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Abstract

A new theory of interaction within small groups posits that group members initiate actions when tension mounts between the affective meanings of their situational identities and impressions produced by recent events. Actors choose partners and behaviors so as to reduce the tensions. A computer model based on this theory, incorporating reciprocal exchanges and actions toward the whole group, was used to generate 1,000 interactions in 500 virtual juries. Behaviors of modeled jurors matched the instrumental and expressive content of behaviors among actual jurors during observed deliberations. The system also reproduced sex differences among jurors, both in behavioral content and in levels of participation. Additionally, the system reproduced the domination of small-group interaction by a few active participants. Plausible changes in outcomes resulted when the system was used to analyze groups other than juries. These results indicate that the theory and model can advance research on small-group processes.

Keywords

small groups, affect control theory, juries

Small-group research dominated sociological social psychology in the middle of the twentieth century, led by Robert Freed Bales at Harvard University (Bales 1999). By the 1970s, the topic had receded as an integrated field of research, but a review by Burke (2006) observed that, rather than expiring, small-group research diffused into multiple areas of social psychological research, such as studies of networks, social exchange, expectation states, leadership, intergroup relations, and justice. Beyond the areas mentioned by Burke, conversation analysis and studies of collective behavior are areas in which group research continues. Gibson (2008) adopted a conversation analytic perspective in his review of models of talking in small groups, turn directing at the end of one's own turn, conflict sequences, interruptions, and topic changes, focusing especially on studies that accounted for sequential context through the use of Markov models, loglinear analysis, or event history models.

Harrington and Fine (2000, 2006) called for revitalization of research on small groups, arguing that small groups are the crossroads of self and society where key processes operate: socialization, challenges to communal standards and

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expectations, development of strong network ties, collective processing of cultural meanings, and allocation of social identity and social position. Wittenbaum and Moreland also called for revitalization, pointing out (2008:199–200) that "the effects produced in small-group research are the largest (and arguably, some of the most important) of any topic area within social psychology. Group scholars have, additionally, contributed to the field some of its most important concepts (e.g., norms, social identity) and theories."

The model of small-group interaction presented here extends previous research on small-group interaction by attending to emergent phenomena. Rather than focusing on a particular outcome variable and attempting to explain its variations in terms of interactional context and attributes of group members, this study theoretically models individuals' capacity for interpersonal behavior. Small-group phenomena are generated by putting several modeled individuals together and letting them interact in order to track group processes, this being the primary method for exploring emergent phenomena in complex systems (Gilbert and Troitzsch 2005). The goal is to predict multiple outcomes at once, including the general substance of interpersonal actions, gender differences in the substance of actions and in degree of participation, and monopolization of interaction by a few group members.

In this report a small social group is conceptualized as a set of individuals committed to enacting one interpersonal action at a time, with anyone being a possible actor and with everyone cognizant of each action's affective and instrumental consequences. This conceptualization draws especially on themes in conversation analysis. In Schegloff's words (2007:1), interactants "talk singly—that is, one at a time; and each participant's talk is inspectable, and is inspected, by coparticipants to see how it stands to the one that preceded, what sort of response it has accorded the preceding turn." The one-at-a-time principle permits overlapping talk and interruptions of the kind observed routinely by conversation analysts during coherent sequences of discourse (Schegloff 2007: Appendix 1), but it excludes multiple foci of interaction such as are common in large social gatherings (Mastrangeli, Schmidt, and Lacasa 2010; McPhail, Schweingruber, and Ceobanu 2006). By this principle, a model of social interaction in a small group should focus on a single line of exchanges and need not be concerned with multiple simultaneous conversations.

Schegloff's allusion to turn taking relates to the fact that interacting individuals pass around the right to initiate action. Any member of the group can be a possible actor, and determining which individual will take that role next is a theoretical challenge. A related challenge is determining why some members rarely take the actor role, whereas a few others dominate activity in the group.

Schegloff's emphasis on inspection of actions relates to the third principle presented in the conceptualization of small groups. Group members not only are cognizant of every action but actively process every action's various meanings—cognitive, logical, and affective—with respect to what is going on in the group, with lapses of attention being rare. Thus, group members need not apprise each other of what is happening in the group because in a small group everyone already knows. A key implication is that a theoretical model need only explain the reactions of a generalized group member, at least under the simplifying assumptions that group members are culturally homogenous and share a definition of their situation. Shared definitions of the situation are especially likely in institutional settings (MacKinnon and Heise 2010).

In this study, expanding on a proposal by Smith-Lovin and Robinson (1992), affect control theory (Heise 2007; MacKinnon 1994; Smith-Lovin and Robinson 2006) serves as the basis for modeling individuals' behaviors in groups. The principles of affect control theory delineate roles associated with a variety of institutional identities, as well as actions associated with informal identities (Heise 1979, 2007; MacKinnon 1994), and the basic principles have been verified experimentally (Robinson, Smith-Lovin, and Tsoudis 1994; Schröder and Scholl 2009; Smith-Lovin and Douglass 1992; Tsoudis and Smith-Lovin 1998; Wiggins and Heise 1987). Thus, the theory provides a practicable basis for modeling social interaction in groups.

The first premise of an affect control theory model of group interaction is that interactions within a group maintain affective meanings of group members. Affect control theory postulates that an actor behaves toward another person so as to confirm affective meanings of self and other, as set by their situational identities—that is, by the individuals' operative role identities combined with their personal attributes. Affect control theory makes no predictions about which group member an actor will choose as the object of a prospective action, but a reasonable hypothesis in the spirit of affect control theory is that the actor will select the individual with whom the actor can build an action that maximally confirms the individuals' situational identities. An experiment by Wiggins and Heise (1987) verified the general idea: dispirited experimental subjects eagerly interacted with an individual introduced as a fellow student but avoided interaction with the same individual when he had been introduced as a delinquent. Interacting with a student allowed them to restore their spirits, whereas interacting with a delinquent would have made them feel worse.

