WORKING PAPER 2014-04-crc
Revision date: May 2014

Aspiration Models of Committee Decision Making

Bernard GROFMAN
Center for the Study of Democracy and Institute for Mathematical Behavioral Sciences, University of California, Irvine

Joseph GODFREY
WinSet Group, LLC

CONDORCET CENTER FOR POLITICAL ECONOMY
UNIVERSITY OF RENNES 1 – CREM-CNRS
www.condorcet-center.fr

Aspiration Models of Committee Decision Making*

Bernard Grofman

Center for the Study of Democracy and Institute for Mathematical Behavioral Sciences,
University of California, Irvine
BGrofman@uci.edu

and

Joseph Godfrey
WinSet Group, LLC
4031 University Drive, Suite 200
Fairfax, VA 22030
http://www.winset.com

Revision May 11, 2014

Very rough draft, not for quotation

*The first-named author's contribution to this research was supported by the Jack W. Peltason (Bren Foundation) Endowed Chair at the University of California, Irvine, the UCI Center for the Study of Democracy and under Social Sciences and Humanities Research Council of Canada (SSHRCC) Grant #410-2007-2153 to study "Political Competition" (co-PIs: Stanley Winer, and J. Stephen Ferris). Portions of this work were carried out while the author was a Straus Research Fellow at the Straus Institute for Advanced Study in the Law, New York University Law School, 2012-13.

I. Introduction

There are many situations, both governmental and private, where choices are made by a small (or not so small) group of people who are picking a single outcome from a set of alternatives by majority rule, and where each voter can be characterized as having a most preferred outcome from this set. In many such situations these alternatives can be characterized as points in some multidimensional issue or policy space, or as allocation vectors that specify a division of outputs among the various actors. How can we predict what choice (what are the most likely choices) the group will make?

There is a huge literature on this question which may, with great simplification, be divided into three approaches: *coalition formation* models, *party competition* models, and *agenda* models. In *coalition* models, the actors bargain among themselves to arrive at a winning coalition (i.e., one containing at least a majority of the voters), usually with an agreed upon outcome.[1] In *party* models, the actors make choices among a small set of alternatives that reflect the candidates/platforms proposed by two or more political parties. In *agenda* models there is a series of votes on alternatives in a finite agenda, sequentially eliminating one or more of them from contention and usually culminating in a final vote against the status quo, or there is an agenda which is not (fully) specified in advance and the process comes to an end through a vote for cloture which, if carried, will lead to an up or down vote on the currently winning alternative. This agenda may either be predetermined (e.g., by an *agenda setter*)[2] or arise as voters propose alternatives to be pitted against the reigning status quo.

In this essay we will limit ourselves to agenda models. Such models are particularly relevant for legislative decision making, whether in a chamber as a whole or in committees, but they also apply to the innumerable private organizations that operate under *Robert's Rules of Order* in the United States or some similar authority in other countries. There are various types of agenda structuring processes which may be used, of which two of the most common are what

---

[1] In such models there may or may not be binding agreements possible.

[2] An *agenda setter* is a term used for the actor (or set of actors) who determine the rule under which voting will take place and the exact sequence of (conditional) votes that will take place (Romer and Rosenthal, XXXX).

is sometimes called *standard amendment procedure* (SAP), because of its use in many private organizations which operate under Robert's Rules of Order or similar rules in English speaking countries, and sequential elimination procedure (SEP). In SAP the agenda is a "king of the hill" type, i.e., where at any given point in time there is a reigning alternative and the next vote is to pair it against some proposed alternative, with the winner (by majority vote) becoming the new (or still reigning) king of the hill. Cloture is reached my majority agreement, in a separate vote. In SEP, there is a (predetermined) sequence of alternatives, and the choice is either to accept the currently proposed alternative (by majority vote) or to reject that alternative and to continue with the process, moving on to accept or reject the next alternative in line, until either some alternative is chosen or we are down to a pairwise vote.

Our aim is to offer new approaches to explaining the outcomes of committee decision making in situations where the actors are free to propose alternatives and the voting rule is SAP. We test these approaches against outcome distributions in five person experimental majority rule spatial voting games conducted under this rule. We lay out two different approaches.

The first looks to particular types of points which correspond to "near core" concepts i.e., concepts that have the property that, when there is a core, they reduce to the core. These points can also be thought of as alternative ways to define the "center" of some set of voter ideal points. The second approach draws on Herbert Simon's concept of satisficing, and on an agent-based approach to simulating committee decision-making processes. [3]

However, before we provide a fuller explanation of these approaches, we provide a brief review of the earlier literature on experimental voting games.

Our understanding of voter behavior under "king of the hill" agendas has been greatly enhanced by the results of a series of experiments on five member committees making choices by majority rule over a two dimensional issue space, with utility functions induced over alternatives in that space. This literature begins with a classic paper by Fiorina and Plott (1978) and includes over a dozen other papers—most done in the subsequent two decades. While these experiments differ in a variety of ways, we simplify by acting as if, in all the experiments whose outcomes we seek to model, preferences were Euclidean and fixed, with voters able to evaluate

---

[3] Our aspiration based model would need to be reformulated were we operating outside the SAP context (see Black, 1958; Ordeshook and Schwartz, XXXX for discussion of alternative agenda procedures), .

the consequences of any choice for their own utility, but with voters unable to communicate with one another or to offer side payments.

The Fiorina and Plott (1978) paper tested different models of voter choice, derived from game theoretic, decision-theoretic, and normative perspectives.[4] Fiorina and Plot (1978: 580-583) divided the models they consider into two main categories, *egoistic and non-egoistic*. The *egoistic* theories "have the common view of decision makers as self-interested maximizers, while the second class, *non-egoistic,* presupposes that committee members look beyond their individual interest to some type of collectively optimal, or consensus outcome." They divided egoistic theories further into four classes: game-theoretic, voting-theoretic, agenda-based voting-theoretic,and coalition- theoretic. (1978: 580). The experiments initially run by Fiorina and Plott (1978) included both a game with a *core* and one without.[5] We show in Table 1 the fourteen distinct models considered by Fiorina and Plott.[6]

<<Table 1 about here>>

Of the fourteen distinct models identified by Fiorina and Plott (1978), more than half could be clearly rejected, while the support for most of the others was limited. And, of the four models for which the most support was found in this paper, which were ones that reduced to the core when one exists, three were largely rejected either by Fiorina and Plott themselves or by subsequent work. The one clear conclusion of the Fiorina and Plott (1978) paper, and one which was repeated in work extending theirs, is that, when there is a *core* to a majority rule voting game, outcomes tend to cluster tightly around that core point. But the remarkable puzzle generated by the experiments in Fiorina and Plott (1978), and reaffirmed in subsequent

[4] While they list 16 models, actually they only have 14 models. One model they consider, the *voting equilibrium*, is identical to the *core*, but has a somewhat different motivation. And they offer two different justifications for considering the set of voter ideal points as a solution concept. Also, some of their solutions lead to identical predictions, so that there are only eight outcomes or outcome sets that they can distinguish among. In particular, in games with a *core* (see below), there are several different solution concepts that lead to the *core*.

[5] In games with an odd number of players, a majority rule *core* is a point that can be expected to get support from a majority in paired competition against each and every other alternative. In majority rule games a core is also known as a *majority winner* or a *Condorcet winner* (Black, 1958).

[6] We label a few of these models in a somewhat different way than do Fiorina and Plott (1978) to better correspond with more recent usage and our own previous work.

experiments, is that, even when there is no core to the majority rule spatial voting game, outcomes are still very well behaved, i.e., highly clustered in the space, and that voters seem to have not much more of a problem finding an agreed upon outcome than they do when the game has a core. The combination of convergence to the core and clustering even in its absence led Fiorina and Plott (1978: 590) to conclude that any successful theory of group voting behavior had "better specialize to the equilibrium/core when the latter exists." However, in the game without a core they examined, one solution concept they tested which has this property, the *min-max set*, "does not do very well" (1978: 590), and another, the multidimensional median, can also be rejected, while for a third solution concept they consider that reduces to the core when one exists**,** the Von Neumann- Morgenstern solution set, their inability to locate this set in majority rule spatial voting games without a core (a problem shared, until now, by subsequent authors) meant that it was impossible for them to test the predictive utility of this solution concept.

Faced with the lack of existing theory to explain their findings, and the puzzle that "the pattern of experimental findings does not explode," in the game without a core, Fiorina and Plott, (1978: 590) "wonder whether some unidentified theory is waiting to be discovered and used". Thus was started a quest for a predictive model that could explain results in experiments on committee voting in agenda games without a core.

