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Noah E. Friedkin¹

Abstract

This article investigates the evolution of power with a formal theory that focuses on the influence network through which control of a group's outcomes emerges via direct and indirect interpersonal influences on group members' positions on a series of issues over time. Power evolves when individuals' openness or closure to interpersonal influences correspond with their prior relative control over the group's issue outcomes. In groups with members who are appraising the relative power of their members over the outcomes of prior issues, a mechanism of "reflected appraisals" will elevate and dampen members' self-appraisals of their relative power and the amount of influence they accord to others. Across a series of issues over time, this mechanism suffices to generate state transitions of a group's influence network. The result is an evolution of the group's influence network such that, with rare exceptions, power becomes concentrated and the preferences of a single leader control the group's outcomes via intermediaries. A laboratory experiment and a simulation provide support for the theory. The analysis suggests that the evolution of the influence network toward concentrated forms of power and control is generated by fundamental social psychological responses to power and may occur in all enduring social groups whose members are dealing with a lengthy sequence of issues, independent of the conditions of bureaucratic organizations.

Keywords: social influence, social networks, dynamic models

In examining power and influence, traditional social network analysis embeds individuals in structures of network relations of various types in organizational settings (e.g., Granovetter, 1985; Krackhardt, 1990; Brass, 1992; Burt, 1992; Mizruchi and Stearns, 2001; Kilduff and Tsai, 2003; Brass et al., 2004). In this tradition, the power and influence of an organization's members are grounded on their structural locations in relevant social networks and on the global structure of the networks in which they are embedded. While the classic foundation of this perspective is the analysis of individuals' structural centralities in social networks, an increasing amount of work deals with social networks as a form

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of social capital that may be enhanced or diminished by the adaptive (tactical or strategic) actions of individuals in constructing and reshaping their local network environments. In addition, an increasing amount of work deals with social networks, within and between organizations, as stable structural contexts in which social contagion or the diffusion of particular behaviors may unfold and that specify the mechanisms underlying behavioral cascades (Strang and Soule, 1998; Stevenson and Greenberg, 2000; Diani and McAdam, 2003; Watts and Dodds, 2007; Friedkin, 2010). Both of these prominent lines of work represent a paradigm shift from a comparative-static analysis of equilibrium conditions to a dynamic analysis, in which social network structure appears as a core theoretical construct.

The social influence network theory from which the present work springs also emphasizes the importance of network structure but defines an influence network as a social cognition structure assembled by the influences that individuals accord and allocate to the displayed positions of other individuals, and to their own positions, on particular issues (Friedkin and Johnsen, 1999, 2011). This article develops and evaluates a formal model of the social organization of accorded influence and its effects on the evolution of power in formal organizations. The analysis focuses on the implications of a "reflected appraisal" mechanism that, over time, and across a sequence of issues, may modify a network of accorded influences and its outcomes.

The premise of the mechanism of reflected appraisals is that individuals' self-appraisals are affected by the appraisals of others of them (Mead, 1934; Cooley, 1964). The premise is a corollary of the general postulate of endogenous interpersonal influence: individuals' thoughts, emotions, and behaviors are affected by the displayed thoughts, emotions, and behaviors of other individuals. Although cast as an effect on individuals, reflected appraisals have important undeveloped implications for the evolution of interpersonal influence networks and the influence process that unfolds in such networks. These implications may be especially apparent in formal organizations, where individuals are continually subject to task-related appraisal and where individuals as objects of appraisal have a differentiated significance as objects of interest by virtue of their appointments to particular roles in a formal hierarchy of distributed activity and authority.

Reflected appraisals, which operate on the relation of an individual to the self, are usefully considered in tandem with the network realization of the relation. A relation defines a network, i.e., a set of elements and set of ordered pairs of these elements. A social network consists of nodes, which may be labeled with additional relevant information, that are linked to other nodes on the basis of directed lines, which also may be labeled with additional relevant information. Social networks include directed relations of interpersonal and self-appraisals in which the nodes are individuals who are the objects of appraisal (evaluation) of other individuals and the objects of self-appraisal. As a network phenomenon, loops corresponding to self-appraisal on a diffuse or issue-specific dimension (self-esteem, self-worth, self-confidence, self-direction) are realizations of a network relation that includes interpersonal appraisals (the accord of esteem, worth, confidence, influence to others). The general premise of the mechanism of reflected appraisals is that the values of the self-appraisal loops of the network are not independent of the interpersonal appraisals of the individual as an object of others' appraisals.