Conversation analysts have identified various transposition structures in which two individuals alternate actor and object positions (Schegloff 2007). For example, asking a question requires that the object of the query take a turn as actor in order to provide an answer. Such structures are a crucial part of human interaction, and they will be incorporated into the model of small-group activity. However, conversation analysis offers no guidance on who gets the next turn outside of transposition structures, when the floor is open. The hypothesis offered here is that the next actor will be the group member with the most tension between the affective meaning the individual is supposed to have in the situation and the affective meaning produced by recent happenings. Action is a resource for reducing tension, and the individual in a group who most needs this resource seizes the moment, with others yielding the floor. This hypothesis is in the spirit of affect control theory: whereas individuals select behaviors so as to minimize tensions associated with situational identities, groups allocate turns so as to keep individuals' tensions from escalating.

The remainder of this article presents a précis of affect control theory and an overview of agent-based modeling in which theoretically defined individuals interact via a computer. Then the proposed model of social interaction in small groups is specified in detail, followed by a description of the empirical data used in this article, namely, published statistics from observations of jury deliberations, along with a discussion of how the model had to be adapted to relate to the jury data. The results section compares statistics generated by the theoretical model with statistics from empirical observations. The discussion section considers the successfulness of the model in predicting the content of small-group interaction, gender differences, and variations in participation, and it demonstrates the model's utility when applied to small groups other than juries.

THEORY AND MODEL

Affect Control Theory

The elements of affect control theory that are incorporated into the proposed model of small-group interaction are reviewed next. A complete exposition of affect control theory is available elsewhere (Heise 2007).

Affective meaning varies on three dimensions. *Evaluation* contrasts pleasant and good with unpleasant and bad. *Potency* contrasts powerful and strong with powerless and weak. *Activity* contrasts lively and active with quiet and inactive. Every concept's affective meaning can be assessed in terms of the Evaluation, Potency, and Activity (EPA) dimensions, by averaging respondent ratings on bipolar scales ranging from -4, which corresponds to bad, powerless, or inactive, to $+4$, which corresponds to good, powerful, or active (Heise 2010). Affective meanings of identities, personal attributes, and behaviors are cultural norms, and norm measurement—where the task is to measure respondent convergence rather than diversity—diverges from some familiar principles of survey research. Heise (2010) provided extensive discussion and methodological analyses of the differences.

Measurements of a concept's affective meaning on all three dimensions constitute the concept's EPA profile. The EPA profiles used in this article were obtained in 1978 from North Carolina undergraduates (Smith-Lovin and Heise 2006). The 1978 ratings were used instead of more recent compilations of sentiments in order to keep as close as possible to the 1950s dates of the jury statistics used in this report.

According to affect control theory, every interactant actually has two affective meanings, one a persistent fundamental meaning associated with the individual's situational identity and the other an immediate transient meaning. The fundamental meaning of an identity is particular to a culture or subculture, instilled in individuals through a variety of socialization processes and interpersonal experiences (Heise 2007). The transient meaning changes circumstantially as a result of actions. For example, doctors are fundamentally good in American culture, but a doctor who hurts a patient will be considered momentarily bad by everyone present.

The basic axiom of affect control theory is that individuals try to keep transient meanings aligned with fundamental meanings, and they do so by building new actions to transform the transient meanings produced in prior actions. Thus, the doctor who hurt the patient apologizes and soothes the patient to get affective meanings back to normal. Affect control theory's basic axiom usually is phrased in terms of minimizing "deflection," but this report uses the more intuitive term "tension." That is, individuals construct actions in order to minimize tension between fundamental and transient meanings. This report also refers to a specific kind of tension, "personal tension," which is the difference between fundamental and transient affective meanings of an individual at a given moment, apart from actions that produced the transient meanings.

Transient meanings change as actions generate new impressions of their participants. Affect control theory incorporates impression formation processes via a set of empirically based equations that predict the outcome EPA profiles of action elements from pre-action EPA of the actor and object, along with the EPA of the behavior. Heise (2007) described various impression formation effects, including stability (outcome feelings about an interactant are influenced by pre-action feelings about that interactant); a morality effect (evaluation of an actor's behavior influences the outcome evaluation of the actor); object diminishment (an individual who is the object of another's behavior loses potency); and behavior-object consistency (an actor who performs a good act toward a good object person seems particularly nice, whereas a bad act on a good object makes the actor seem particularly bad, not only because of the morality effect but additionally because of inconsistency between behavior and object).

Data for estimating the impression formation equations used in this study were obtained in a 1987 North Carolina study (Smith-Lovin 1987). Nine equations for predicting the outcome EPA of actor, behavior, and object were estimated by presenting vignettes of actions to respondents and regressing outcome ratings of action elements on out-of-context ratings of the elements, along with multiplicative products of the out-of-context ratings (see Heise 2010).

Individuals' role identities in a situation set their fundamental affective meanings, with personalization by statuses, traits, and moods. Visually salient statuses like race and sex can become part of individuals' composite identities, changing how they carry out their roles and affecting everyone's expectations regarding that individual (Wagner and Berger 2002). Personality traits similarly skew individuals' behavior—for example, being a conscientious employee versus an impulsive employee. Similarly, moods can be incorporated into individual identity—for example, serving as juror while in a lingering state of anger or in a state of pride. Empirically estimated equations predict the EPA profiles of amalgamated identities and modifiers (statuses, traits, and moods) from the EPA profiles of the identities and modifiers (Averett and Heise 1988; Heise 2007; Heise and Thomas 1989).

Affect control theory's proposition about behavior is that interpersonal actions are shaped so as to transform current transient meanings of interactants into new transient meanings that are as close as possible to the interactants' fundamental meanings. This premise is used to derive proaction equations for predicting an actor's next behavior toward a given object person, as follows. The impression formation equations are used to predict symbolically the transient meanings produced by the future action, and a mathematical solution gives the behavior EPA profile that minimizes the differences between future transient meanings and the fundamental meanings being maintained in the situation (see Heise 2007). The EPA profile computed with proaction equations affectively defines the kind of action that would confirm interactants' fundamental meanings in the circumstances.

The proaction equations predict an actor's behavior toward an object person from the fundamental affective meanings of the identities each person has and from each person's transient affective meaning at the beginning of the action. The dependence on identity sentiments means, for example, that a doctor's next behavior toward another doctor differs from the doctor's next behavior toward a patient. The dependence on initial transients means that a doctor's next behavior toward a patient writhing in pain differs from the doctor's next behavior toward a patient sitting sedately.