In our view, this quest for predictive theory led essentially nowhere for more than a quarter century, leading to a situation in which work on this experimental paradigm of "king of the hill" voting slowed and then stopped, while other areas of experimental political economy where successful predictive models were developed, such as work on auctions, flourished.[7] This situation changed in 2004 with the publication of work by William Bianco, Ivan Jeliazkov and Itai Sened on locating the *uncovered set* in congressional voting over a two-dimensional space inferred from roll call votes, based on a computer algorithm they developed, that allowed for the first time finding (at least approximately) the points which were uncovered in two dimensional

[7] However, during this same time period, considerable predictive empirical power was being demonstrated by game-theoretic models seeking to explain patterns of government coalition formation (see literature reviews in Laver and Shepsle 1994; Laver and Schofield, 2001) and ones dealing with patterns of party competition (see literature review in Adams, Merrill, and Grofman, 2005), but the models developed in these context do not apply to the type of agenda experiments we are considering.

voting situations with a large number of actors. In 2006 came the seminal article by Bianco et al. reanalyzing nearly a dozen canonical experiments on committee voting games, including that by Fiorina and Plott (1978), that demonstrated that 90% of all outcomes in these experimental games were located within the uncovered set.[8]

The *uncovered set* (Miller, 1980, 1983, 2007) is the set of points such that no alternative in the set has another alternative that is both majority preferred to it and majority preferred to all point that it defeats. Another way of defining the uncovered set is as the set of points that beat all other points either directly or at one remove. The Bianco et al. (2006) article represents, in our view, a major theoretical breakthrough in the study of agenda games since the uncovered set is a very general concept applicable to essentially all majority rule games and because it has the nice property that, when there is a core, the uncovered set reduces to the core, and because, for finite "king of the hill" agenda games, it includes the set of alternatives that would be chosen by voters who are engaging in strategic behavior in the sense of Farquharson (Farquharson, 1969; Shepsle and Weingast, 1984; Banks, 1985).[9] Moreover, thanks to relatively recent developments in computer software (Bianco et al, 2004; Godfrey, 2007), for games whose alternatives are specified as points in a two dimensional space, it is now possible to identify the location of the uncovered set for games with large numbers of actors, even though an analytic solution for the uncovered set is known only for the three-voter case (Feld at al., 1987; Hartley and Kilgour, 1987; Miller, 2013).

Several years after the work by Bianco et al., another team of scholars offered a different game theoretic concept to explain outcomes in experimental committee agenda games, the *strong point*. In a majority rule spatial voting game the *strong point* (Owen and Shapley, 1989; Owen, 1995)[10] is the point with smallest *win set*,[11] i.e., the point which loses to the fewest other points.[12]

---

[8] See also Bianco et al. (2008).

[9] However, it also may include some items which are not sophisticated outcomes of SAP. The set of sophisticated outcomes of SAP is a subset of the uncovered set, commonly referred to as the Banks set (Banks, 1985; Miller, Grofman and Feld, 1990; Feld, Godfrey and Grofman, 2013).

[10] See also Grofman et al. (1987).

[11] The *winset* of a point is the set of other points that a majority of voters prefer to that point.

Owen and Shapley provide an elegant algorithm to locate the strong point as a weighted average of the locations of the set of voter ideal points, where the weights are the *Shapley-Owen* scores of the voters. These score measure the proportion of median lines on which the given voter is pivotal.[13] Owen and Shapley (1989) show that, in two dimensional majority rule voting games with Euclidean distance,[14] the sizes of win sets of alternatives in the space fall off as the square of their distance from the strong point and they show how to calculate the size of any alternative's win set simply by knowing the size of the win-set of the strong point and the distance of that alternative from the strong point. For two-dimensional games, Joseph Godfey's WIN-SET computer program (Godfrey, 2007) can calculate the location of many solution concepts, including the strong point.

Godfrey, Feld and Grofman (2011) and Feld, Godfrey and Grofman (forthcoming) look at the same set of games previously analyzed by Bianco et al. (2006) and show that they, too, can explain 90% of the outcomes in these games by positing that voters end up settling on alternatives with small win sets – outcomes that tend to be clustered around the *strong point*. Like the uncovered set, the *strong point* has the nice property that, when there is a core, the strong point is the core.

Because both the uncovered set and the strong point/points with small win sets have shown excellent and virtually identical predictive power in the canonical experimental committee games, it is hard to choose between them. As noted earlier, both reduce to the core when the core exists. The uncovered set is centered roughly around the center of the yolk, the smallest circle intersecting all median line (Mckelvey, 1986; Miller, Grofman and Feld, 1989); but the strong point is located very close to the center of the yolk (Tovey, 2010), and recent unpublished work by Feld and Grofman (2014) suggests that the strong point is always inside the

---

[12] The *strong point* can be thought of as the spatial equivalent of the *Copeland winner*, the alternative which loses to the fewest other alternatives (Straffin, 1980). Saying that there is no core is equivalent to saying that all points have non-empty winsets.

[13] Shapley-Owen scores can be thought of as a generalization to the spatial context of the standard Shapley-Shubik power score (Owen, 1995).

[14] When we posit a Euclidean distance metric, the shape of voter's utility functions are circular, with preference falling off with distance from the voter's most preferred point (known as the voter's *bliss point* or *ideal point*).

yolk, so, when the yolk radius is small, empirically, the predictions of the two theories are, for all practical purposes, indistinguishable.

However, neither Bianco et al. (2006) nor the work by Feld and co-authors (Godfrey, Feld, and Grofman, 2011, or Feld, Grofman, Godfrey, 2014 forthcoming) offer a specific mechanism by which outcomes in the uncovered set or outcomes near the strong point can be generated when voters are choosing from an infinite space of alternatives, although the former offers a very plausible intuition about why we might expect to see uncovered points rather than covered points being chosen, and the latter makes a very sensible claim that alternatives that beat most alternatives are likely to survive a competitive process of pairwise elimination.[15] In particular, neither set of authors offers specific predictions about the nature of the trajectories of choice among alternatives that we might expect to see in games whose agenda procedure is SAP where the sequence of alternatives is generated by the choices of the players.

For comparison purposes, we specify, for the various committee experimental games we examine the two near core concepts that have been highlighted in previous work:

(1) the *center of the yolk*, which the reader will recall is the center of the smallest circle that is tangent to all median lines (McKelvey, 1986; Miller, 2014), and which can also be thought of as (roughly speaking) the center of the *uncovered set*, the smallest set of points which can beat all other points either directly or at one remove (Fishburn, 1977; Miller, 1980; Moulin, 1986; Feld et al., 1987; Miller, 2007).
(2) the *strong point* (Grofman et al., 1988; Shapley and Owen, 1989; Godfrey, Grofman and Feld, 2011; Feld, Godfrey and Grofman, forthcoming) which, the reader will recall, is the spatial analogue of the Copeland winner (Straffin, 1980), i.e., the point with the smallest *win-set*, that is, the point that loses to the fewest other points.

[15] An older paper using simulation techniques, Ferejohn, Mckelvey and Packel (1984), does have a sequential choice process leading both to the uncovered set and to points with small win sets that is, in part, the inspiration, both for the earlier work by Feld, Godfrey and Grofman and that of Bianco and his colleagues. However, the aspiration approach we offer later has very different roots.

In addition we will compare the results in the experimental voting games we review to the predictions of

(3) the *benefit of the doubt point* (*BOD point*), which is the point with the smallest "benefit of the doubt" that will enable that point to defeat all other points; where the "benefit of the doubt," b, assigned to a point is a value such that the point will be preferred by any voter to any point that is closer to the voter's bliss point as long as the difference in distances is less than b units (Feld and Grofman, 1991).

The *benefit of the doubt point* is linked to the concept of a von Neumann-Morgenstern solution set. For three voters, it is identical to the *finagle point*, which is the center of the smallest circle that is a von Neumann-Morgenstern solution set (Wuffle et al, 1989).[16]
The three solution points: the *center of the yolk*, the *strong point* and the *benefit of the doubt point* can also all be thought of in terms of *half win-sets*. The *half-win set* of a point, y, is the set of points you obtain by uniformly reducing each ray in the win set of that point by a factor of ½ (Feld and Grofman, 1991b). The *yolk* is the smallest circle that encloses the half-win set of its center point, i.e., the point whose longest half-win petal is the shortest. The *benefit of the doubt point* is the point whose widest half-win petal is the narrowest. The *strong point* is the point whose half-win set is the smallest.[17]

In addition, for each of the experimental games we review, we will identify

(4) The spatial analogue of the *Borda winner* (Feld and Grofman, 1988).