The premise of reflected appraisals, "that our self-concepts are formed as reflections of the responses and evaluations of others in our environment," is well established (Gecas and Schwalbe, 1983: 77). But even though the premise is also supported by some empirical investigations (most recently, Yeung and Martin, 2003), an unresolved set of questions concerns the nature and implications of the mechanism. What, for example, are the implications of individuals being embedded in a network of appraisals in which the appraisals of particular members of the network, to which each individual is responding, are being influenced directly and indirectly by the appraisals of others? There is little doubt that the concept of reflected appraisals has had a remarkable impact on social theory, but much of the literature that is guided by the premise is inexact with respect to its characteristics and implications. We do not have formal definitions of the mechanism that apply to specific substantive dimensions of appraisal, which may then be used to derive other researchable propositions about social systems and the emergent attitudes and behaviors of the systems' members. Although the lines of work on the premise have been overwhelmingly qualitative in the symbolic-interaction tradition that has drawn on it, a new arena of social theory can be developed based on the formal specifications of the constructs and processes of social influence networks.

REFLECTED APPRAISALS

Gecas and Schwalbe (1983) provided a useful analysis of the several dimensions on which investigators depart from one another in the treatment of Cooley's (1964) and Mead's (1934) foundational speculations on reflected appraisals (also see Reitzes, 1980). Gecas and Schwalbe's analysis attended to the three key features of Cooley's perspective and the important assertion that the mechanism is one in which the appraisals of others are not only imagined but are also congruent with the observable appraisals of selected others. Moreover, Gecas and Schwalbe emphasized a condition of the mechanism in which appraisals are affected by the proactive influences of individuals, which alter the appraisals of others of them. The three key features of Cooley's perspective are perception, selectivity, and self-appropriation, which are also central to the formalization presented here.

Imagined and Objective Appraisals

Cooley (1964) grounded the mechanism of reflected appraisals on perception, regardless of what the actual appraisals of others are. There may be a dramatic discrepancy between perception and actuality, however, so that some individuals' self-appraisals are either much higher or lower than the average or consensual appraisal of others of them. Such discrepancies would present a serious constraint on the development of elaborated social theory if they were ubiquitous and substantial, but it is more likely that they are neither and that objective interpersonal appraisals and perceptions of those appraisals are commensurate (Yeung and Martin, 2003). The merits of the assumption of accurate reflected appraisals rest on its theoretical fecundity, like the assumptions of perfect information and rational action.

Selectivity and Agency

Cooley (1964) also grounded the mechanism of reflected appraisals on accorded influence. Not all appraisals of others are salient, and not all salient appraisals are equally weighted. Individuals do not passively receive and process appraisals. Cooley's premise was that individuals are selective and evaluative with respect to whose appraisals matter and how much they matter. Selectivity can only operate on displayed and observed appraisals. In sufficiently large groups, interpersonal visibility has its own social organization (Friedkin, 1983). Some individuals may be known by all, and many individuals may be known only by subsets of others. Moreover, information about individuals varies in depth and breadth. Individuals are subject to different levels of scrutiny in domains of thought, emotion, and behavior that are defined differently, depending on the positions of the individuals. For prominent individuals, the scrutiny may be intense and include all dimensions of the individual—displayed appearance, thought, emotion, and behavior in public and private settings. For other individuals, the appraisals may be limited to one dimension and scanty information. The information upon which appraisals are based is, in part, actively controlled by the individuals themselves, who understand that appraisals *will* be formed, based on any available information about their utterances and behaviors.