Affect control theory specifies a future behavior in terms of an EPA profile that usually is converted to a verbal prediction of particular behaviors having a similar profile. The research reported in this article instead converted EPA profiles for predicted behavior into a classification within a system for coding social interaction called Interaction Process Analysis (IPA) (Bales 1951). Expanded definitions of the IPA categories (Bales 1999), plus the

Table 1. Categories of Interaction Process Analysis (IPA), With Sample Behaviors, and Average Evaluation, Potency, and Activity Scores for Sample Behaviors

IPA Category Number	IPA Category Name	Sample Behaviors	E	P	A
1	Shows solidarity	help, compliment, gratify	1.78	1.29	.21
2	Shows tension release	josh, laugh with, cheer	1.48	.91	1.12
3	Agrees	agree with, understand, accommodate	1.60	.78	.01
4	Gives suggestion	encourage, cue, coach	1.28	1.18	.25
5	Gives opinion	evaluate, analyze, entreat	.16	.59	−.02
6	Gives orientation	inform, educate, explain	1.68	1.62	−.14
7	Asks for orientation	quiz, question, ask about	.50	.62	.45
8	Asks for opinion	consult, prompt, query	.48	.74	.16
9	Asks for suggestion	entreat, ask, beseech	.30	.24	.09
10	Disagrees	disagree with, ignore, hinder	−1.00	.35	.45
11	Shows tension	fear, cajole, evade	−.89	−.16	.35
12	Shows antagonism	argue with, deride, defy	−.82	.71	1.32

detailed instructions to coders given in the appendix of Bales's 1951 book, were examined in order to identify three signature acts in each category. The goal was to have signature acts that were mentioned explicitly in the sources. However, signature acts also had to have been rated on EPA in 1978, and this constraint forced inclusion of some acts that were not mentioned explicitly but were descriptive of the kind of activity that is coded within a given category.

The average EPA profile across the three signature behaviors in a category and across male and female ratings yielded an EPA profile for that category. Table 1 shows a brief label for each IPA category, the three behaviors that were used to represent the category, and the category's EPA profile.

An EPA profile for a predicted behavior was classified into the IPA category with the most similar EPA profile. Similarity was determined as the shortest Euclidean distance between the position of the predicted behavior in EPA space and the positions in EPA space of the IPA categories. Euclidean distance between two profiles is "the square root of the sum of squared differences on each of the EPA dimensions" (Heise 2007:146).

Agent-Based Modeling

Agent-based models (Gilbert 2008) comprise sundry subtypes (Wooldridge 2009) and as a group are one type of computer simulation (see Gilbert and Troitzsch 2005). Macy and Willer (2002) provided examples of sociological agent-based models in their review of 18 models focusing on emergent structure (differentiation and diffusion) or on emergent order (cooperation and collective action).

Social psychological research with agent-based models involves the following strategy. First, crucial characteristics of people operating in the domain of interest are abstracted theoretically in order to model agents who would act like real individuals in the domain, even though being highly simplified. Each agent is autonomous, capable of interaction with other agents, reactive to the environment, and capable of proactive behavior (Gilbert and Troitzsch 2005). As Miller and Page explain, "Next, collections of these agent-based objects will be 'solved' by allowing the objects to interact directly with one another using computation" (2007:65). Results of the computerized interactions constitute rigorous derivations from the theory. Thagard backs this approach by arguing that "in the biological, social, and cognitive sciences, descriptions of mechanism are rarely so mathematical that predictions can be deduced, but running computer programs provides a looser way of evaluating theories and models. A computer program that instantiates a model that simplifies a theory can be run to produce simulations whose performance can be compared to actual behaviors" (2012:10).

Gilbert and Troitzsch (2005) noted similarities between social science simulations and social science statistical research. In the case of statistical research, investigators abstract social processes into conceptual models, collect empirical data representing the processes, and attempt to parameterize the models by analyzing the data. Simulation models also are abstracted from social processes, but they are formulated with parameters specified as variables in order to generate diverse outcomes when the parameters are set at different values. The models may be used to conduct thought experiments (What would happen if . . .) or to generate statistics that can be compared with empirical data.

Why leave well-explored realms of statistical modeling for agent-based computer simulations? Coping with complex nonlinearities is one reason: "One of the themes of social simulation research is that even when agents are programmed with very simple rules, the behaviour of the agents considered together can turn out to be extremely complex [i.e., nonlinear]. . . . The only generally effective way of exploring nonlinear behaviour is to simulate it by building a model and then running the simulation" (Gilbert and Troitzsch 2005:10).

Discovering emergent phenomena is another reason for conducting agent-based simulations: "Emergence occurs when interactions among objects at one level give rise to different types of objects at another level. More precisely, a phenomenon is emergent if it requires new categories to describe it which are not required to describe the behaviour of the underlying components" (Gilbert and Troitzsch 2005:11). For example, suppose a leader seeking a destination is followed by a group of individuals, and each follower tries to stay near the leader while avoiding collisions with other followers or with any other obstacle. When the leader reaches a destination and stops, the followers gather round, each trying to get close to the leader while maintaining some personal space with regard to other followers. In their agent-based simulation of this process, McPhail, Powers, and Tucker (1992:20) found that "the result is an arc or a ring around [the leader], not unlike the arcs and rings that form around preachers, politicians, performers, or demonstration organizers in the course of their remarks to or performances for their followers."

Anthropologist Michael Agar (2005) argued that agent-based modeling is most realistic and makes the greatest advances toward theory integration when the process takes advantage of insiders' perspectives regarding what is important in a system, while simultaneously making use of empirically established theory. The research reported here offers such a case in that it relies on proficient observation of juries for verisimilitude while using an established social psychological theory to shape the agent-based simulations.

Model of Group Interaction

The model of group interaction in this study posits that group members operate according to affect control theory. Each has a fundamental affective meaning to maintain, defined in terms of an EPA profile that represents the individual's situational identity. Each group member also has a transient affective meaning—another EPA profile—that is determined by recent actions involving that individual.

Several such individuals are assembled and allowed to interact in order to see how group process emerges. At each turn, the next actor is the group member whose personal tension is greatest, or alternatively the object person of the last action, thereby representing transposition processes in social interaction. The next object of action is the group member with whom the actor can create the most sentiment confirming action, or alternatively the whole group. The next behavior is the one that optimally moves transient affective meanings of actor and object toward their fundamental affective meanings, in accord with affect control theory's proaction equations. The effects of the action are changes in the transient affective meaning of the actor and object, as computed with impression formation equations.