---

[16] In the Wuffle et al. (1989) article, there is a construction, due to Guillermo Owen, for finding the finagle point in the three voter case.

[17] When the definitions of these three points are stated as above it should be intuitively clear why we expect that they will also be located close to one another. We are indebted to Scott L.Feld (personal communication, 2006) for providing this way of thinking about these three near-core concepts.

Unlike the first three points we identify, the spatial analogue of the Borda winner, like the more usual Borda winner, may not coincide with the majority rule core (*Condorcet winner*) when such exists. In two dimensions, the *spatial Borda winner* is the *center of gravity* of the *Pareto set* (Feld and Grofman, 1988a), and thus also ought be considered a candidate to be called the "center" of the space of voter alternatives.[18]

The first three of these concepts can be thought of as directly responsive to the concluding suggestion of the Fiorina and Plott (1978) paper that we look for concepts that reduce to the *core* when one exists. Thanks to recent developments, both analytically and in computer software (such as WINSET), these points can now readily be located in majority rule spatial voting games in two dimensions, even for a relatively large number of voters.[19] At the time Fiorina and Plott were writing, one of these four concepts had not yet been defined, and even the three that were already well recognized -- the *uncovered set*, the *Copeland winner*, and the *Borda winner* -- the location of these concepts in spatial voting games, even for five voter ones (indeed, even for three voter games), was not known.

While we find the approaches to experimental game outcomes in terms of near core concepts a dramatic improvement over the limitations of earlier models, we are troubled by the absence of a way to directly infer from such approaches clear expectations about the nature of choice trajectories. The new approach we offer in principle allows us to address this issue and is also quite different from most of what has been written about agenda games. Rather than trying to predict (mean) outcomes based on concepts that can be given game theoretic roots in terms of individual optimization decisions, or reduction to the core when one exists, or in terms of concepts of fairness (as per some of the solution concepts discussed in Fiorina and Plott, 1978),

[18] There are other candidates for the "center" of the space of voter ideal points that we have considered, e.g., the *multidimensional median*, the point which corresponds to the median on each axis; and the *mean* of the set of voter ideal points, both of which are among the solution concepts considered in Fiorina and Plott (1978) , but it is the four just identified in the text on which we will focus.

[19] With the exception of the *strong point*, which can be solved for analytically, computer search techniques on finite grids are used to identify the other solution concepts.

we will model voter's cognitive processes in terms of a satisficing decision heuristic involving changing levels of aspiration (Simon, 1957). We will simulate this aspirational process using agent-based modeling (**CITES NEEDED**).

By *aspiration level* we mean the standard that determines which options will be regarded as satisfactory and which will be insufficiently satisfactory for a given actor.[20] In the experimental games we consider, if the current "king of the hill" alternative is valued below the actor's aspiration level, the actor will vote against cloture. We offer a dynamic model (actually, a set of alternative models that we test empirically) to specify how aspiration level changes as the game continues and voters observe the outcomes of previous pairwise contests.

Now we present our own modeling efforts, which will produce a specific type of mechanism to account for observed outcomes, one tied to voter's changing aspiration levels. Each of the mechanisms we consider specifies a particular dynamic process of aspiration level adjustment, based on how many votes have been conducted and /or on the outcomes of those votes relative to the location of th[21]e actor's own bliss point.

In some of these experiments, more general (elliptical) utility functions were used to assign voter payoffs. In operationalizing these mechanisms, as noted earlier, we simplify the framing of the original five-voter experiments, by considering only the Euclidean metric. This can have consequences for the fit of our models.

[20] Our approach to *aspiration lev*el draws its direct inspiration from work by the psychologist Sidney Siegel (see esp. Siegel, 1957; 1959, Siegel and Goldstein, 1959; see also Becker and Siegel, 1958, 1962; Siegel and Fouraker, 1960) which in turn is closely linked to Herbert Simon's idea of *satisficing* (Simon, 1955, .1957, 1972, 1991). See further discussion below.

[21] In follow-up work we hope to drop this assumption, but for now, it was simpler to posit Euclidean preferences, which are easier to work with.

II. An Agent-Based Satisficing Model of Outcomes in Committee Voting Games with "King of the Hill" Agendas

Satisficing

As noted above, most work on experimental voting games has taken some game-theoretic concept such as the core (or core-extension ideas such as the uncovered set or the strong point) as the foundation for its predictions. In contrast, the approach we present in this section will be based on decision heuristics and agent-based modeling rather than game theory. In particular we build on Herbert Simon's (1957) notion of *satisficing*, and we develop a model in which voters begin with some very constrained notion of what is an acceptable solution, what we refer to as an initial aspiration level, and then lower their aspirations as they fail to achieve outcomes located within their original aspiration zone. As voter's aspirations are lowered (in a fashion that is specific to each voter and dependent upon the history of past binary choices made by the group as whole) the probability increases that the current "king of the hill" will be found within the aspiration level of a majority of the voters and thus, upon a motion for cloture, the agenda process will end with this collectively (i.e. majority) satisficing alternative chosen.

This is exactly the kind of *satisficing* process described by Herbert Simon (1957) except as applied to a collective choice setting rather than choices to be made by a single individual. As explained by Simon (1972: 168):

> [I]f the number of alternatives is very large than a choice has to be made before all or most of them have been looked at. … But if all alternatives are not to be examined, some criterion must be used to determine that an adequate, or satisfactory, one has been found. In the psychological literature, criteria that perform this function in decision processes are called *aspiration levels*. The Scottish word "satisficing" (=satisfying) has been revived to denote problem solving and decision making that sets an aspiration level, searches until an alternative is found that is satisfactory by the aspiration level criterion and selects that alternative (Simon, 1957, Part IV). In satisficing procedures, the existence of satisfactory

alternatives is made likely by dynamic mechanisms that adjust the aspiration level to reality on the basis of information about the environment.[22]

Here we adopt satisficing ideas to the group decision-making context, although we approach collective choice through the lens of agent-based modeling of individual actor behavior.

Agent-Based Modeling Protocol

To describe the committee choice process in the voting games we will study, there are seven key elements that must be identified: (1) the voting rule, (2) the nature of the voter's utility function, (3) the space of alternatives, (4) the rule for generating proposals, (5) the information base of the voters, (6) the possibility of communication, and (7) the stopping rule.

In the experimental games we are concerned with:

(1) The voting rule is standard amendment procedure, i.e. sequenced binary choices operating in a "king of the hill" fashion.

(2) The nature of the voter's utility function has been varied, with the three main variants: ellipsoidal indifference curves, circular indifference curves, and the city-block metric, and with payments being recorded in dollars as a function of distance of the chosen alternative from the voter's bliss point.[23]

(3) The space of alternatives has generally been a rectangle with axes simply labeled x and y, though sometime only alternatives on a grid (e.g, integer values) were permitted, thus giving us a finite space of potential alternatives .

(4) The rule for generating proposals has been to start at some designated status quo, usually far from the center of the space, and then allow actors to seek recognition to propose alternatives.

[22] Also see Simon (1991).

[23] For a useful review of types of alternative metrics see Humphreys and Laver (2010).

(5) Voters have not known the ideal points of other players or the compensation other players would receive if they succeeded in achieving their bliss point, and the agenda was essentially unknown in advance, but they do know the outcome of any pairwise vote, and they usually do know which voters supported which alternative

(6) Communication rules have varied across experiments, with no-communication **far** and away the most common, but with communications that are constrained in exactly what information about preferences can be revealed also being used . And

(7) the stopping rule has usually been a motion of cloture requiring only a majority vote, followed by an up-or-down vote on the status quo (the reigning "king of the hill").

In our agent-based simulation:

(1) We assume standard amendment procedure.

(2) We simplify by consistently using circular indifference curves (Euclidean preferences).

(3) We replicate the same rectangular grid used in each given experiment.

(4) We start the game at some voter's ideal point and then allow a pattern of subsequent random recognition of voter proposals.[24]

(5) Agents operate in ignorance of other voter's preferences.[25]

(6) There is no communication among agents. And

---

[24] Voters make proposals based on their aspiration level (see below).

[25] In our model, voters do not attempt to estimate the locations of other voters; rather they react to the information provided by the binary outcomes of the pairwise votes in a Markovian fashion (see below). Thinking about voting outcomes as an information gathering device to allow one to "triangulate" on the preferences of other voters is a potentially important alternative way to think about modeling the processes of decision in experimental voting games where voters begin with limited or no information about the preferences of the other voters, but pursuing that direction is well beyond the scope of this paper.

(7) The stopping rule is that cloture is invoked whenever a majority of the voters agree to stop.

