

Getting In Each Other's Way? Some Mathematical Aspects of Interaction In Small
Groups

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Abstract

This paper reports an application of a formal mathematical model (developed by Leik and Meeker 1995; Meeker and Leik, 1997; Meeker, 2002) and based on the classic Lotka-Volterra species competition model (Lotka, 1932; Volterra, 1931; see also Boyce and DiPrima, 1986) to a question long of interest to students of small group interaction. This is, how to describe and explain the inequalities in amount of talking that arise in unstructured face-to-face discussion groups. Data from an experiment conducted by Skvoretz, Webster and Whitmeyer (1999) for 50 same-sex 4-person problem-solving groups are re-analyzed to permit examination of the number of verbal acts by each group member for each minute of the discussion. Several possible indicators of differentiation are examined, and the 50 groups are divided into four categories according to whether the most talkative member was or was not one experimentally assigned higher status. Parameters for the model are estimated for each category, and a computer simulation using these parameters is compared to the actual results for each. One set of assumptions (that group members strive for equality) for the model produces results that fit several aspects of the actual data well, while an alternative set of assumptions (that inequalities are accepted) does not.

Introduction

A well-known and well-replicated social phenomenon is that, in a face-to-face problem-solving small group, otherwise unstructured, inequalities of participation typically develop; one member talks more than others. Furthermore, these inequalities are important both theoretically and practically, because they are typically associated

with influence and prestige within the group and with inequalities in the larger society. (Bales et al 1951; Bales, 1965; Berger, Rosenholtz and Zelditch, 1980; Fararo and Skvoretz, 1988; Ridgeway and Walker, 1995). Recent explanations incorporate performance expectation and status generalization theories (Fisek, 1974; Fisek, Berger and Norman, 1991; Robinson and Balkwell, 1995; Skvoterz, 1988; Skvoretz and Fararo, 1996; Smith-Loven, Skvoretz and Hudson, 1986). Much now is known about **which** group member is likely to emerge as most talkative, but less about **why** inequalities emerge in the first place. The model presented here is not a theoretical competitor with these approaches; rather, it takes up a different aspect of the process; the interdependence of action within a discussion group imposed by the need to allocate talking time.

Models of interdependence

Why explore this particular mathematical model? Because, I believe, this kind of model may help understand many sociological questions about interpersonal interaction, including, but not limited to, the question of why small problem-solving discussion groups seem inevitably to differentiate in interaction. This model (or, more accurately, set of models) may provide a framework for examining the relationships among individual actions, motivations and the ways in which individual actions may have consequences in human interaction by asking in what way the actions of members (or, in exchange theory terms, ‘actor’) may interfere with or enhance the actions of another. Examples of these other models from current research include the research programs in exchange networks (Molm and Cook, 1995) and a very large set of applications of game theory; especially (for sociologists) the use of ‘collective goods’ models (Yamagishi, 1995)

The dynamic systems models introduced by Lotka and Volterra were helpful in developing theory and methods in ecological biology (Scudo and Zeigler, 1978) but have not been often used by sociologists (for one exception, see Felmlee and Greenberg, 1999; also the classic Richardson arms race model, see Huckfeldt, Kohfeld and Likens, 1982 is one of this group of mathematical systems) It is my belief that these models may ultimately yield some of the same kind of results the game theory and network models have, if appropriately approached.

The basic logic of this model is that in a dyad the acts performed by each actor both enhance and provide a hindrance for the other. Likewise, the acts performed by each actor may 'get in the way' of his/her own next acts. [see Figure 1a]

As applied to a task-oriented group, we may think of a task as requiring both members of a dyad to listen to each other, to make contributions, and that the task itself may create inhibitions. Some of the inhibitions are consequences of the task itself. For example, consider a task involving loading a dishwasher or filing items in a file cabinet; the earlier items are easy to place but the more items are added, the harder the task becomes (this will increase the parameter S, 'self', reaction to own cumulative task contributions). Another factor that may increase S is deference; the more one actor wishes to defer to another the less the first will immediately follow an act with another, rather waiting for an act from the other. A third factor that may increase 'S' is satiation or fatigue; the more an actor has performed an act in the recent past, the less rewarding the next act is. For the parameter R, Reaction to others' acts, we see that with some tasks the more others contribute, the more time/effort a receiver must spend to understand or

process the act, or the acts or the other may use up scarce time and space (as when someone else is helping load the dishwasher).

In a face-to-face problem-solving group, the scarce resources are time for speaking (only one person can talk at once) and competition for resolution of disagreements and direction of the group's activities (only one person's suggestion can be followed at once, and time must be spent in discussion and compromise when there is a disagreement).