Cooley's premise allows for individuals to influence the appraisals of the significant others whose appraisals matter to them. Interpersonal appraisals are evaluative attitudes about individuals as objects that are subject to interpersonal influences and the attitude-change processes that unfold in groups. Hence, in addition, individual *i*'s appraisal of individual *j* may be influenced by other individuals' appraisals of *j*. When such interpersonal influences are affecting individuals' appraisals, explanations of a group's matrix of interpersonal appraisals cannot strictly rest on individual-level or dyadic-level analysis. The consensus and settled disagreements on issues that are emergent outcomes of interpersonal influence processes in groups include interpersonal alignments and disagreements in the appraisals of group members. Hence, we may take a group's matrix of appraisals as the result of an interpersonal influence system in which appraisals are affecting accorded influences, and accorded influences are affecting appraisals (Friedkin and Johnsen, 2003, 2011).

Self-Appropriation

A less well known but exceeding important feature of Cooley's argument is its premise that individuals are (a) evaluative on the dimension of power and control and (b) self-appropriative when they may influence the social environment in which they are situated. This premise is analogous to the response of a rational actor who seeks opportunities to acquire more material resources and, when presented with such opportunities, acts upon them. But Cooley's mechanism is broader in that it includes symbolic resources and control over the conditions of the social environment in which individuals are situated. If individuals can influence decisions on issues that are of interest to them, then the premise is that they will do so. Hence, in this framework, an individual who is accorded influence by others and, on the basis of those direct influences, is able to influence issue outcomes, will not be an individual who gives control to others by according them influence; such an individual will self-appropriate the

influence that he or she might accord to others. The premise of reflected appraisals defines a structural tendency—a greedy expected response to manifest control over issue outcomes. Individuals with manifest power and control will become self-weighted persons who accord little influence to others.

The implied converse of the self-appropriation premise is that individuals who are unable to influence the conditions of their situation will not attempt to do so; their self-appraisals of locus of control and self-efficacy will be commensurate with their manifest absence of influence over the conditions of the situation in which they find themselves. The low self-weights of these accommodative individuals reflect the little weight they accord to their own preferences in a domain of issues on which their interest is low, their uncertainty is high, or their pursuit of a compromise outweighs their attachment to particular positions. The occurrence of a diminishing self-weight is stipulated only for a *regular* pattern of manifest absence of control over issue outcomes in a domain of issues of interest to an individual. The diminishing sense of efficacy may be an antecedent of the “becalming” that has been noted in voluntary organizations (Zald and Ash, 1966).

Extension

The present investigation extends the theory of reflected appraisals to a group process in which a sequence of issues is being considered by a group. The members of enduring groups typically deal with numerous issues, large and small, over time. For each issue in the sequence of issues that arise in a group, a process of interpersonal influence on the issue may unfold in a fixed structure of accorded influence, in a flexible structure that is modified in complex ways depending on the specific issue, or in a structure that has evolved in a systematic way over the sequence of issues. The formalization developed here of the evolution of an influence network across issues is one in which individuals modify their self-weights (i.e., weights they accord to their own initial positions on an issue corresponding to the extent which they are open or closed to interpersonal influences) within a fixed structure of interpersonal weights. The postulate of reflected appraisals suggests that individuals’ relation to self (their self-esteem, self-confidence, self-efficacy, locus of control) is responsive to the broader network of interpersonal appraisals in which individuals are embedded. I formalize this postulate by taking each individual’s accord of weight to self versus others as a response to their manifest control over *prior* issue outcomes. In social influence network theory, group members’ self-weights are important components of influence networks. Within a fixed structure of interpersonal influences, changes of individuals’ extent of openness or closure to interpersonal influences may have dramatic effects on the outcomes of the influence process and power structure of the group. Hence, if group members’ relations to the self are being altered across a sequence of issues by their levels of control over prior issue outcomes, then the power structure of the group also is being altered over time across a sequence of issues.