The computer program generating interaction within groups was written in the NetLogo language (Wilensky 1999), developed especially for agent-based modeling. The program constructs the agents, administers the agents' actions toward one another, and records results of interest. The computer program is available on the Internet as a Java applet (Heise 2012) and can be used to analyze sundry kinds of groups, not just those discussed in this report. Source code for the program can be downloaded at the Internet site and examined to ascertain in detail how the simulations work.

Interpreting the model. Group process develops as follows in this model of group interaction. First, individuals adopt role identities according to a shared definition of the situation, allowing everyone to be cognizant of basic expectations applying to each individual. For example, in a jury everyone adopts the role of juror or of jury foreman; in a hospital emergency room, individuals take roles of physicians, nurses, and patients.

An individual's fundamental affective meaning is specified quantitatively as an EPA profile that represents an amalgamation of EPA profiles for the individual's role identity with EPA profiles for the individual's personal modifiers. Other group members rapidly infer the individual's implicit statuses, traits, and moods from appearance and from behavior observed in initial interactions (Smith-Lovin and Robinson 1992).

The model adopts Goffman's (1959) suggestion that a small group operates as a "team" in which individuals are committed to helping each other maintain their identities (faces). Thus, the definition of the situation assigns each group member an affective meaning—a fundamental EPA profile—that everyone seeks to maintain.

The model proposes the following regarding who takes the next available turn in a group: an individual seizes initiative when that individual's personal tension exceeds the personal tension of any other group member. Theoretically, incipient actors could sense that their turn is next under the assumptions that group members share a definition of the situation and that all appraise the meanings of every action, so all group members know whose personal tension is highest. An alternative interpretation of this postulate is that greater personal tension reflects exigency, so the individual with highest tension has a shorter latency to action, thereby preempting actions of others with less tension and longer latencies. Besides accounting for turn taking, the latency explanation also might predict interruptions (Robinson and Smith-Lovin 1990; Smith-Lovin and Brody 1989) and nonparticipation (Gibson 2010).

The model also must specify the object of the next action: "Second only to the question of who speaks, the question of who is addressed is the most fundamental aspect of a turn" (Gibson 2008:375). An extension of affect control theory to cover this issue is straightforward. An individual motivated to action selects as object the group member who provides an optimal basis for creating a tension-reducing action that will confirm the fundamental affective meanings of actor and object. Psychologically, this involves imagining action with different partners in fast, subconscious assessment of the prospects. The computer program accomplishes this step by actually formulating an action with each possible object and computing the outcomes, and then selecting the object person who resulted in the lowest tension.

With actor and object settled, the individual selects a behavior that changes transient meanings of actor and object into new transients as close as possible to fundamental meanings. Psychologically the actor intuits the behavior that will create desired impressions. The computer program identifies the behavior by applying affect control theory's proaction equations to the EPA profiles of the given actor and object, thereby specifying how good, potent, and lively the behavior must be in order to achieve the desired transformation. In the small-group model, this EPA profile is converted into an IPA category in order to characterize the behavior qualitatively. (The computer program also permits conversion into named behaviors.)

Actualization of the individual's action generates new transient affective meanings for the actor and object, with all members of the group registering the same transformation, under the assumptions that members are culturally homogeneous, share the same definition of the situation, and attend to all actions in the group. The computer program accomplishes this step by applying the impression formation equations in order to compute the transient affective meanings generated by the given actor's behavior on the given object.

Once an action is accomplished, and the computer program has recorded information about the action for later analysis, the next turn in interaction begins developing, most likely with a different actor since the last action lowered the personal tension of the prior actor.

The complete model includes two supplementary modes of selecting actor and object in order to deal with processes outside the purview of affect control theory.

Actor–object transpositions (Schegloff 2007) may be determined mainly by cognitive considerations and thereby are not predictable within an affect control framework. Yet the model of social interaction has to incorporate such sequences since transposition sequences occur often in social interaction, and the actions have affective impacts that change transient meanings of actor and object. In the group interaction model, actor–object transpositions are introduced probabilistically by reversing the actor and object in some percentage of all actions. Then behavior is defined in the usual way, using affect control theory's proaction equations.

The group as a whole is included in the computerized model as a phantom element with a fundamental affective meaning equal to the average fundamental affective meanings of all group members. An agent can choose to direct a behavior toward this element as a means of reducing tension, and sometimes this occurs in simulations. However, the frequency of such affectively motivated actions on the whole group is less than the observed frequency in some real groups. Therefore, every new object outside of a transposition sequence is assigned a probability of being the whole group. Whenever the whole group is the object of action, the actor's behavior is obtained with affect control theory's proaction equations applied to the selected actor with the phantom element as object. An action on the whole group generates new impressions of the actor and of the whole group element. Additionally, other group members are affected by having the actor engage in the same behavior toward each group member individually in order to reset every object person's transient affective meaning.

Juries

University of Chicago sociologist Fred Strodtbeck ran mock-jury trials beginning in 1954 with jurors selected from the jury pools of Chicago, St. Louis, and Minneapolis. In a judicial complex with a courtroom and jury deliberation room, under the supervision of a court bailiff, Chicago jurors listened to a taped recording of a trial and then deliberated in order to reach a judgment. Their deliberations were recorded and transcribed, and interpersonal actions were classified using Bales's interaction process analysis. The authenticity of judgments in mock trials (Diamond and Rose 2005) is not an issue here, because the juries serve simply as empirically studied groups of randomly selected diverse individuals in an institutionally defined situation.

A report by Strodtbeck and Mann (1956) focusing on 29 Chicago juries presented the statistics that are considered in this article. Their Table 1 reported the proportionate distribution of 22,021 actions in 17 of the trials into IPA categories and also presented information related to jurors' frequency of initiating acts. Strodtbeck and Mann's Table 2 reported results from the other 12 trials that enabled calculation of the proportionate distributions of actions in IPA categories by males and females as well as the relative frequency of male and female participation.

Model parameters for juries. The agent-based model of group interaction implementing affect control theory and auxiliary hypotheses was oriented toward juries as follows. The group size was set to 12, corresponding to the number of jurors in the mock trials. Women constituted 32 percent of the 1950s juries, so one-third of the jurors were women in the groups created and analyzed on computers.