Within exchange theory, in addition to the assumptions that behavior is goal-directed we also encounter the assumption that actors aim for 'equity' (for equal status actors, equality). In the Leik-Meeker model, this is incorporated in a set of equations that allow the parameters S, R and C may change on each 'cycle' of action if the amount of contribution departs from equality (see figure 1b). Earlier work with this version of the model (Meeker, in press) has shown that the combination of UP (parameter increases as actor's own output exceeds other's) for R, DOWN (parameter increases as other's output exceeds actor's) for S, and EQUAL (parameter increases with any departure from equality) produces a dyadic pattern of initially equal output, with a period of alternating 'dominance' and eventually a stable differentiated pattern. This is the pattern that describes many discussion groups that begin with an unstructured interaction among status equals. We refer to this as the 'Equity' form of the model. An alternative set of assumptions is that the actors endorse inequality from the beginning of the interaction and that the values of the parameters do not change (this is the classic species competition model). This produces a pattern of output of smooth gradual differentiation in which the 'dominant' person's output is always greater than the other's. This is

referred to as the 'Fixed' model. I assume that a legitimately differentiated dyad may show the Fixed pattern while an initially status equal dyad will show the 'Equity' pattern. Figure 2 shows some of the possible theoretical outcomes of the model under different assumptions and starting values for the parameters. It is important to note that only a very few combinations of assumptions and initial parameter values produce anything like the patterns of interest; the model is quite demanding in the sense that many possible parameter estimates do not 'work'.

Methods

These data were collected by a team composed of John Skvoretz, Murray Webster and Joseph Whitmeyer with assistance by other collaborators. (See Skvoretz, Webster and Whitmeyer, 1999). I began with, as kindly provided by Skvoretz and Webster, data and videotapes from 50 4-member groups. The groups were composed of university undergraduates, previously unacquainted, same gender (80% of groups are female). The task is a 'survival' problem: to rank order 15 items according to usefulness in a fallout shelter in the event of nuclear attack. Groups are asked to talk until they reach consensus and are informed their decisions will be evaluated by their reasoning as well as their answers; the groups ranged from 27 minutes to 45 minutes to solve the task.

The task involved placing a strip with the name of an object (e.g., water, a flashlight, a Geiger counter) into a frame with the top most valuable item placed first. Thus, **making** a decision requires some group member's fixing a strip in the frame, and **challenging** or **changing** a decision requires some group member to remove a strip and replace it with another. In my model, this is important, because it means that an important part of task activity is non-verbal (no, I don't mean squirming, frowning, or other such 'nonverbal'

actions, I mean manipulating the strips). When I looked at some of the video-tapes, I saw one group member picking up a strip, waving it around, 'claiming' its value, putting in it the frame. Other views show members sitting in silence while studying their instructions, and yet others show one person removing an item from the frame in order to challenge others' rankings or to respond to others' second thoughts about it.

Each group member was equipped with a voice-activated recorder, which was attached to a computer system that registered when the person began and finished talking, in fractions of a second. I transformed the resulting file of seconds of talking (kindly sent to me by J. Skvoretz) into number of 'acts' per minute. An 'act' is defined as a continuous speech except that a 1.5 second pause between speeches does not make two acts). Appendix 1 in this paper should be compared with Table 3 in Skvoretz Webster and Whitmeyer, (1999).

Variables. The experiment had 3 condition of 'status' operationalized by both class standing (1st year vs 4th year student) and an additional manipulation that informed subjects that 4th year student were more likely to have ability at this task. Subjects were randomly assigned to same-sex group with one of the following status conditions:

4 equal (all 'low') n=17

2 High, 2 Low n=16

1 High, 3 Low n=17

Next, I ask whether the person(s) named by the experimenters as high status were actually the ones who talked the most. 'Legitimate' differentiation I here define as what matches the experimental manipulation. Table 1 shows how many groups accepted 'legitimate' differentiation (top 2 for 2H2L, top 1 for 1H3L). The experimental

manipulation clearly has some effect, but not universal; in a number of groups the most talkative person is not one identified by the experimenter as likely to have superior ability at the task. For further analysis, the groups are divided into four categories: 4 Low (the control condition, no status assigned); 2H2L and 1H3L with the most talkative member being one **not** assigned high status (these groups rejected the experimental assignment); 2H2L with the most talkative member being **one** of the two high status persons; and 2H2L and 1H3L in which the rate of talking reflects the experimental assignment of status.

In order to aggregate the groups in these four categories, we must deal with the problem of there being different numbers of minutes for different groups (minutes range from 27 to 45). Table 2 presents some evidence that behavior in the first 27 minutes for all groups does not differ much from behavior for all minutes; therefore, it is the first 27 minutes that are used (data for all minutes are shown in appendix 2.). Measures of group behavior here include: ratio of top talker to second most talkative, top to all others, total number of acts, number of minutes, and percent of groups that differentiated early (this is operationalized by asking whether the person who talked the most in the first three minutes was also the one who talked the most in total).

Results

Figure 3 shows the ‘output’ of average number of acts per minute for each group member for the four categories. Tables 3a and 3b report statistical summaries. Table 4 reports t-tests comparing the three status differentiated conditions with 4 Low (the control condition). The ratio of top to others seems the most sensitive measure of differentiation, and does show a significant or almost significant difference for all three

compared to the control condition. None of the categories are very highly differentiated; for example, the most talkative member does not participate more than the total of all others. More of the groups in which the differentiation is legitimate also differentiated early (82% and 90%) than those in which the group rejected the experimenter's assignment (58%).

The correlations reported in Table 3 show that most of the variance in ratio of top to others is due to variance in ratio of top to second. It appears that most of the differentiation, whether legitimate or not, happens between the top two talkers. Thus, it seems sensible to treat the top and second as a dyad for purposes of applying the model.

Test of the model

Estimates of parameters for the model were obtained by performing a regression analysis using the first three minutes of interaction of the top two actors. These values were then entered into a computer simulation of the model as initial values. The resulting output of the model can then be compared with the actual data. Two forms of the model were estimated; the Fixed and the Equity. My initial hypothesis was that the two legitimately differentiated categories will look like the Fixed model and the other two will look like the Equity model.