In short, we model these experimental games by adhering reasonably closely to the original protocols, though imposing a somewhat greater uniformity in design than was actually found.

There are four key features of an aspiration-based agent-based model that must be specified. We need to set an initial aspiration level; we need to specify how voters decide what alternative to propose at each stage of the game; we need to specify the rule for adapting aspirations to new information**,** and we need to specify how voters decide when to vote for cloture. In our simulation we assume:

(8) Voters initial aspiration level is a circle of radius zero at their bliss point.

(9) Voters propose the alternative on the line between their ideal point and the status quo that is on the boundary of their aspiration circle.[26]

(10) After observing the outcome of a pairwise vote each voter revises the radius of her aspiration circle upward, but in some models, if the status quo moves toward the voter, the aspiration circle is allowed to shrink.

(11) Cloture occurs whenever a majority of voters have the current status quo as a point within their aspiration circles..

At the heart of our dynamic satisficing story of committee voting are theories about how actors develop lowered expectations over time in reaction to the outcomes they have observed to date.

There are basically three different ways we might think of voters choosing to update aspirations: (a) by simply increasing the radius of their aspiration circle by a fixed amount each time there is a new vote, (b) by responding to outcomes in terms of how far away those outcomes

[26] In future work we will revisit this simplifying assumption and allow for some level of random perturbation, rather than making deterministic predictions..

are from the voters own ideal point (taking the size of the Pareto set as our norming value), and (c) by lowering aspirations (increasing the radius of their aspiration circle) only when they are on the losing side of a vote.

In the simulations reported below we considered only the first two options, as shown in Table 3.

<<Table 3 about here>>

Model 1

(10a) Each voters increases the radius of their aspiration circle by an amount k_1 after each vote, with $0 < k_1 < 1$. Here we have set $k_1 = .5$

For Rule (10a), though this is set up as a dynamic model, it is possible to is possible analytically to solve for the point at which three of the five aspiration circles in each of our experimental games would overlap -- essentially regardless of the value of k chosen (except possibly for lumpiness effects of overshooting).

The second type of rule we consider is based on the second intuition, that voters decrease their aspirations more the further away from their most preferred point is the observed outcome.

Model 2

(10b) Each voter increases the radius of their aspiration circle by an amount that is a fixed fraction of the distance between the current status quo and the closest point on the voter's aspiration circle, with $0 < k_2 < 1$. Here we have set $k_2 = .01$.

III. Results of Agent-Based Simulations Under Two Types of Aspiration Models, with and without the Possibility of a Shrinking as well as an Expanding Aspiration Circle; and Comparisons to Near-Core Models and the Spatial Borda Winner

We show in Table 4 the comparisons between observed mean outcomes in eight experimental games and the predictions of three different near-core models. For comparison purposes we also show in this table the Borda winner and the center of the uncovered set. It is apparent from this table that all the near core outcomes do well, with the *strong point* and the *center of the yolk* and as the best performers. With the exception of one game where the Borda winner does best and the near-core models perform relatively poorly, given the spread of actual outcomes and the small samples sizes, the near core models do amazingly well in matching mean outcomes.

<<Table 4 about here>>

Table 5 provides an empirical test of alternative dynamic mechanisms of aspiration formation by evaluating their predictions against experimental evidence gathered by others. Unlike previous work attempting to understand player behavior in such five person games, we offer models in which the setting of aspiration levels is central.[27] Table 5 shows the outcomes of

[27] We take the preferences over outcomes classified as acceptable or not to be analogous to what we might call *constructed preferences* (*cf*. Druckman and Lupia, 2000). In the experimental games we review, the location of voters determines their preferences over outcomes in one fundamental sense, the farther away from their bliss point the less the payoff they will receive, and yet, when it comes time to proposing alternatives, it may be reasonable, at least from a heuristic standpoin, for players to propose alternatives further away, though still within their current aspiration circle. Thus they are making proposals (and voting or not voting for cloture) strategically, even if the strategic considerations involved are not the fully rational ones of standard economic search models (Kohn and Shavell, 1974). In the context of these voting games the usual rationality assumptions are unreasonable; voters have to learn about their environment and what they regard as the best "possible" outcome for them will change over time, but we posit that they make such "calculations" on the basis of simple heuristics, rather than trying to use past outcomes to probabilistically predict the long run (equilibrium) outcome of many many pairwise votes, or to precisely evaluate alternatives on the basis of the utility

Models 1 through 4-- based on simulations involving only from 1 to 3 runs.. Uniformly Model 4 is best. Though its predictions are not as good as the best near core model, they are respectable.

Note that all the decision heuristics of a satisficing sort we use are very simple, even Model 4. That is a deliberate choice. We wished to see how well we can capture the main features of observed game outcomes with really stripped down algorithms before we worry about more complex models, e.g., models that combine the assumptions of 10(a) and 10(b), or that allow for different behavior when a voter is on the winning side of a vote than when she is on the losing side. The level of predictive success for Model 4, though limited, strongly suggests to us that further work on aspiration models can lead to an improved understanding of committee decision processes.

To better allow the reader to appreciate the differences among the various experimental voting games, Figure 1 illustrates these games graphically, with voter ideal points indicated, and shows the scatter of observed outcomes.

<< Figure 1 about here>>

---

derived from them discounted by some inferred probability that the outcome could become the group choice (cf. Schotter, 2006) .

IV. Discussion

Simon's notion of satisficing is part of his broader emphasis on what he refers to as "bounded rationality," the idea that human beings have limited memory, and limited cognitive capacities, including attention span, that make it unrealistic to suppose that they are successful in finding the "optimal" strategies that, at least until the behavioral economics revolution of past few decades, economists posited for rational actors.[28] Instead, in the bounded rationality view, human being make use of more or less simple heuristics, i.e., information and decision shortcuts, to do well. **Herbert** Simon's (1957) concept of heuristics has proved immensely fruitful, especially in social psychology and political psychology (see review in Bendor, 2010). As noted earlier, our own inspiration for taking an aspiration level approach comes in large part from Simon's work on *satisficing* and bounded rationality, and in part from Siegel's work on aspiration levels, which in turn can be closely linked to Simonian ideas about bounded rationality. However, unlike Siegel and some subsequent authors we do not attempt to link aspirations directly to expectations about outcomes and expected value calculations, rather we treat aspiration level as a heuristic whose value is responsive to unfolding events.[29]

Although there was a spate of work by psychologists following up on Siegel's pioneering (1957) article on the concept of *aspiration level*, [30] the work on this topic has largely dried up in psychology since the 1980s,[31] though there has been a newer literature in economics and in management science on aspiration level that, often empirically linked to experimental games, is

[28] "[T] he capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world—or even for a reasonable approximation to such objective rationality" (Simon 1957: 198).

[29] See details in previous sections.

[30] See e.g. Hartnett (1967); Lopes (1987), Komorita and Ellis (1988); Thompson, and Mannix and Bazerman (1988). However, like the later work by economists this work, too, tends to involve aspirations across a small and finite set of outcomes, and is most often concerned either with individual decision-making or seeks to compare aspiration based theories to other models of individual decision-making, or is concerned with two-person interactions.

[31] Important work done by psychologists since the 1980s that draws on Siegel's ideas about aspiration level includes Lopes (1996) and Lopes and Oden (1999).

just as relevant for our purposes.[32] However, even the recent work on aspiration done by economists, e.g., Napel (1993), Karadikar et al. (1998), Borfers and Sarin (2000), Oechssler (2002), Cho and Matsui (2005), Güth, Levati and Ploner (2012), Hoffman, Henry and Kalogeras (2013) \ ADD CITES, is of limited relevance for the present modeling effort in that

(a) it is about individual decision-making or two-person rather than multi-person games, and

(b) it is mostly about 2x2 games or games with a limited number of strategy choices rather than the essentially infinite set of alternatives considered here. [33]

Similarly, the operations research and management science literature on *satisficing* and *aspiration level* of which we are aware is either purely formal, and not tied to experimental or real world data (see e.g. Vetschera , 1994; Wang and Zionts, 2006), [34] or deals with empirical contexts quite different from voting processes (see e.g., Mezias, 1988; Mezias, Chen and Murphy, 2002). The paper we have found that we regard as the closest in terms of testable ideas that might be adapted to the voting context with which we are concerned is Berninghaus et al. (2011), which asks how salespeople change their aspirations when they find themselves unable to meet previous expectations. FIND ADDITIONAL CITES

There has only been a limited amount of new empirical or modeling work on the *satisficing* heuristic done in political science since Simon's original contributions. Other heuristics such as "cueing" (Downs, 1957; Grofman and Norrander, 1990; Popkin, 1991; Lupia, 1994), "framing" (Kahneman and Tversky, 1989; and a voluminous subsequent literature), or "incrementalism" (Dahl and Lindblom, 1953; Lindblom 1959; Braybrooke and Lindblom 1963; Davis, Dempster and Wildavsky, 1966; Padgett, 1980; Wildavsky, 1986; see also Bendor 1995) have attracted more attention.