In formal organizations, where issue outcomes define the situation in which members will operate, interest in those defining issues, and who is contributing to the issue outcomes, should be strong. The stakes are especially high when they bear, as they often do in formal organizations, on the individuals’ employment status, upward mobility, and access to symbolic and material resources and rewards. Krackhardt (1990) has demonstrated that individuals in organizational settings have sufficient information to construct an image of the global

network structure in which they are situated. While an individual's image of the global network may be more or less reliable, the key point is that Krackhardt did not appear to encounter difficulty in eliciting such images: most individuals do not state that they have "no idea" about the pattern of contacts, friends, and advisors in the larger network in which are embedded. Information on who is influencing whom, and who has played a strong or weak role in determining important issue outcomes, may be especially valuable and circulated among individuals located in organizational settings. In high-stake groups, like the groups embedded in formal organizations, where the outcomes of issues are important to their members, the state-transition process of the influence network is one in which individuals accurately appraise the relative power and control of other individuals in determining issue outcomes, and individuals' self-weights (their allocations of influence to self versus others) are elevated and dampened in correspondence with their proportionate influence on the outcomes of prior issues.

FORMALIZATION

The Influence Network Construct

Here, an analysis is presented of networks of accorded influence, formalized as a positive finite distributed resource for each individual, in which each individual i of a group of n individuals apportions influence to self and to particular other members of a group of n individuals,

$$0 \leq w_{ij} \leq 1, \sum_{j=1}^n w_{ij} = 1,$$

for each $i = 1, 2, \dots, n$. The accord of self-weight is a self-appropriation of the influence resource, and the accord of influence to another is a gift of the resource. Both types of allocation may be importantly subject to constraints. In such an influence network, a directed line exists from individual i to individual j if i accords influence to j , $i \xrightarrow{w_{ij} > 0} j$, and a loop exists if an individual i accords weight to him- or herself, $i \xrightarrow{w_{ii} > 0} i$. This network may be represented as an $n \times n$ matrix $\mathbf{W} = [w_{ij}]$ of accorded weights, corresponding to the distribution of accorded influence for each individual,

$$\mathbf{W} = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1n} \\ w_{21} & w_{22} & \cdots & w_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{n1} & w_{n2} & \cdots & w_{nn} \end{bmatrix},$$

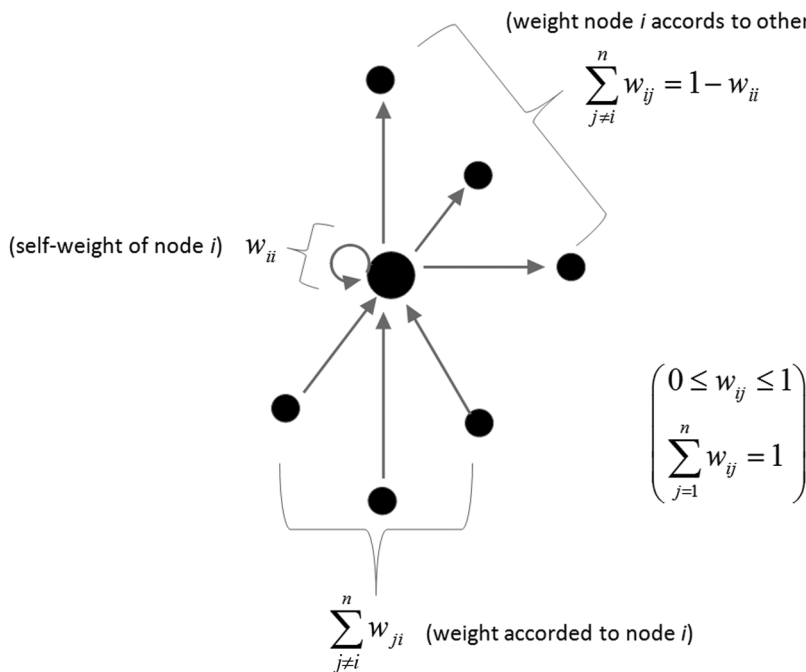
with main diagonal values $\{w_{11}, w_{22}, \dots, w_{nn}\}$ that are the self-weights (self-appropriations of the resource) of the individuals in the network.¹ Each such self-weight determines the weight that is accorded to others as an aggregate,

¹ This matrix \mathbf{W} may consist of heterogeneous values, including instances of $w_{ij} = 0$. The configuration of positive weights, $w_{ij} > 0$, may be described as a valued network, a directed graph, for the relation of accorded influence.

$$w_{ii} = 1 - \sum_{j \neq i}^n w_{ij}.$$

That is, the aggregate relative influence that individual i accords to other individuals, $1 - w_{ii}$, describes the extent to which an individual is inner- or other-directed. More broadly, the accorded influences in the construct \mathbf{W} may involve heterogeneous bases of social power, e.g., perceived authority, power to reward or punish, identification, and expertise (French and Raven, 1959). Figure 1 illustrates the situation of each individual in the matrix of direct accorded influences.