Figure 4 shows the results of estimating the Equity model for each of the four legitimacy categories, and Figure 5 (some) results for the Fixed model. The hypothesis is not supported for the legitimately differentiated categories; in fact, none of the parameters for the Fixed form of the model produce good outcomes whereas all of the Equity models produce at least reasonable outcomes.

One interesting feature of the simulations for the Equity form of the model is that they show an increase in rate of talking at the beginning of the interaction followed by a gradual decline toward the end. This is true of the actual data, also; Table 5 reports an analysis of variance of the first, second, and last third of the 27 minutes and all four categories do show higher rates of output in the first third. (The Fixed form of the model, when it produces any output at all, shows a gradual increase throughout the interaction). The simulations generally overestimate the differentiation between top and second, largely because of overestimating the output of the top talker. This might be attributed to the effects of the other two group members (not included in the model), whose acts use up time and space and decrease the output of the top talker .

Conclusions

The assumptions that actors in a discussion group both inhibit and enhance their own and others' ability to talk, and that in this setting at least, they try to maintain equality of output, receive support from the results of estimating the model. Also, the assumption that most of the differentiation occurs in interaction between the top two talkers is supported. It is my guess that this particular task is not heavily competitive in terms of talking time; for example, some of the decision-making occurs non-verbally, in the handling of the strips rather than verbally. It should be a benefit of this kind of model that we can incorporate assumptions about the effect of different types of tasks on status differentiation. An increase in the amount of coordination required could increase the value of parameter R , and thus change the pattern of differentiation.

Previous work with this model has been primarily deductive, exploring the consequences of making different assumptions about the task and the interaction via

computer simulations. One paper (Meeker, in press) looks at the fit of the model to a set of data from actual small groups, in which the output is 'directive acts', that is acts specifically designed to direct the behavior of other group members such as suggestions for a way to proceed or proposals for a way to resolve conflicts. Directive acts are theoretically more 'competitive' than many other types of actions in a discussion group; only one person's suggestion can be followed at once. They are also rarer. In that application, the 'dyad' was defined as the top actor and 'all others' (the sum of all other group members) and the Equity form of the model fit reasonably well. The present paper is the first to show that some features of the Equity form of the model also apply to speech acts generally.

Lotka-Volterra model of species competition

$$O_{1,t+1} = O_{1,t} + O_{1,t}[-R_1 * O_{2,t} - S * O_{1,t} + C_1]$$

$$O_{2,t+1} = O_{2,t} + O_{2,t}[-R_2 * O_{1,t} - S * O_{2,t} + C_2]$$

-two actors, #1 and #2

-a series of time points, $t = 0, 1, \dots, T$,

-each actor's "output" at each time point: and,

-the assumption that each actor's output is a function of three things:

the other actor's previous output;

the actor's own previous output; and

factors specific to the situation but independent of either own or other's previous level of output.

Figure 1a Equations and assumptions of the Lotka-Volterra model

Calculation of Parameters. To calculate the Reactivity parameter, R, for example:

- a. calculate the proportion of total output coming from #1; this is referred to as 'REL' (for 'relative output of the two actors'). (Equation 3)

$$Rel_{i,t} = O_{i,t} / (O_{1,t} + O_{2,t}) \quad \text{Eq 3}$$

- b. For conditions: Fixed, Up, and Down, and Equal, use the following equations to compute the value of Reactivity for the next cycle:

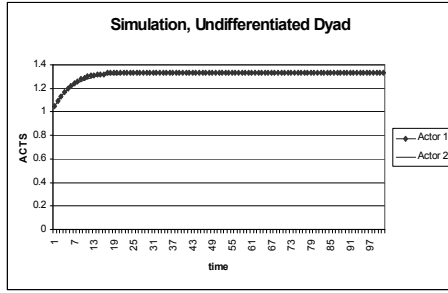
$$R_{i,t+1} = R_{i,t} \quad \text{Eq 4.1 Fixed}$$

$$R_{i,t+1} = R_{i,t} + (Rel_{i,t} - 0.5) \quad \text{Eq 4.2 UP}$$

$$R_{i,t+1} = R_{i,t} + (0.5 - Rel_{i,t}) \quad \text{Eq 4.3 Down}$$

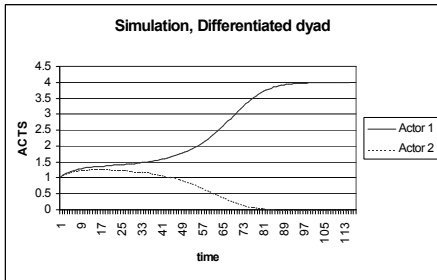
$$R_{i,t+1} = R_{i,t} + (labs[rel_i rel_j]) \quad \text{Eq 4.4 Equal}$$