---

[32] Here we might remind the reader that Simon's seminal 1955 article on bounded rationality appeared in a leading economics journal, the *Quarterly Journal of Economics*. For a discussion of the links between Sidney Siegel and experimental economics see Innocenti (2010).

[33] Similar features apply to virtually all the work in an earlier collected set of articles (almost all by economists) using the concept of aspiration level: Tietz (1983). **TO DOUBLECHECK**

[34] Palomino and Vega-Redondo (1999), Kim (1999), Davies (2006) and Diecidue and Van de Ven (2008) also fall into this category.

We share with Bendor (2003:433) the regret that, "Although Herbert Simon's work is often cited by political scientists, it has not generated a large research program in the discipline." [35] We agree with him as well that this neglect has been "a waste of a major intellectual resource," and we further agree that "the main challenge to the rational choice research program—now the most important research program in political science—can be developed by building on Simon's ideas on bounded rationality." [36] But the proof of the pudding is in the eating.[37]

In developing models of satisficing behavior that are appropriate to the context of group decision-making in the context of committee voting we see ourselves as taking up a challenge to political scientists offered by Bendor (2003: 443, emphasis added).

> As set out in his [Simon's] famous 1955 paper, the early theory of satisficing was not applicable to many problems in politics. The reason was simple: *Whereas the theory analyzed a single, isolated decision maker, political science focuses on multiperson situations*. There was nothing wrong with the initial formulation being decision theoretic;

---

[35] Once we look beyond the classic sources such as Cyert and March (Cyert and March, 1963), Lindblom (1959, 1965, 1979) and Simon himself (e.g., March and Simon, 1958;see also Simon, 1991) some of the most important recent work by political scientists on bounded rationality, including *satisficing*, has been done by Jonathan Bendor (e.g., Bendor, Mookherjee, and Ray 2006; Bendor, Kumar and Siegel, 2009, Bendor, 2010) and by Bryan Jones (1999, 2001). There is also interesting work on satisficing done by philosophers from a more normative perspective. See Byron (2004).

[36] For rather similar views see Quattrone and Tversky (1988) and a number of the essays in Hogarth and Reder (1987).

[37] As Bendor (2010) points out, here is an ongoing debate between those who see heuristics as involving substantial cognitive biases that lead to flawed decision making (e.g., Kahneman, Slovic, and Tversky 1982; Gilovich, Griffin, and Kahneman 2002; Kahnemann, 2003; see also Nisbett and Ross, 1980) and those who see heuristics in a much more favorable light, including political scientists such Popkin (1991) Grofman and Norrander (1990), Fiorina (1990), Lupia (1994) and Lupia and McCubbins (1998) – see also Miller (1983, 1986); and psychologists such as Gigerenzer and his colleagues (Gigerenzer and Goldstein, 1996; Chase, Hertwig and Gigerenzer, 1998; Gigerenzer, Todd and the ABC Group, 1999; Gigerenzer and Selten, 2001). Bendor (2010) steers an intermediate path. He strongly makes the point that a "mental procedure such as *satisficing* is well matched to certain problem contexts. It may match some so well that it is optimal in those. But other problem contexts will reveal a rule's weaknesses." (See also Cooper, 2000.) In our view the algorithms we propose are well suited to "reasonable behavior" in the context of the uncertainty involved in the protocols in these experimental games. (See later footnote discussing the idea of "constructed" preferences.)

> indeed, one could make a good case, based on an incremental strategy ofscientific progress, that it was exactly the right first step in developing a behaviorally realistic theory of choice. The problem was the discipline's reaction. Instead of treating the theory and its formalizations (Simon 1955, 1956) as work in progress, the first in what should have been a long series of steps, the discipline largely treated it as a finished product. Hence few political scientists in the following decades constructed theories of satisficing more appropriate to political contexts.[38]

One goal of this essay has been taking a useful step in the direction of that agenda, by showing that a satisficing approach can provide a mechanism allowing us to model observed outcomes in experimental voting games involving multiple actors -- a setting where, hithertofore, almost the only models applied, and the only models to have had any success, had been derived from game theory. We regard Model 4, the most complex of our models, but still remarkably simple in form, as a useful beginning, but clearly more work is required before we can develop aspiration based models that have the same level of predictive power as the near core models developed by Bianco and colleagues and Feld and colleagues.

[38]Bendor (2003, with internal citations omitted) continues his explanation of the failure of political scientists to build on Simon's work on bounded rationality as follows: "Worse, even some thoughtful scholars saw the Simon-March tradition [as having] been … thoroughly nonpolitical in its design and development. Given that many saw the formulation as a finished product not requiring active work, while others saw it as apolitical, it is perhaps not surprising that the Simonian program stagnated in political science."

Table 1

The 14 Models Tested in Fiorina and Plott (1978)

MODEL	TYPE	UNIQUENESS	VARIANT	DESCRIPTION
Core/ voting equilibrium	egoistic	unique (if n odd), but may not exist	game-theoretic	point which defeats all other points in paired comparisons
Von Neumann-Morgenstern solution	egoistic	not unique (unless there is a core);	game-theoretic	set of points which is both externally and internally stable (minimal set which defeats all points not in the set)
min-max set	egoistic	not unique (unless there is a core); may consist of disjoint segments	voting theoretic	points defeated by the lowest supermajority
multidimensional median	egoistic	Unique (if n odd)	voting theoretic	point which corresponds to the median on each dimension
top cycle among voter ideal points	egoistic	Usually not unique (unless there is a core, or n=3)	agenda-based voting theoretic	Minimal set of voter ideal oint(s) each of which defeats all voter ideal points not in the set
dimension by dimension median	egoistic	usually not unique because the sequence will matter (unless there is a core)	agenda-based voting theoretic	pick a dimension and find the median on it, then find the median on the line orthogonal to that point

Table 1

(cont.)

MODEL	TYPE	UNIQUENESS	VARIANT	DESCRIPTION
top cycle set	egoistic	With no core, will usually be the entire space	agenda-based voting theoretic	the smallest set such that every alternative in the set beats every alternative outside the set
set of voter ideal points	egoistic	size of the set equals the number of voters	agenda-based voting theoretic	set of voter ideal points
centroid of each minimal winning coalitions (MWC)	egoistic	n(n-1)/2 such points	coalition theories	assumes that voters will (implicitly) coordinate with like-minded others
resource based coalitions	egoistic	centroid preferred by a majority -- unique if no cycles among MWC centroids	coalition theories	coalitions chose the centroid of their members; individuals pick the coalition in which they do best

Table 1

(cont.)

MODEL	TYPE	UNIQUENESS	VARIANT	DESCRIPTION
maximum (summed) value of a MWC	non-egoistic[39]	usually unique	coalitional	coalitions chose the centroid of their members; individuals pick the coalition with highest total value
maximum (summed) group return	non-egoistic	usually unique	collectivist	sum up the payoffs and choose the point with highest sum
mean of the voter ideal points	non-egoistic	unique	fairness oriented	the mean of the ideal points can be seen as a "fair" point
interior point	non-egoistic	may be unique, may not exist	based on psychological considerations	can be seen as the "Schelling" prominent point

[39] We chose to classify this model as non-egoistic though it is classified as egoistic in Fiorina and Plott (1978: 582)

Table 2

Basic Elements of the Four Aspiration Models Tested

	Aspiration circle can only grow	Aspiration circle can both grow and shrink/stay constant
Fixed growth of aspiration circle	Model 1	Model 3
Percentage growth of aspiration circles	Model 2	Model 4

Table 3

More Detailed Assumptions of Aspiration Models

	Model 1	Model 2	Model 3	Model 4
Initial Motion	member selected by uniform random	member selected by uniform random	member selected by uniform random	member selected by uniform random
Motion to Amend	member selected by round robin	member selected by round robin	member selected by round robin	member selected by round robin
Amendment	point closest to SQ on member aspiration circle	point closest to SQ on member aspiration circle	point closest to SQ on member aspiration circle	point closest to SQ on member aspiration circle
Adoption	majority rule	majority rule	majority rule	majority rule
Cloture	majority rule	majority rule	majority rule	majority rule
Aspiration - Preference	Euclidean	Euclidean	Euclidean	Euclidean
Aspiration - Growth	fixed delta	% distance to status quo	fixed delta	% distance to status quo
Aspiration - Delta	0.5 (fixed)	0.01 (percentage)	0.5 (fixed)	0.01 (percentage)
Aspiration - Initial Radius	0	0	0	0
Aspiration - Can Shrink/Not Expand	no	no	yes	yes
Uncertainty – new proposal location	no	no	no	no
Uncertainty – order of recognition	no	no	no	no