The proportion of transpositions, the next actor being the object of the last action, was .61 in Gibson's data (2003: Table 3) on corporate groups formed for strategizing, coordinating, or sharing information. The probability was set higher for juries, to .80, because Pincus et al. (2008) found that reciprocal actions become more frequent when the level of conflict increases in a group, and Strodtbeck and Hook (1961:412) reported that "jurors enter their deliberation with a real apprehension that they may be coerced into accepting a verdict with which they do not agree."

The probability of the whole group being the object of action was set to .40, which approximates the observed proportion of actions toward the whole group in task-oriented groups (see Bales 1951, Chart 170; Bales 1999, Figure 8.9).

It was assumed that each individual adopted the *juror* identity in jury deliberations. Strodtbeck and Hook (1961:412) suggest there was little deviance from this legalistic definition of the situation: "The institutional context of the court in which the jurors serve lends importance to their experimental task. Unlike one's preference for lemon or cream in tea, the issues of the deliberation are highly salient in Newcomb's sense of the term. The jurors sincerely wish to reach a genuine consensus of attitude."

Although all jurors had the identity of *juror*, most institutional roles in mid-twentieth century America implicitly were male and had to be marked as female when women occupied them. This idea was elucidated by Stanley (1977:67):

> When women move into activities outside their roles of wife and or mother, we move into *negative semantic space*, semantic space that does not exist for us because it is already occupied by the male sex. When a woman becomes a professional in one of the fields usually reserved for males, she does not move into the corresponding semantic space covered by the noun conventionally used as its label. Instead, her anomalous position must be marked by the addition of a special, female-specific marker: for nouns such as *doctor, lawyer, surgeon*, or *sculptor*, we feel uncomfortable unless we place some qualifier such as *woman, female, lady* in front of the occupational term. In our usage, then, we are accustomed to talking about the *lady doctor*, a *female surgeon, women lawyers*, and *lady sculptors*. . . . We understand any noun that occurs in its "unmarked" form to refer to a male, and failure to provide the information that the person referred to is a woman, in the given context, often results in confusion for the hearer.

Extension of this framework to the juror role is supported by Bosmajian's (1977) historical review of legal resistance to females serving as jurors and of special considerations given to female jurors in courts.

According to this reasoning, women in the 1950s enacted not a *juror* role but rather a *female juror* role. Accordingly, the base EPA profile that females had to confirm in model analyses was (1.2, .7, 0), which is the profile amalgamating the 1970s EPA profile for *female*, (1.6, .4, 1.0), with the profile for *juror*, (.8, 1.6, –.5; male and female ratings averaged), using amalgamation equations derived from 1978 data (Averett and Heise 1988). Compared with the profile for *juror*, the profile for *female juror* is more positive in evaluation, is much less potent, and is less quiet. Meanwhile, males in model analyses confirmed the EPA profile for *juror*.

Behavioral differences between individuals maintaining the same identity arise from individuals amalgamating various attributes with the identity. Individualized variations in jurors' situational self-sentiments corresponding to statuses, traits, and moods were generated as follows. An individual's fundamental affective meaning was obtained by a random draw from a multinormal distribution with standard deviation of 1.0, centered on the EPA profile for *juror* in the case of males and on the EPA profile for *female juror* in the case of females. The standard deviation of 1.0 approximates the variation arising when the juror identity was amalgamated with the 147 personality traits whose sentiments were assessed in 1978. Thus, in effect, the random draws populated each simulated jury with individuals having a variety of personality traits. The sampling variation also allowed for variability in jurors' statuses and moods, for the special role identity of jury foreman, and for occasional group deviants who resisted institutional pressures and performed in some identity other than juror during deliberations.

Group members' initial transient affective meanings were varied in a similar way. An individual's fundamental affective meaning served as the center of a multinormal distribution with standard deviation of 1.0, and the individual's transient affective meaning was obtained by a random draw from this distribution. In this case, the standard deviation reflects the variation produced by amalgamating the juror identity with 139 emotions, and the sampled transients specify jurors in a variety of emotional states as they sat down to

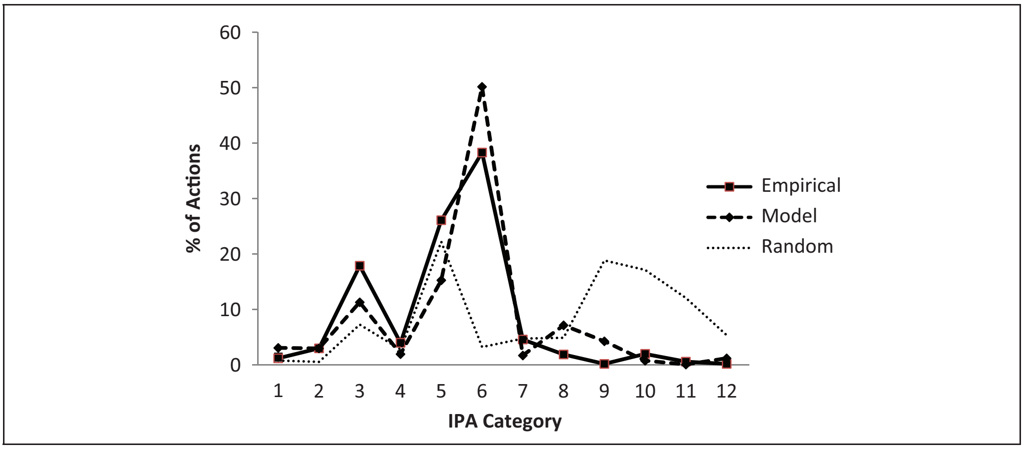

Figure 1. Distributions of Actions into the Twelve IPA Categories

deliberate, such as anxious, irate, proud, and calm. Activities in the group, especially actions directed to the group as a whole, soon changed these initial emotions.

RESULTS

The empirical statistics discussed in this article are from Strodtbeck and Mann's (1956) report regarding interpersonal actions in 29 jury deliberations. Model statistics reported in this article are derived from analyses of 500 computer-generated juries. Each jury was run through 1,000 interactions, corresponding to about one hour of deliberations. Additional statistics were obtained from another set of computer runs in which actors, behaviors, and objects were selected randomly. The random results amount to null hypotheses and provide baselines for assessing the degree of structuring in both the empirical and model statistics.