Figure 1b Additional Assumptions Of The Leik-Meeker Model



Other possibilities
 -one or both go to 0
 -one or both escalate to infinity

FIXED MODEL



EQUITY MODEL

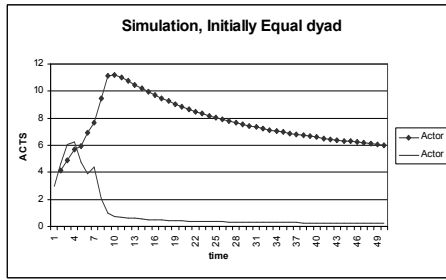


Figure 2. Some Theoretical Possibilities For Outcomes Of Leik-Meeker Model

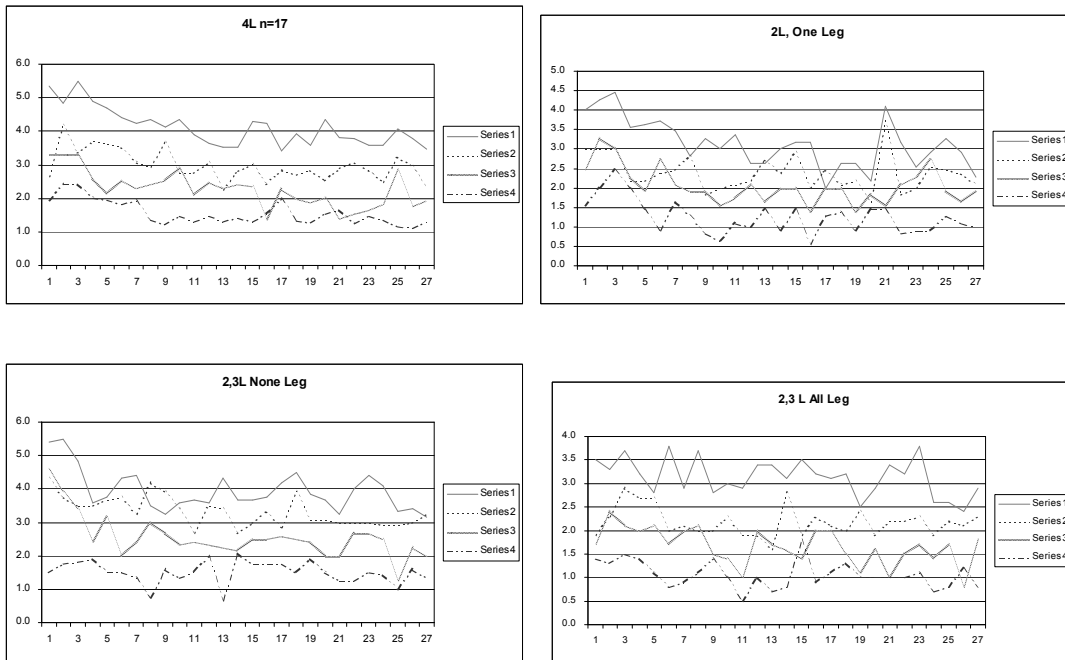
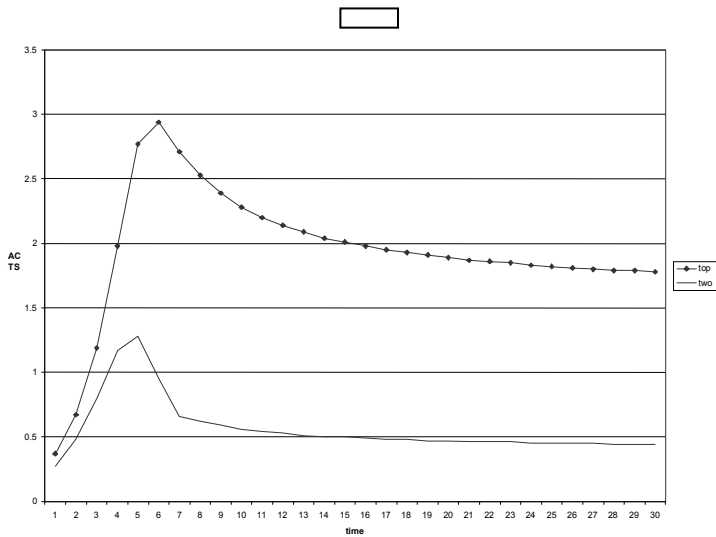


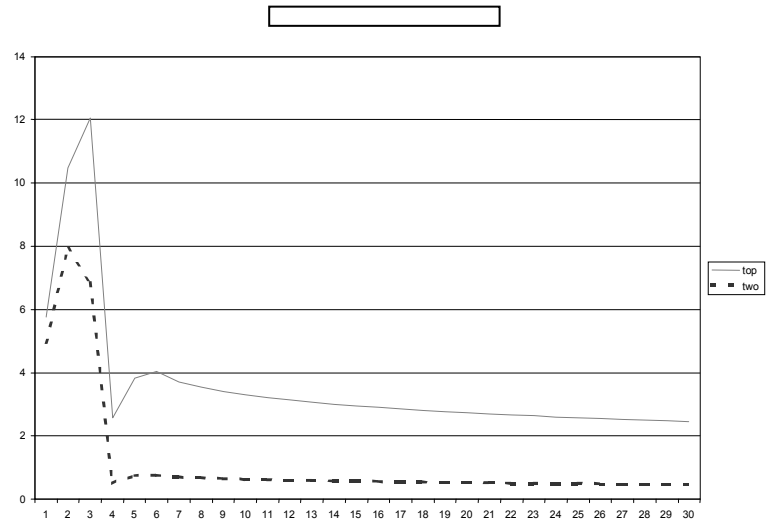
Figure 3. Groups By Type Of Legitimacy, Skvoretz-Webster-Whitmeyer Data