Table 4

Comparisons of Mean Outcomes in Eight Experimental Games with Three Near Core Concepts and the Mean of the Uncovered Set and the Spatial Borda Winner

(closest fitting model(s) shown in **bold**)

	Mean Game Outcome	Strong Point	Center of the Yolk	Mean of Uncovered Set	Benefit of the Doubt Point	Spatial Borda Winner/ Mean of Voter Ideal Points
Fiorina-Plott (1978) game with core	(38, 69)	**(39, 68)**	**(39, 68)**	**(39, 68)**	**(39, 68)**	(64, 67)
Fiorina-Plott (1978) game without core	(45, 63)	(49, 62)	**(45, 64)**	(44, 64)	(47, 64)	(67, 65)
Laing - Bear	(85, 57)	**(83, 57)**	(76, 50)	(80, 47)	(80, 52)	(70, 56)
Laing - House	(76, 55)	(90, 54)	(89, 53)	(81, 54)	(86, 54)	**(76, 56)**
Laing -Skew Star	(69, 67)	**(65, 68)**	**(64, 67)**	(66, 52)	(69, 59)	(67, 63)
Laing – Two Insiders	(66, 34)	(60, 36)	(61, 38)	**(61, 32)**	(59, 33)	(63, 47)
Endersby PH 1	(60, 28)	(58, 36)	(57, 36)	**(57, 34)**	(55, 36)	(50, 38)
McKelvey-Ordeshook PH	(58, 37)	**(58, 37)**	(57, 36)	(57, 34)	(56, 37)	(50, 38)

Table 5

Comparisons of Mean Outcomes in Eight Experimental Games with Four Aspiration Models and Best Fitting Model from Table 4

(closest fitting aspiration model(s) shown in **bold**)

	Mean Game Outcome	Aspiration Model 1	Aspiration Model 2	Aspiration Model 3	Aspiration Model 4	Best Fitting Model shown in Table 4
Fiorina-Plott (1978) game with core	(38, 69)	(39, 68)	**(38, 69)**	(39, 68)	**(38, 68)**	(39, 68)
Fiorina-Plott (1978) game without core	(45, 63)	(38, 63)	(44, 74)	(39, 65)	**(42, 63)**	(45, 64)
Laing - Bear	(85, 57)	(60, 55)	(75, 55)	(58, 47)	**(79, 56)**	(83, 57)
Laing - House	(76, 55)	(109, 50)	(93, 52)	(120, 48)	**(90, 52)**	(76, 56)
Laing -Skew Star	(69, 67)	(52, 64)	(56, 62)	(51, 61)	**(56, 65)**	(65, 68)
Laing – Two Insiders	(66, 34)	(67, 22)	(69, 30)	(70, 25)	**(68, 31)**	(61, 32)
Endersby PH 1	(60, 28)	(73, 31)	(58, 35)	(73, 31)	**(59, 34)**	(57, 34)
McKelvey-Ordeshook PH	(58, 37)	(68, 32)	(60, 34)	(73, 31)	**(60, 35)**	(58, 37)

Figure 1

Graphical Representation of Seven of the Eight Experimental Games We Reanalyze

(games without a core)

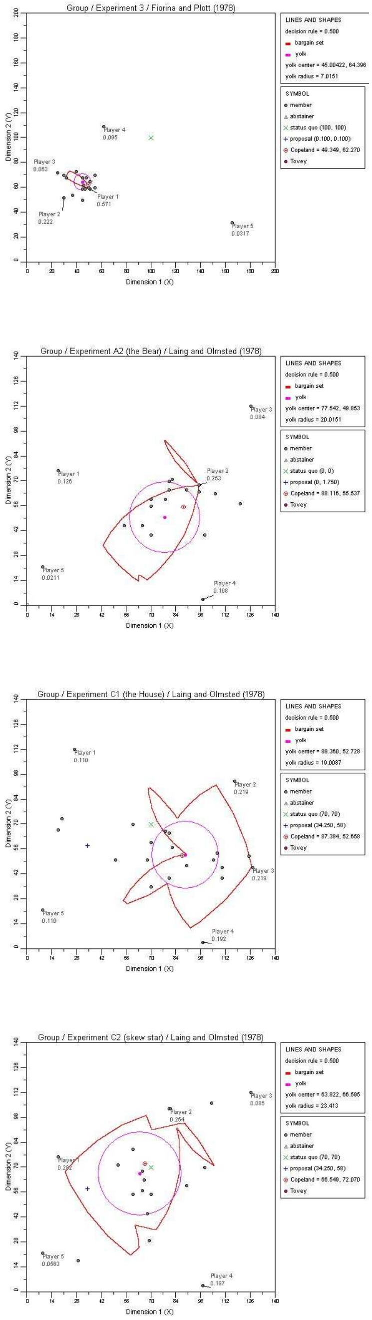
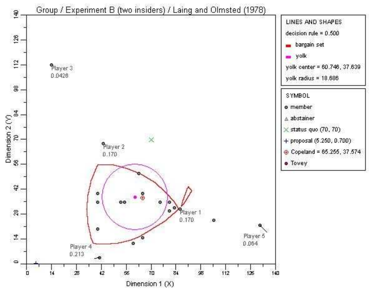
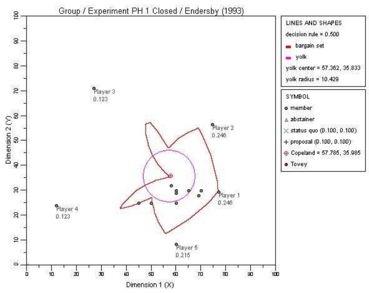


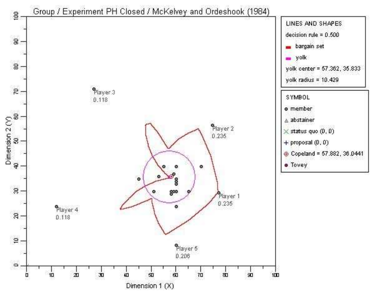
Figure 1

Graphical Representation of Seven of the Eight Experimental Games We Reanalyze (cont.)

(games without a core)







REFERENCES

Adams, James, Samuel Merrill and Bernard Grofman. 2005. *A Unified Theory of Party Competition: A Cross-National Analysis Integrating Spatial and Behavioral Factors*. New York: Cambridge University Press.

Banks, Jeffrey. 1985. Sophisticated Voting Outcomes and Agenda Control. *Social Choice and Welfare* 1(4): 295-306.

Becker, S. W. and S. Siegel. 1958. Utility of Grades: Level of Aspiration in a Ddecision Ttheory Context. *Journal of Experimental Psychology* 55: 81-5.

Becker, S. W. and S. Siegel. 1962. Utility and level of aspiration. American Journal of Psychology, 75: 115-20.

Bendor, Jonathan. 1995. A Model of Muddling Through. *American Political Science Review* 89: 819–40.

Bendor, Jonathan. 2001. Bounded Rationality in Political Science. In N. Smelser and P. Baltes *(Eds.) International Encyclopedia of the Social and Behavioral Sciences*, Amsterdam: Elsevier, 1303–7.

Bendor, Jonathan. 2003. Herbert A. Simon: Political Scientist. *Annual Review of Political Science* 6: 433-471.

Bendor, Jonathan. 2010. *Bounded Rationality and Politics*. Berkeley CA: University of California Press.

Bendor, Jonathan, Sunil Kumar, and David A. Siegel. 2009. Satisficing A Pretty Good Heuristic. *B E Journal of Theoretical Economics* 9(1).

Bendor, Jonathan, Dilip Mookherjee, and Debraj Ray. 2006. Satisficing and Selection in Electoral Competition. *Quarterly Journal of Political Science* 1(2): 171-200.

Berninghaus, Siegfried, Werner Güth, M. Vittoria Levati, and Jianying Qiu. **2011.** Satisficing Search Versus Aspiration Adaptation in Sales Competition: Experimental Evidence. *International Journal of Game Theory* 40**(**1)**:** 179**-**198**.**

Bianco, William T, Ivan Jeliazkov, and Itai Sened. 2004. "The Uncovered Set and the Limits of Legislative Action. *Political Analysis* 12:256–276

Bianco, William T., Michael S. Lynch, Gary J. Miller, and Itai Sened. 2006. A Theory Waiting to be Used: A Reanalysis of Canonical Experiments on Majority Rule Decision-making. *Journal of Politics* 68:837–50.