Figure 1 indicates the content of interaction in empirical juries, modeled juries, and juries whose members operate randomly by showing how actions distributed into the categories of Interaction Process Analysis (IPA). The profile labeled "Empirical" is based on 22,021 observed actions, as reported by Strodtbeck and Mann. The profiles labeled "Model" and "Random" each are based on 500,000 computer-generated actions.

The actions of empirically observed jurors most frequently fall into IPA Category 6—giving orientation (e.g., informing, educating, explaining). Second most frequent is Category 5—giving opinion (e.g., evaluating, analyzing, entreating). After these instrumental–adaptive forms of activity comes expressive–integrative activity in Category 3—agreeing (e.g., agreeing with, understanding, accommodating). Fewer than 5 percent of observed actions fall in any one of the other nine IPA categories.

The actions of modeled jurors also most frequently fall into IPA Category 6, and Category 5 is the second most frequent category for modeled jurors as well as for observed jurors. Compared with the empirical jurors, the modeled jurors have too many actions in Category 6 and too few in Category 5. Actions in Category 3 constitute the third most frequent form of activity among modeled jurors as well as among observed jurors, although the modeled jurors have a somewhat lower frequency in this category than the observed jurors. Seven percent of actions

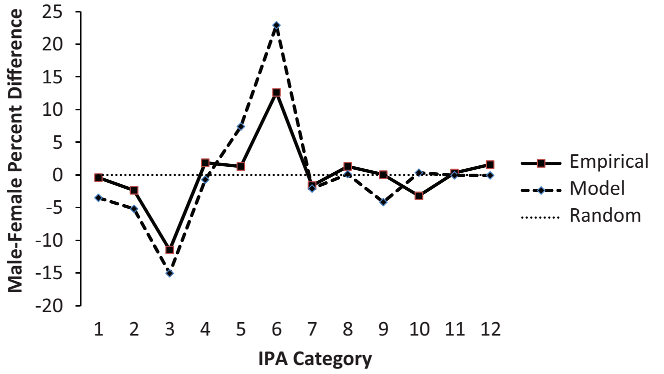

Figure 2. Gender Differences in Content of Actions, as Assessed by IPA Coding (Points on the Graph Represent Male Percentages Minus Female Percentages)

by modeled jurors fell into IPA Category 8—asking for opinion (e.g., consulting, prompting, querying), although fewer than 2 percent of actions among observed jurors fell into that category.

The random profile shows the IPA distribution of actions selected from a multinormal distribution with standard deviation of 1.0 centered at the origin of the Evaluation, Potency, and Activity (EPA) space. The standard deviation approximates the EPA variability of the 600 behaviors rated in 1978 (Smith-Lovin and Heise 2006). The profile shows the kinds of guesses one might make regarding actions in a group about which nothing is known, not even whether it is a conventional or deviant group. Giving opinion (Category 5) is the most frequent classification for randomly selected actions. Then, however, come three categories with no appreciable use among observed jurors or modeled jurors: Category 9 represents asking for suggestions (e.g., entreating, asking, beseeching); Category 10 represents disagreeing (e.g., disagreeing with, ignoring, hindering); and Category 11 represents showing tension (e.g., fearing, cajoling, evading).

The substantial correspondence between the empirical profile and the model profile in Figure 1 is reflected by a correlation of .91 between the two profiles computed across the 12 IPA categories. In contrast, the empirical profile correlates .09 with the random profile. Thus, the model of group interaction applied to juries generates the same kind of nonrandom content as occurs in actual jury deliberations.

Figure 2 deals with gender differences in content. Among observed jurors, male jurors were more likely than female jurors to give orientation (Category 6), and females were more likely than males to show agreement (Category 3). The same finding emerges for modeled jurors, with differences that are somewhat more extreme, and additionally modeled male jurors are somewhat more likely than modeled female jurors to give an opinion (Category 5). The similarity of the empirical and model profiles is reflected in a correlation of .92 between the two.

These gender differences depart from what is obtained with random selections of behaviors for both male and female actors. Random selection gives males and females the same percentage of actions in every category, so all gender differences are zero.

