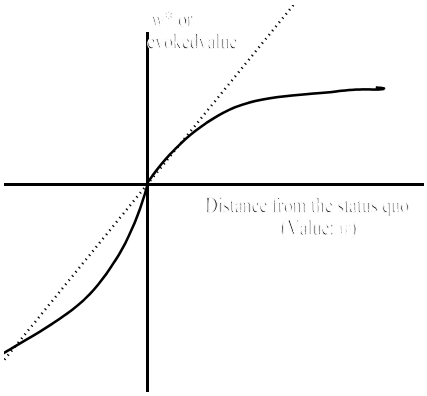

Figure 2: A valuation of changes from the status quo.

Figure 3

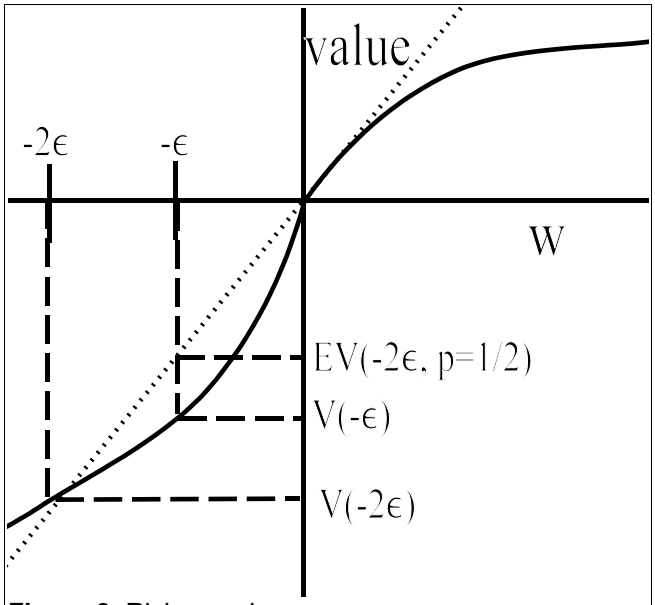

Figure 3: Risk aversion

Figure 4

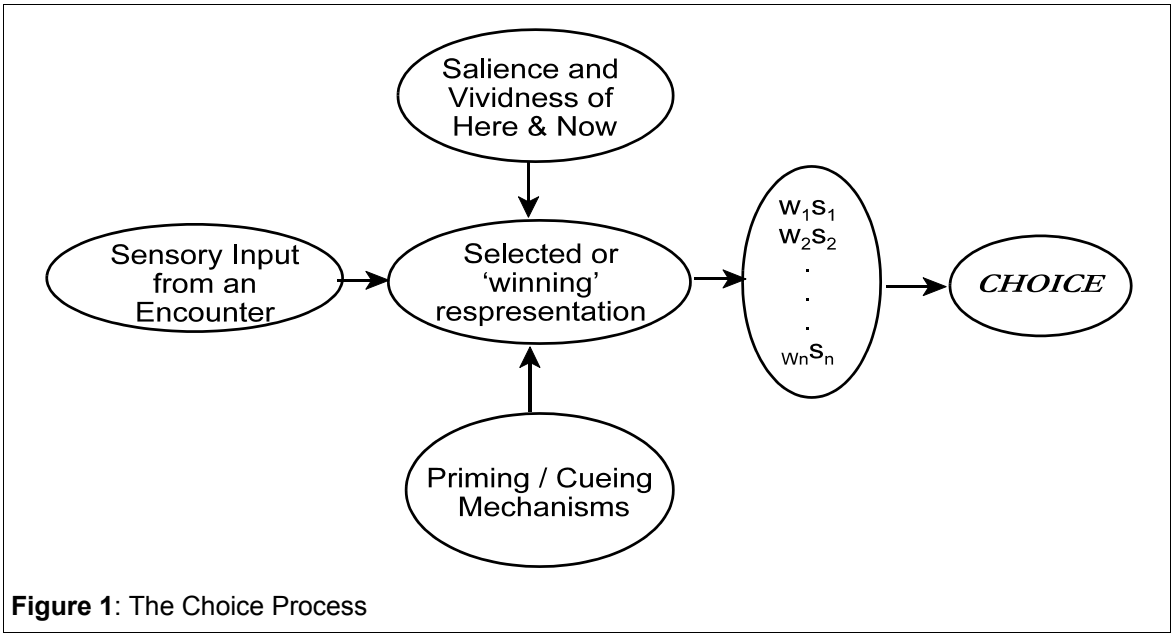

Figure 1: The Choice Process