Bianco, William T., Michael S. Lynch, Gary J. Miller, and Itai Sened. 2008. "The Constrained Instability of Majority Rule." *Political Analysis* 16:115-37.

Black, Duncan.1958. *The Theory of Committees and Elections*. London: Cambridge University Press.

Borgers, T and R. Sarin, 2000. http://apps.webofknowledge.com/full_record.do?product=WOS&search_mode=Refine&qid=15&SID=2BMT9Jo9uNXOiQl6oeE&page=9&doc=84 *International Economic Review* 41**(**4)**:** 921-950.

Braybrooke, David and Charles Lindblom. 1963. *A Strategy of Decision*. New York: Free Press.

Byron, Michael (Ed.). 2004. *Satisficing and Maximizing: Moral Theorists on Practical Reason.* Cambridge: Cambridge University Press.

Chase, Valerie, Ralph Hertwig, and Gerd Gigerenzer. 1998. Visions of Rationality. *Trends in Cognitive Science* 2:206-14.

Cho, In-Koo and Akihiko Matsui. 2005. Learning Aspiration in Repeated Games. *Journal of Economic Theory* 124 (2): 171–201.

Cooper, Richard. 2000. Simple Heuristics Could Make Us Smart, But Which Heuristics Do We Apply When? *Behavioral and Brain Sciences* 23:746- **XXX**

Cyert R. and J .March . 1963. *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice-Hall.

Dahl, Robert and Charles Lindblom. 1953. *Politics, Economics ,and Welfare*. New York: Harper and Row.

Davies, G. 2006. Rethinking Risk: Aspiration as Pure Risk. *Theory and Decision* 61: 159–90.

Davis Otto, M. Dempster and Aaron Wildavsky. 1966. A Theory of the Budget Process. *American Political Science Review*. 60: 529–47.

Diecidue, Enrico And Jeroen Van De Ven. 2008. Aspiration Level, Probability of Success and Failure, and Expected Utility. *International Economic Review* 49(2): 638-699.

Downs, Anthony. 1957. *An Economic Theory of Democracy.* New York: Harper and Row.

Farquharson, Robin. 1969. *Theory of Voting*. New Haven, Connecticut. Yale University Press.

Feld, Scott L. and Bernard Grofman. 1987. Necessary and Sufficient Conditions for a Majority Winner in N-Dimensional Spatial Voting Games: An Intuitive Geometric Approach. *American Journal of Political Science* 32(4):709-728.

Feld, Scott L. and Bernard Grofman. 1988a. The Borda count in n-dimensional issue space. *Public Choice* 59:167-176.

Feld, Scott L. and Bernard Grofman. 1988b. Majority rule outcomes and the structure of debate in one-issue-at-a-time decision making. *Public Choice*, 59:239-252.

Feld, Scott L. and Bernard Grofman. 1991a. Incumbency advantage, voter loyalty and the benefit of the doubt. Journal of Theoretical Politics, 3(2):115-137.

Feld, Scott L. and Bernard Grofman. 1991. The half-win set and the geometry of spatial voting. *Public Choice*, 70:245-250.

Feld, Scott L., Bernard Grofman, Richard Hartley, Mark O. Kilgour and Nicholas Miller. 1987. The Uncovered Set in Spatial Voting Games. *Theory and Decision*, 23:129-156.

Feld, Scott L., Joseph Godfrey and Bernard Grofman. 2013 forthcoming. In Quest of the Banks Set in Spatial Voting Games. *Social Choice and Welfare*.

Feld, Scott L., Joseph Godfrey and Bernard Grofman. forthcoming. The Shapley-Owen Value and the Strength of Small Winsets: Predicting Central Tendencies and Degree of Dispersion in the Outcomes of Majority Rule Decision-Making. In Maurice Salles et al. (eds.) *Festschrift for Moshe Machover and Daniel Felsenthal*.

Ferejohn, John A., Richard D. Mckelvey and Edward W. Packel. 1984. Limiting Distributions for Continuous State Markov Voting Models. *Social Choice and Welfare* 1: 45-67.

Fiorina M. 1990. Information and Rationality in Elections. In J. Ferejohn and J. Kuklinski (Eds.) *Information and Democratic Processes*. Urbana, Illinois: University of Illinois Press, 329–42.

Fiorina, Morris P. and Charles R. Plott. 1978. "Committee Decisions under Majority Rule: An Experimental Study." *American Political Science Review* 72 (June): 575-598.

Gigerenzer, Gerd, and Daniel Goldstein. 1996. Reasoning the Fast and Frugal Way: Models of Bounded Rationality. *Psychological Review* 103:650-69.

Gigerenzer, Gerd, and Reinhard Selten (Eds.) 2001. *Bounded Rationality: The Adaptive Toolbox*. Cambridge, MA: MIT Press.

Gigerenzer, Gerd, P. Todd, and the ABC Group (Eds.) 1999. *Simple Heuristics That Make Us Smart*. Oxford: Oxford University Press.

Gilovich, T, D. Griffin and D. Kahneman. 2002. Introduction, Heuristics and Biases: Then and Now. In Gilovich T., D. Griffin, and D. Kahneman (Eds.) *Heuristics and Biases: the Psychology of Intuitive Judgment*, Cambridge, UK: Cambridge Univ. Press, 1–18.

Godfrey, Joseph. 2007. WIN-SET **JOE FILL IN**

Godfrey, Joseph, Bernard Grofman, and Scott L. Feld. 2011. Applications of Shapley-Owen Values and the Spatial Copeland Winner. *Political Analysis* 19(3): 306-324.

Grofman, Bernard and Barbara Norrander. 1990. Efficient Use of Reference Group Cues in a Single Dimension. *Public Choice,* 64:213-227.

Grofman, Bernard, Guillermo Owen, Nicholas Noviello and Amihai Glazer. 1987. Stability and centrality of legislative choice in the spatial context. *American Political Science Review* 81(2): 539-553.

Harnett, D. L. 1967. A Level of Aspiration Model for Group Decision Making. *Journal of Personality and Social Psychology,* 5(1): 58-66.

Hartley, Richard and Mark Kilgour. 1987. The Geometry of the Uncovered Set in the Three-Voter Spatial Model. *Mathematical Social Sciences* 14:5-183.

Hoffmann Arvid O. I. , Sam F. Henry, and Nikos Kalogeras. 2013. Aspirations as Reference Points: An Experimental Investigation of Risk Behavior over Time. *Theory and Decision* 75(2):193-210.

Hogarth, R. M. and M. W. Reder (Eds.). *Rational Choice: The Contrast Between Economics and Psychology*. Chicago: University of Chicago Press.

Humphreys, Macartan and Michael Laver. 2010. Spatial Models, Cognitive Metrics and Majority Rule Equilibria. *British Journal of Political Science* 40 (January)**:** 11-30.

Innocenti, Alessandro. 2010. How a Psychologist Informed Economics: The Case of Sidney Siegel. *Journal of Economic Psychology* 31(3): 421–434.

Jones, Bryan. 1999. “Bounded Rationality.” In *Annual Review of Political Science* 2: 297-321.

Jones, Bryan. 2001. *Politics and the Architecture of Choice*. Chicago: University of Chicago Press.

Kahneman, Daniel. 2003. “A Perspective on Judgment and Choice: Mapping Bounded Rationality.” *American Psychologist* 58(9): 697-720.

Kahneman, Daniel, Paul Slovic, and Amos Tversky. 1982. *Judgment under Uncertainty: Heuristics and Biases*. New York: Cambridge University Press.

Karandikar, Rajeeva, Dilip Mookherjee, Debraj Ray, and Fernando Vega-Redondo. 1998. Evolving Aspirations and Cooperation. *Journal of Economic Theory* 80: 292-331.

Kim, Y. 1999. Satisficing and optimality in 2 x 2 Common Interest Games. *Economic Theory* 13**(2)**: **365-375.**

Kohn, Meier, and Steven Shavell. 1974. The Theory of Search. *Journal of Economic Theory* 9: 93-123.

Komorita, Samuel S. and Alan L. Ellis. 1988. Level of Aspiration in Coalition Bargaining. *Journal of Personality and Social Psychology* 54(3): 421-431.

Kramer, G. H. 1978. Existence of Electoral Equilibrium. In P.C.Ordeshook (Ed.), *Game Theory and Political Science*. New York: New York University Press, 375–391.

Laver, Michael and Norman Schofield. 2001. *Multiparty Government: The Politics of Coalition in Europe*. Ann Arbor: University of Michigan Press.