Figure 4. Simulation of equity model for each of the four legitimacy conditions

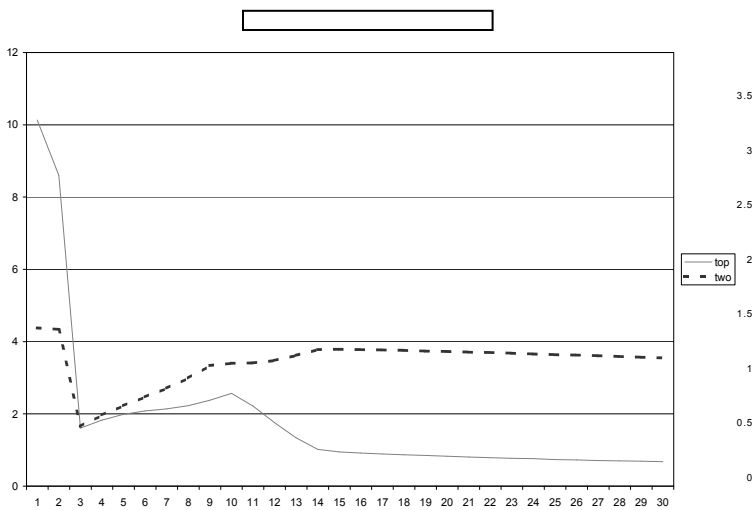
4 Low: Top = 58.17, Two = 16.85, Top/Two = 3.45
 2, 3 L None: Top = 107.92, Two = 35.05, Top/Two = 3.08
 2 L One: Top = 102.69, Two = 54.59, Top/Two = 1.88 [reversal of dominance]
 2, 3 L All: Top = 84.78, Two = 21.94, Top/Two = 3.86



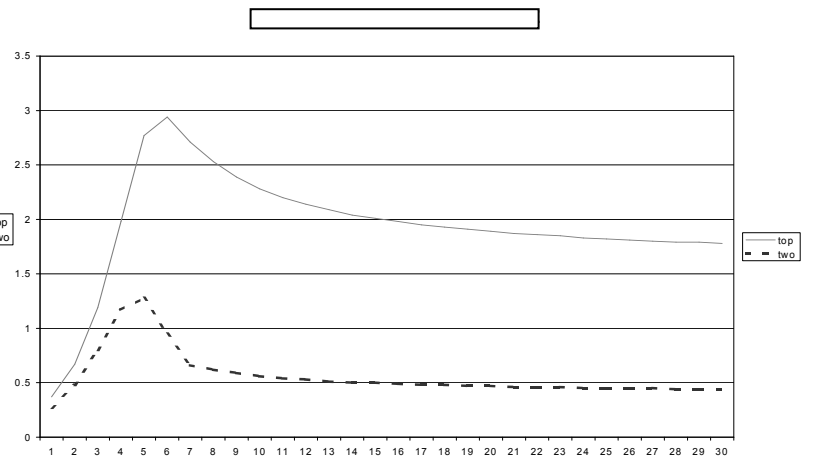
4 Low



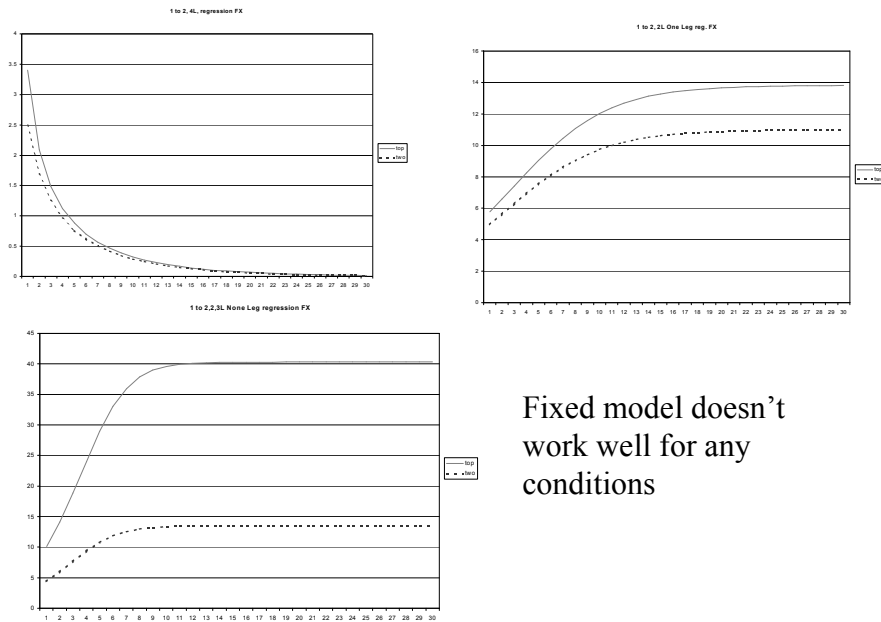
2 Low, One Legitimate



2, 3 Low None Legitimate



2, 3 Low All Legitimate



Fixed model doesn't work well for any conditions

Figure 5. simulations of fixed model for 3 of the 4 legitimacy conditions (for the th, the initial parameters result in immediate escalation to infinity)

Table 1. Types of Differentiation.

a. Distribution of Groups by All Possible Types of Legitimacy.