Figure 3 shows a more structural aspect of gender differences. Females in

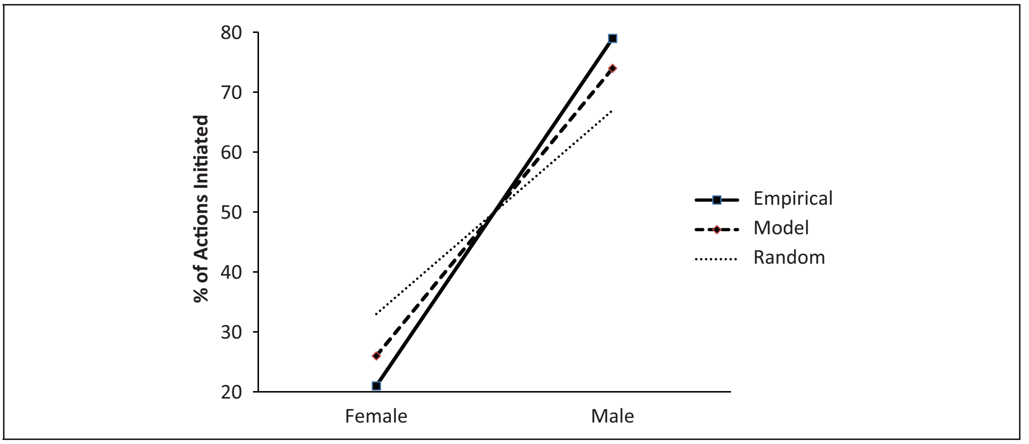

Figure 3. Percentages of Actions Initiated by Females and Males

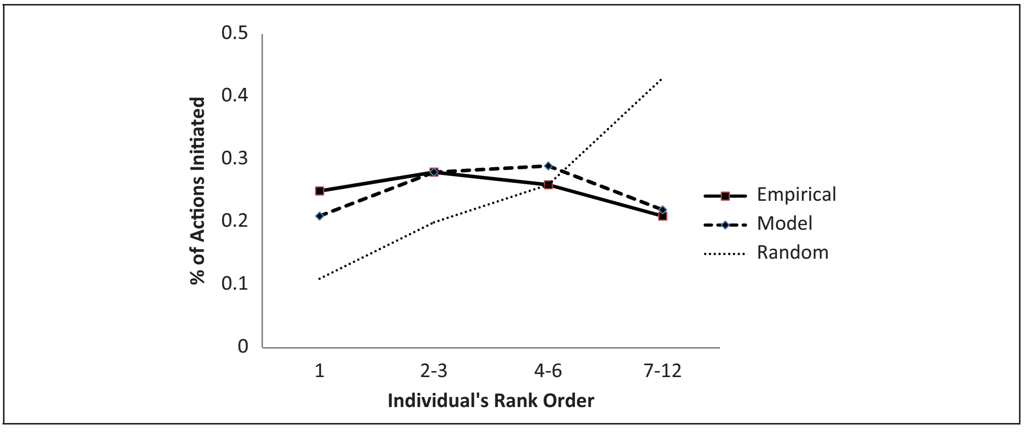

Figure 4. Percentages of Actions Initiated by Group Members at Different Ranks as Initiators

observed juries initiated only 21 percent of all actions, despite the fact that they comprised 32 percent of all jurors. Males, comprising 68 percent of jurors, initiated 79 percent of all actions. Modeled jurors similarly showed disproportionate participation by females and males, although not quite so extreme, with females initiating 26 percent of all actions and males initiating 74 percent. Meanwhile, random draws of actors produced initiation statistics that directly reflected the sex composition of the group, 33 percent for females and 67 percent for males.

Figure 4 shows another aspect of structure in small groups, the relative frequency of participation by different group members. A few members typically dominate group interaction, with the first-ranking individual often initiating around twice as many actions as the next most active person. The amount of participation of lower ranked individuals dwindles in a manner that is predictable from their rank order as initiators (Stephan and Mishler 1952).

Strodtbeck and Mann (1956) did not present frequency data for all 12 rank positions in their observed juries but instead presented the frequencies of initiations by all first-ranking jurors, by all second- and third-ranking jurors combined, by all fourth- through sixth-ranking jurors combined, and by all seventh- through twelfth-ranking jurors combined. As can be seen in Figure 4, the combinations of ranks resulted in four categories with roughly equal frequencies of initiated actions.

The rank–initiation graph for modeled jurors is similar to the one for observed jurors, except that first-ranking jurors initiated somewhat less and medium-ranking jurors initiated somewhat more than was observed empirically.

With random selection of actors, each member of the group had an equal probability (.083) of initiating action. Because the ranking process took advantage of sampling variations in the 1,000 actor selections, the first-ranking individuals initiated 11 percent of all interactions in their group rather than 8.3 percent, and the lowest ranking six individuals initiated 43 percent rather than 50 percent. Nevertheless, the graph reveals that participation in observed juries was far from random, and participation in modeled groups also was nonrandom in the same way.

DISCUSSION

In the model of jury deliberations presented here, individuals used social interaction to maintain their personal affective meaning; the individual with most personal tension took the next available turn and chose an object person and behavior that would reduce tension; actors engaged in frequent reciprocal exchanges with one another; and actors often addressed the group as a whole. Self-sentiments of males in the group were centered on the affective meaning of the *juror* identity, whereas the self-sentiments of females were centered on the affective meaning of *female juror* in order to represent mid-twentieth-century gender marking of institutional identities. Individuals' situational self-sentiments represented their institutional identities amalgamated with statuses, personality traits, and moods.

Computer-based interactions with this model generated realistic representations of jury deliberations with regard to the four factors considered in Figures 1 through 4. The high correlations between empirical and model statistics involved no fitting of the model to the data. Rather, correspondences between empirical and model graphs resulted solely from unfolding the potentialities of the model, with key parameters set to represent juror identities, variability in the affective meanings of modifying states, and the probabilities of actor–object transpositions[1] and of members addressing the whole group.

The degree of correspondence between empirical reality and model predictions is less than perfect for several reasons. First, model predictions of 1950s jury processes are based on 1978 sentiments about "juror" and "female," and cultural change in the quarter century between jury observations and sentiment measures may have reduced the level of predictability to be expected. Second, empirical data were derived from 29 juries, 17 providing data for Figures 1 and 4 and the other 12 juries providing data for Figures 2 and 3, and larger numbers of juries would have

[1]The probability of jurors sequentially exchanging actor and object roles was conjectured to be .8—higher than an empirically observed value of .6 in order to allow for contentiousness in jury deliberations. An analysis with the value lowered to .6 maintained results relating to IPA behavior classifications and generated a proportion of female-initiated actions (.24) close to the empirical value (.21) but diminished the rank-frequency relation by creating too few initiations by frequent participators and too many initiations by participators in the fourth through sixth ranks.

yielded more accurate empirical statistics. Third, the system used to classify model behaviors into IPA categories was based on three signature behaviors in each category, and the coding system might have been more accurate if based on a larger number of signature behaviors. Finally, it might be possible to fine-tune model parameters in order to improve relationships with empirical statistics, for example, by adjusting the probability of addressing the whole group.

Just as it stands, though, this study provides substantial evidence of a workable model of social interaction in small groups. The results indicate that key group processes develop under affective control—automatically and subconsciously in what Kahneman (2011) called "System 1" of the mind, rather than in the deliberative "System 2." In contrast, the affect control system does not account for the content of conversations and task activities, which is the purview of rationalistic processing in System 2.

The model can be adapted for analysis of other groups in which a shared definition of the situation governs interpersonal actions. For instance, consider a group of sports fans gathered at someone's home to watch a major event on television. For the sake of continuity, suppose that the group is mid-twentieth century, consisting of eight males and four females, and that the probabilities of reciprocal exchange and addressing the whole group are the same as in the juries analyzed above. Men in the group take the identity of *fan* with a 1978 EPA profile of (1.0, .3, 1.7), and women take a gender marked identity of *female fan*, which has nearly the same affective meaning, (1.1, .1, 1.4). Analyses of 1,000 interactions in 200 such groups resulted in an IPA profile differing from the IPA profile of task oriented juries, as follows. In the fan groups, 53 percent of actions were in IPA Category 2, showing tension release (e.g., josh, laugh with, cheer). Next most frequent (15 percent) were actions in category 12, showing antagonism (e.g., argue with, deride, defy); then came Category 5, giving opinion, with 9 percent of all actions. This mostly expressive pattern contrasts with the mostly instrumental pattern of behavior prevailing in juries. Another contrast is that female fans initiated as much as males did, and the content of female actions barely differed from that of males. Meanwhile, the rank–initiation pattern was the same as in juries, with some individuals dominating interaction whereas others' participation was meager.