Laver, Michael, and Kenneth Shepsle. 1994. *Making and Breaking Governments: Cabinets and Legislatures in Parliamentary Democracies*. London: Cambridge University Press.

Lindblom, Charles. 1959. “The Science of ‘Muddling Through. Public Administration Review 19:79-88.

Lindblom, Charles. 1965. *The Intelligence of Democracy*. New York: Free Press.

Lindblom, Charles. 1979. Still Muddling, Not Yet Through. *Public Administration Review* 39:517-26.

Lopes, L. L. 1987. Between Hope and Fear: The Psychology of Risk. *Advances in Experimental Social Psychology* 20: 255–95.

Lopes, L. L. 1996. When Time Is of the Essence: Averaging, Aspiration, and the Short Run. *Organizational Behavior and Human Decision Processes* 65: 179–89.

Lopes, L. L. and G. C. Oden. 1999. The Role of Aspiration Level in Risky Choice: A Comparison of Cumulative Prospect Theory and SP/A Theory. *Journal of Mathematical Psychology* 43: 286–313.

Lupia, Arthur. Shortcuts Versus Encyclopedias - Information and Voting Behavior In California Insurance Reform Elections. *American Political Science Review* 88 (1): 63-76.

Lupia, Arthur and Matthew D. McCubbins. 1998. *The Democratic Dilemma: Can Citizens Learn What They Need to Know?* New York: Cambridge University Press

Mckelvey, Richard D. 1986. Covering, Dominance, and Institution-Free Properties of Social Choice. *American Journal of Political Science* 30 (2): 283–314.

McLeod, W. Bentley and Mark Pingle. 2005. Aspiration Uncertainty: Its Impact on Decision Performance and Process. *Journal of Economic Behavior and Organization* 56(4): 617-629.

Merrill, Samuel III and Bernard Grofman. 1999. *A Unified Theory of Voting: Directional and Proximity Spatial Models*. New York: Cambridge University Press.

Mezias, S. J. 1988. Aspiration Level Effects: An Empirical Investigation. *Journal of Economic Behavior and Organization* 10: 389–400.

Mezias, S. J., Y. R. Chen, AND P. R.Murphy. 2002. Aspiration-Level Adaptation in an American Financial Services Organization: A Field Study," *Management Science* 48: 1285–1300.

Miller, Nicholas R. 1980. A New 'Solution Set' for Tournaments and Majority Voting. *American Journal of Political Science* 24: 68-96.

Miller, Nicholas R. 1983a. The Covering Relation in Tournaments: Two Corrections. *American Journal of Political Science* 27 (2): 382-385.

Miller, Nicholas R. 1983b. Pluralism and Social Choice. *American Political Science Review* 77(3):7 34-747.

Miller, Nicholas R. 1986. "Information, Electorates, and Democracy: Some Extensions and Interpretations of the Condorcet Jury Theorem." In Bernard Grofman and Guillermo Owen (Eds.). *Information Pooling and Group Decision Making*. Greenwich, CT: JAI Press.

Miller, Nicholas R. 2007. In Search of the Uncovered Set. *Political Analysis*. 15: 21-45.

Miller, Nicholas R, Bernard Grofman, and Scott L. Feld. 1989. The Geometry of Majority Rule. *Journal of Theoretical Politics* 1(4):379-406

Miller, Nicholas, Bernard Grofman and Scott L. Feld. 1990. The Structure of the Banks Set. *Public Choice*, 66:243-25.

Napel, S. 1993. Aspiration Adaptation in the Ultimatum Minigame. *Gamesand Economic Behavior* 43**(1):** 86-106.

Nisbett, Richard, and Lee Ross. 1980. *Human Inference: Strategies and Shortcomings of Social Judgment*. Englewood Cliffs, NJ: Prentice-Hall.

Oechssler, Jurg. 2002. Cooperation as a Result of Learning with Aspiration Levels. *Journal Of Economic Behavior & Organization* 49 (3): 405-409.

Ordeshook, Peter and Thomas Schwartz. 1987. Agendas and the Control of Political Outcomes. *American Political Science Review* 81**(**1)**:** 179-199.

Owen, Guillermo. 1995. *Game Theory, 3rd Edition*. San Diego, CA: Academic Press.

Owen, Guillermo and Lloyd. S. Shapley. 1989. Optimal Location of Candidates in Ideological Space." *International Journal of Game Theory* 18:125-142 and 339-356.

Padgett, John. 1980. Bounded Rationality in Budgetary Research. *American Political Science Review* 74: 354-72.

Palomino, F. and F. Vega-Redondo. 1999. Convergence of Aspirations and (Partial) Cooperation in the Prisoner's Dilemma. *International Journal Of Game Theory* 28(4)**:** 465-488**.**

Plott, Charles R. 1967. A Notion of Equilibrium and its Possibility under Majority Rule. *American Economic Review* 57: 787–806

Popkin, Samuel L. 1991. *The Reasoning Voter*. Chicago: University of Chicago Press.

Quattrone, G. and Amos Tversky. 1988. Contrasting Rational and Psychological Analyses of Political Choice. *American Political Science Review* 88: 193-199.

Romer, T. and H. Rosenthal H. 1978. "Political Resource Allocation, Controlled Agendas and the Status Quo." *Public Choice*. 33:27-43.

Schotter, Andrew. 2006. Strong and Wrong: The Use of Rational Choice Theory in Experimental Economics. *Journal of Theoretical Politics* 18(4):498-511.

Shepsle K. and B. Weingast. 1984. Uncovered Sets and Sophisticated Voting Outcomes with Implications for Agenda Institutions, *American Journal of Political Science* 28:.49–74.

Siegel, S. 1957. Level of Aspiration and Decision Making. *Psychological Review* 64: 253-62.

Siegel, S. 1959. Theoretical Models of Choice and Strategy Behaviour: Stable-state Behaviour in the Two-choice Uncertain Outcome Situation. *Psychometrika* 24: 303-16.

Siegel, S. and L. E. Fouraker. 1960. *Bargaining and Group Decision Making*. New York: McGraw-Hill.

Siegel, S. and D. A. Goldstein. 195). Decision-making Behaviour in a Two-choice Uncertain Outcome Situation. *Journal of Experimental Psychology* 57: 37-42.

Simon, Herbert A. 1955. A Behavioral Model of Rational Choice. *Quarterly Review of. Economics* 69: 99-118.

Simon, Herbert A. 1957. *Models of Man*. New York: John Wiley.

Simon, Herbert A. 1972. Theories of Bounded Rationality. In C. B McGuire and Roy Radner (eds.) *Decision and Organization*. Dordrecht: North-Holland.

Simon Herbert A. 1991. Bounded Rationality and Organizational Learning. *Organization Science* 2(1): 125-134.

Straffin, Jr., Philip D.   1980. *Topics in the Theory of Voting*. Boston: Birkhauser

Thompson, Leigh L. Elizabeth A. Mannix, and Max H Bazerman. 1988. Group Negotiation: Effects of Decision Rule, Agenda, and Aspiration. *Journal of Personality and Social Psychology* 54(1): 86-95.

Tietz, R. (ed.). 1983. *Aspiration Levels in Bargaining and Economic Decision Making. (Proceedings of the 3rd Conference on Experimental Economics, Winzeinhol, Germany, 1982.)* Berlin: Springer-Verlag.

Tovey, Craig. 2010. Bounds on the Area of the Winset in Terms of the Yolk Radius and Distance to the Yolk Center in the Spatial Euclidean Model in Two Dimensions. Unpublished, Dept. of Engineering, Georgia Institute of Technology.

Tversky A. and Daniel Kahneman. 1987. Rational Choice and the Framing of Decisions. In R. M. Hogarth and and M. W. Reder (Eds.). *Rational Choice: The Contrast Between Economics and Psychology*. Chicago: University of Chicago Press, XXX-XXX.

Vetschera, R. 1994 . Estimating Aspiration Levels from Discrete Choices - Computational Techniques and Experiences. *European Journal of Operational Research* 76(3): 455-465.

Wang J. and S. Zionts. 2006. The Aspiration Level Interactive Method (AIM) Reconsidered: Robustness of Solutions. *European Journal of Operational Research* 175: 948-958.

Wildavsky, Aaron. 1986.   *Budgeting: A Comparative Theory of the Budgeting Process.* New Brunswick, NJ: Transaction Books.

Wuffle, A, Scott L. Feld, Guillermo Owen and Bernard Grofman. 1989. Finagle's law and the Finagle point, a new solution concept for two-candidate competition in spatial voting games. *American Journal of Political Science* 33(2):348-375