	Frequency	Percent
4L	17	34.0
3L None Leg	10	20.0
3L Leg	7	14.0
2L None Leg	2	4.0
2L One Leg	11	22.0
2L Both Leg	3	6.0
	-----	-----
Total	50	100.0

b. Distribution of Groups by Combined Types of Differentiation.

	Frequency	Percent
4L	17	34.0
2,3L None Leg	12	24.0
2L, One Leg	11	22.0
2,3L All Leg	10	20.0
	-----	-----
Total	50	100.0

c. Comparing Gender Distribution with Random Conditions

Gender Distribution for Types of Differentiation

% Female Groups	mean	s.e.	N
For Entire Population	.8000	.4041	50
4L	.9412	.2425	17
2,3L None	.8333	.3892	12
2L One	.6364	.5045	11
2,3L All	.7000	.4830	10

Table 2a. Correlations between output variables for the first 27 minutes and for all minutes, 50 groups

TOPTOT	TOP1TO27	.7571**
TWOTOT	TWO1TO27	.8081**
THIRDTOT	THR1TO27	.8136**
LASTTOT	LST1TO27	.8359**
TOPTO2	top227	.9399**
TOPTOTH	TOPOTH27	.9555**
GPTOT	GP1TO27	.7594**
GPPERMIN	GPMIN127	.9781**

2b. Correlations between number of minutes and output variables:

MINUTES	with	
GPTOT		.5379**
TOPTOTH		-.0355
EDIFF		-.0462
GPPERMIN		-.1492
TOPTO2		-.0048

Table 3a. Distribution of Output Variables by Type of Differentiation,
First 27 Minutes

	Mean	StDev	N
All Groups			
TopToOthers	.61	.16	50
TopToTwo	1.39	.40	50
ActsPerMinute	9.67	2.24	50
Total Acts	261.06	60.42	50
%EarlyDiff	.74	.44	50
4 Lows			
TopToOthers	.54	.02	17
TopToTwo	1.23	.06	17
Total Acts	269.59	14.82	17
ActsPerMinute	9.98	.55	17
%EarlyDiff	.71	.11	17
2,3 Lows None Legitimate			
TopToOthers	.60	.05	12
TopToTwo	1.35	.13	12
Total Acts	269.17	21.92	12
ActsPerMinute	9.97	.81	12
%EarlyDiff	.58	.15	12
2 Lows, One Legitimate			
TopToOthers	.64	.05	11
TopToTwo	1.46	.08	11
Total Acts	246.82	13.39	11
ActsPerMinute	9.14	.50	11
%EarlyDiff	.82	.12	11
2,3 Lows, All Legitimate			
TopToOthers	.70	.07	10
TopToTwo	1.62	.18	10
Total Acts	252.50	18.56	10
ActsPerMinute	9.35	.69	10
%EarlyDiff	.90	.10	10

Table 3b. Correlations Among Output Variables by Type of Differentiation, First 27 Minutes

All Groups

	TopToTwo	ActsPerMinute	%EarlyDiff
TopToOthers	.8506**	-.2876	.2851
TopToTwo		-.1962	.3590
ActsPerMinute			-.1138
N of cases: 50	2-tailed Signif: * - .01 ** - .001		

4 Lows

	TopToTwo	ActsPerMinute	%EarlyDiff
TopToOthers	.7172*	-.3634	.0417
TopToTwo		-.0256	.1693
ActsPerMinute			-.0001
N of cases: 17	2-tailed Signif: * - .01 ** - .001		

2,3 Lows None Leg

	TopToTwo	ActsPerMinute	%EarlyDiff
TopToOthers	.8612**	-.3497	.4374
TopToTwo		-.1401	.4655
ActsPerMinute			.1298
N of cases: 12	2-tailed Signif: * - .01 ** - .001		

2 Low, One Leg

	TopToTwo	ActsPerMinute	%EarlyDiff
TopToOthers	.6161	.1160	.3314
TopToTwo		.0102	.4521
ActsPerMinute			-.3693
N of cases: 11	2-tailed Signif: * - .01 ** - .001		

2,3 Low All Leg

	TopToTwo	ActsPerMinute	%EarlyDiff
TopToOthers	.9342**	-.3518	.1485
TopToTwo		-.3837	.3374
ActsPerMinute			-.5538
N of cases: 10	2-tailed Signif: * - .01 ** - .001		

Table 4. t-tests comparing variables for each of three types of differentiation with the base (4 Lows) for first 27 minutes.

4L(N=17) vs 2,3L None Legitimate(N=12)

	t-value	df	2-Tail Sig	SE of Diff
Top to Others	-1.23	27	.231	.050
Top to Two	-.91	27	.371	.125
Total Acts	.02	27	.987	25.464
% Early Diff	.67	27	.512	.184

4L(N=17) vs 2L,One Legitimate(N=11)

Top to Others	-2.31	26	.029	.045
Top to Two	-2.37	26	.026	.094
Acts per Minute	1.06	26	.297	.792
% Early Diff	-.65	26	.521	.172

4L (N=17) vs 2,3L All Legitimate (N=10)

Top to Others	-2.90	25	.008	.057
Top to Two	-2.47	25	.020	.156
Acts per Minute	.71	25	.483	.889
% Early Diff	-1.16	25	.258	.168

Table 5. Analysis of variance for number of acts, first 27 minutes, by Type of Differentiation, Actor (top, two, third, last) and Phase (first third, second third, last third).
 (note: 'subject' = 'group' since 'group' is the unit of analysis)

Tests of Between-Subjects Effects.