For another example, consider groups of 12 convicts (1978 male EPA: −1.5, −.6, 1.2), four of whom are dominant convicts (−1.8, .6, 1.1). Simulations with the model indicated that behaviors in these groups fall mainly in IPA categories 12—shows antagonism (arguing, deriding, defying; 69 percent of actions) and 11—shows tension (fearing, cajoling, evading; 17 percent), with fewer than 3 percent of the actions in the positive IPA categories, one through six. Letting the computer program predict physical actions rather than IPA categories indicated that shoving, socking, and raping might erupt in groups of convicts. According to Gambetta, these predictions accord with real interactions in prisons, where frequent hostilities range from verbal abuse to physical violence and sexual assaults, providing an institutional experience that prisoners "hate and fear" (2009:110).

Strodtbeck and Mann (1956) found that female jurors initiated at a lower rate than male agents, and their actions were more expressive–integrative than males'. Such gender differences were found ubiquitously in twentieth-century groups (e.g., Eskilson and Wiley 1976; Shackelford, Wood, and Worchel 1996), as reported by Wood (1987:54):

> Most of the research in this area has followed Bales's interaction process analysis by distinguishing between at least two interaction styles—active task behavior (e.g., giving opinions and giving information) and positive social behavior (e.g., agreeing and acting friendly). Carli's [unpublished] meta-analytic review, which located the largest number of studies, estimated a mean effect size (d) of .59 for active task behavior, revealing greater task contribution by men than by women. The mean effect size for positive social behavior was –.59, revealing greater positive interpersonal activity for women. The magnitude of these sex differences in interaction appears relatively large in comparison with many psychological sex differences.

Smith-Lovin and Robinson (1992) and Andrews (1992) considered a variety of theoretical explanations for gender differences in interaction style and leadership. One explanation is sex role specialization, which was argued by Strodtbeck and Mann (1956:8) as follows: "There is a continuance in jury deliberations of sex role specialization observed in adult family behavior," namely, "it is the husband or father who preponderantly plays the task role and the mother-wife who plays the social-emotional role." Such sex-role specialization was supposed to have important functions in child socialization and stability of the nuclear family (Parsons and Bales 1955; Parsons, Bales, and Shils 1953). Another explanation of gender differences is Joseph Berger's expectation states theory, which treats sex as a status characteristic aligning males with competence. Ridgeway (2009) extended expectation states theory, proposing that gender automatically sets an interpretive frame in individuals' minds that promotes expectations of males being more competent and females being more expressive. Ridgeway indicated that such a framing is especially salient in mixed-sex situations and in settings that are culturally typed as masculine.

Ridgeway and Smith-Lovin (1999:193) remarked that "gender is a background identity that modifies other identities." Ridgeway (2009:148) elaborated this motif with her notion of gender framing: "We so instantly sex-categorize others that our subsequent categorizations of them as, say, bosses or coworkers are nested in our prior understandings of them as male or female and take on slightly different meanings as a result." One implication is that female jurors have to maintain an affective meaning that amalgamates the affective meanings of *female* and *juror*. Simulation analyses in this study incorporated this idea, giving simulated twentieth-century women the identity of *female juror* rather than the identity of *juror*, and the feminist formulation produced male–female differences that matched the observed differences reported by Strodtbeck and Mann (1956). The modeled individuals behaved like actual women and men in the 1950s, even though all that distinguished them were the sentiments associated with their identifications, *female juror* versus *juror*.

Is group process the same in contemporary juries as in mid-twentieth-century juries? The answer is, probably not because twenty-first-century measurements of affective meanings (Francis and Heise 2006) suggest that females and males have diverged in sentiments about both "juror" and "female." Females have increased their attribution of juror potency so that it is higher than the 1978 value and higher than the contemporary male value. Additionally, females now attribute substantially more positive Evaluation, Potency, and Activity to "female," whereas males have less positive EPA values for "female" than in the twentieth century. Consequently, analyses with the model of group interaction suggested that females now take an instrumental rather than an expressive role in jury deliberations, whether or not they operate with a gender-marked identity, and male jurors are more expressive than they were in the twentieth century. The analyses further indicate that contemporary female jurors initiate as many actions as do males, which is substantiated by results from unpublished studies indicating that there no longer is a gender difference in participation in real juries (Kellerman 2011). Thus, although gender framing still may be operative, it now yields different results than it did in the twentieth century because cultural sentiments have changed.

The model outcomes regarding monopolization of interaction by a few group members match empirical data well, as shown in Figure 4. Yet, no agents in the model were created as frequent actors, and no rule provided extra turns for those who had acted in the past. This result indicates that monopolization of interaction by a few group members is an emergent group phenomenon, like listeners gathering in a circle around a speaker. Exploratory examination of the agent-based simulations revealed no single determinant of rank-frequency patterning in initiation of action, but that is not surprising since many researchers have tried to model the phenomenon, with limited success (e.g., Doreian 1979; Goetsch and McFarland 1980; Gray and von Broembsen 1976; Shelly and Troyer 2001; Smith-Lovin, Skvoretz, and Hudson 1986). Eventually, agent-based modeling will allow the rank-frequency relation to be dissected and understood, by varying model parameters until the phenomenon fails to emerge in simulations.

Hypotheses from the theory of small-group interaction presented in this report can be examined with observational studies of the kind that Bales, Strodtbeck, and others made during the heyday of small-group research or with experiments and surveys relating to groups. Computer-generated materials for comparison with empirical data can be obtained with the group simulation program (Heise 2012), allowing for variations in the definition of the group situation, group size, bases for selecting the next actor and the next object of action, the proportion of actor-object transpositions, and the proportion of actions toward the whole group. Thus, the theory and its accompanying computer program constitute useful tools for social psychologists who want to respond to the calls by Harrington and Fine (2000, 2006) and by Wittenbaum and Moreland (2008) for a resurgence of small-group research.

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BIO

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