Source of Variation

WITHIN CELLS	15220.34	46	330.88		
DIFFTYPE	464.14	3	154.71	.47	.706

Tests involving 'ACTOR' Within-Subject Effect.

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	8624.42	138	62.50		
ACTOR	33906.84	3	11302.28	180.85	.000
DIFFTYPE BY ACTOR	557.41	9	61.93	.99	.450

Tests involving 'PHASE' Within-Subject Effect.

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	3067.25	92	33.34		
PHASE	3023.50	2	1511.75	45.34	.000
DIFFTYPE BY PHASE	224.59	6	37.43	1.12	.355

Tests involving 'ACTOR BY PHASE' Within-Subject Effect.

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	5957.09	276	21.58		
ACTOR BY PHASE	203.26	6	33.88	1.57	.156
DIFFTYPE X ACTOR X PHASE	334.81	18	18.60	.86	.626

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Appendix 1. Number of acts by group.

GROUP	SEX	LOWS	FIRST	SECOND	THIRD	FOURTH	GROUP
1.00	1.00	3.00	122.00	47.00	42.00	31.00	242.00
2.00	1.00	3.00	150.00	125.00	93.00	61.00	429.00
3.00	.00	2.00	168.00	144.00	96.00	84.00	492.00
4.00	1.00	3.00	139.00	127.00	99.00	39.00	404.00
5.00	1.00	3.00	126.00	63.00	52.00	44.00	285.00
6.00	1.00	3.00	165.00	156.00	114.00	58.00	493.00
7.00	1.00	4.00	107.00	86.00	78.00	64.00	335.00
8.00	1.00	2.00	166.00	116.00	101.00	39.00	422.00
9.00	1.00	3.00	211.00	155.00	121.00	106.00	593.00
10.00	1.00	2.00	98.00	79.00	51.00	47.00	275.00
12.00	1.00	3.00	177.00	96.00	88.00	69.00	430.00
13.00	1.00	3.00	166.00	140.00	107.00	87.00	500.00
15.00	.00	2.00	156.00	61.00	54.00	50.00	321.00
16.00	1.00	4.00	198.00	152.00	103.00	58.00	511.00
17.00	1.00	4.00	110.00	109.00	94.00	67.00	380.00
19.00	.00	2.00	139.00	94.00	30.00	20.00	283.00
20.00	1.00	3.00	121.00	78.00	65.00	47.00	311.00
21.00	1.00	2.00	187.00	165.00	106.00	22.00	480.00
22.00	1.00	3.00	101.00	91.00	87.00	59.00	338.00
23.00	.00	2.00	109.00	82.00	62.00	40.00	293.00
24.00	1.00	2.00	203.00	128.00	121.00	70.00	522.00
25.00	1.00	4.00	173.00	151.00	149.00	129.00	602.00
26.00	1.00	2.00	184.00	101.00	68.00	56.00	409.00
28.00	.00	3.00	111.00	104.00	85.00	64.00	364.00
29.00	.00	4.00	117.00	114.00	63.00	38.00	332.00
31.00	1.00	2.00	118.00	111.00	84.00	41.00	354.00
33.00	1.00	4.00	143.00	101.00	75.00	65.00	384.00
34.00	1.00	4.00	163.00	156.00	76.00	46.00	441.00
36.00	1.00	4.00	106.00	82.00	59.00	31.00	278.00
38.00	1.00	4.00	82.00	72.00	54.00	30.00	238.00
39.00	1.00	4.00	104.00	90.00	78.00	36.00	308.00
40.00	1.00	4.00	147.00	117.00	103.00	95.00	462.00
41.00	1.00	2.00	87.00	86.00	75.00	44.00	292.00
42.00	1.00	4.00	151.00	144.00	121.00	73.00	489.00
43.00	1.00	2.00	146.00	81.00	68.00	59.00	354.00
44.00	1.00	3.00	162.00	88.00	55.00	45.00	350.00
45.00	1.00	2.00	89.00	72.00	61.00	26.00	248.00
46.00	1.00	2.00	62.00	61.00	59.00	45.00	227.00
47.00	.00	2.00	170.00	88.00	79.00	74.00	411.00
48.00	.00	2.00	125.00	89.00	78.00	43.00	335.00
49.00	1.00	4.00	128.00	118.00	70.00	57.00	373.00
50.00	1.00	4.00	181.00	142.00	121.00	108.00	552.00
51.00	1.00	3.00	160.00	68.00	55.00	39.00	322.00
53.00	.00	3.00	162.00	108.00	62.00	36.00	368.00
54.00	1.00	4.00	108.00	78.00	75.00	29.00	290.00
56.00	.00	3.00	95.00	86.00	71.00	62.00	314.00
57.00	1.00	3.00	109.00	66.00	42.00	7.00	224.00
59.00	1.00	3.00	118.00	89.00	77.00	64.00	348.00
60.00	1.00	4.00	72.00	45.00	44.00	17.00	178.00
61.00	1.00	4.00	84.00	78.00	44.00	37.00	243.00

'sex': 0=Male, 1=Female. 'lows': 4= 4L, 3=1H3L, 2=2H2L.

Appendix 2a. Distributions of Output Variables by Type of Differentiation, All Minutes

	Mean	S.E.	N
All Groups			
Minutes	38.32	6.82	50
Top to Others	.61	.16	50
Acts per Minute	9.68	2.26	50
Top to Two	1.39	.39	50
% Early Diff	.74	.44	50
Total Acts	368.5800	100.6463	50
4 Lows			
Minutes	37.71	1.65	17
Top to Others	.53	.02	17
Acts per Minute	9.93	.58	17
Top to Two	1.21	.04	17
% Early Diff	.71	.11	17
Total Acts	376.2353	118.8310	17
2,3 Lows, None Legitimate			
Minutes	38.67	1.61	12
Top to Others	.62	.06	12
Acts per Minute	10.07	.81	12
Top to Two	1.42	.13	12
% Early Diff	.58	.15	12
Total Acts	379.5833	76.9184	12
2 Lows, One Legitimate			
Minutes	39.91	2.38	11
Top to Others	.64	.05	11
Acts per Minute	9.05	.45	11
Top to Two	1.47	.09	11
% Early Diff	.82	.12	11
Total Acts	361.6364	98.2510	11
2,3 Lows, All Legitimate			
Minutes	37.20	2.42	10
Top to Others	.69	.07	10
Acts per Minute	9.48	.69	10
Top to Two	1.59	.17	10
% Early Diff	.90	.10	10
Total Acts	350.0000	106.6542	10

Appendix 2b. Correlations Among Output Variables by Type of Differentiation, All Minutes

All Groups

	ToptoTwo	ToptoOthers	Total Acts	ActsperMinute	%EarlyDiff
Minutes	-.0048	-.0355	.5379**	-.1492	-.0462
Top to Two		.8614**	-.1958	-.2002	.3403
Top to Others				-.2744	-.2732
Total Acts					.7433**
Acts per Minute					-.1464
N of cases:	50			2-tailed Signif: *	-.01 ** - .001

4 Lows

	ToptoTwo	ToptoOthers	TotalActs	ActsperMinute	%EarlyDiff
Minutes	-.4484	-.4189	.6514*	.1197	.0494
Top to Two		.6259*	-.2493	-.0588	.0852
Top to Others			-.4849	-.3748	-.0469
Total Acts				.8238**	.0080
Acts per Minute					-.0333
N of cases:	17			2-tailed Signif: *	-.01 ** - .001

2, 3 Lows None Leg

	ToptoTwo	ToptoOthers	TotalActs	ActsperMinute	%EarlyDiff
Minutes	.0298	.1286	-.1007	-.6703	-.4956
Top to Two		.8761**	-.3829	-.2412	.5068
Top to Others			-.5472	-.4465	.4549
Total Acts				.7960*	-.2986
Acts per Minute					.0894
N of cases:	12			2-tailed Signif: *	-.01 ** - .001

2Low, One Leg

	ToptoTwo	ToptoOthers	TotalActs	ActsperMinute	%EarlyDiff
Minutes	.5470	.0795	.7836*	.0610	.1825
Top to Two		.6777	.4213	.0912	.4379
Top to Others			.1496	.2425	.3385
Total Acts				.6623	-.1100
Acts per Minute					-.3982
N of cases:	11			2-tailed Signif: *	-.01 ** - .001

2, 3 Lows, All Leg

	ToptoTwo	ToptoOthers	TotalActs	ActsperMinute	%EarlyDiff
Minutes	-.1957	-.1030	.5469	-.1699	.0552
Top to Two		.9366**	-.3936	-.3358	.2972
Top to Others			-.2843	-.2556	.0813
Total Acts				.7266	-.4283
Acts per Minute					-.6179
N of cases:	10				

Appendix 3. Number of Acts, First 27 Minutes, by Type of Differentiation, Actor, and Phase (first third, second third, last third).

All Groups (N=50).

Phase	Actor		Top		Second		Third		Fourth	
	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
First Third	36.90		27.68		23.16		14.36			
		1.33		1.29		1.11		.92		
Second Third	31.62		23.60		18.56		11.86			
		1.19		1.03		.89		.84		
Last Third	30.50		23.54		16.78		11.06			
		1.24		1.06		1.00		.96		

4Lows, (N=17.00)

First Third	35.59		27.29		23.59		15.82			
		1.86		1.75		1.75		1.57		
Second Third	29.53		25.35		19.82		13.76			
		1.67		1.85		1.53		1.67		
Last Third	30.76		26.65		18.35		12.12			
		1.92		1.50		1.88		1.62		

2,3 Lows, None Leg (N=12)

First Third	36.92		28.92		24.42		12.67			
		3.57		2.96		2.51		1.62		
Second Third	31.83		25.17		19.92		11.75			
		2.47		2.31		2.30		1.95		
Last Third	31.17		24.58		17.08		13.50			
		3.34		2.47		2.08		2.68		

2 Lows, One Leg (N=11)

First Third	36.55		27.36		22.55		14.27			
		2.51		2.97		2.62		2.09		
Second Third	32.18		20.27		17.45		11.18			
		2.98		1.24		1.52		1.44		
Last Third	29.45		20.09		14.73		7.82			
		2.59		1.33		1.54		.93		

2,3 Lows, All Leg (N=10)

First Third	39.50		27.20		21.60		14.00			
		3.16		3.53		2.42		2.33		
Second Third	34.30		22.40		16.00		9.50		2.93	
		2.56		1.59		1.13				
Last Third	30.40		20.80		16.00		9.90			
		2.44		2.91		2.49		1.80		