Figure 1. The situation of each individual in the group's matrix of direct accorded influence.



A remarkable number of lines of inquiry on the formalization of influence networks have converged on their specification as a matrix of relative non-negative weights.² Friedkin and Johnsen's work has presented the most exhaustive analysis of the implications of this specification, its empirical supports, and applications in social psychology (Friedkin, 1999; Friedkin and Johnsen, 1999, 2011) and organizations (Friedkin, 1998, 2001; Friedkin and Johnsen, 2002). I employ the Friedkin-Johnsen formalization in the present article and extend it

² This specification is consistent with negative interpersonal sentiments, which are among the possible bases of influence. When such negative-positive sentiments have been explicitly considered (e.g., Friedkin and Johnsen, 2003, 2011), they are mapped onto a 0–1 scale of non-negative values.

to a consideration of the evolution of influence networks across a sequence of issues.

In the context of a fixed structure of accorded influence, the process of endogenous interpersonal influence on a particular issue may either generate consensus or a settled pattern of unresolved disagreement. In the former case, bargaining and social choice (voting) mechanisms are moot, or pro forma. In the latter case, when the interpersonal influence process fails to generate consensus, the unresolved disagreements set the stage for bargaining and social choice mechanisms. In either case, in the issues considered by small groups and in the differentiated issue domains of large organizations, endogenous interpersonal influences may modify some persons' positions on issues and affect the size and power of the emergent factions advocating particular courses of action. The assumption of stable social structures that enter into issue resolutions, although analytically useful and accurate for some groups, does not present an account of the quick formation of a network of accorded influence on specific issues or the slower evolution of such networks over time across a sequence of issues that arise in a group.

The evolution process that may modify a network of accorded influences and its outcomes is triggered by the adaptive responses of individuals to the influence process that has unfolded in the group on each issue in the sequence of issues dealt with by the group. The analytical focus is on group members' self-weights, i.e., the main diagonal elements $\{w_{11}, w_{22}, \dots, w_{nn}\}$ of the influence network construct \mathbf{W} . In the seminal work on social influence theory, initiated with French (1956), Harary (1959), and DeGroot (1974), the influence process unfolding on an particular issue was modeled as a "memoryless" Markov chain mechanism in which individuals' initial positions on an issue have no ongoing direct contribution to individual responses. In a broad class of influence networks, this process generates consensus. Friedkin and Johnsen's (1999, 2011) generalization introduced "memory" in the form of an ongoing anchorage on initial positions and, by implication, an anchorage on the antecedent conditions of individuals' initial issue positions, e.g., their fixed interests and circumstances. Thus the French-Harary-DeGroot process was opened to allow for end states of unresolved interpersonal disagreement on an issue in the context of influence network structures that previously had one inevitable outcome—consensus. In the Friedkin-Johnsen generalization, the extent of individuals' anchorages on their initial issue positions depend on their self-weights. The resultants of the influence process crucially depend on these self-weights, holding constant the structure of interpersonal influences.³ I begin with Friedkin and Johnsen's standard model of the endogenous interpersonal influence process that occurs in a group on a particular issue and then develop the formalization of the state transitions of the group's influence network across a sequence of issues, based on group members' relative power in the prior issue.

The Influence Process on a Specific Issue

The standard model of Friedkin and Johnsen's social influence network theory does not assert that all, or any members of a group are influenced by the

³ This decomposition of the influence network is detailed later in the article.

positions of other members of the group. Whether such influence occurs depends on the individual-level self-weights of the group's members. This formalization, in which self-weights correspond to individuals' anchorage on their initial positions on an issue and the extent to which they are open or closed to the interpersonal influence of other individuals, is specified by a discrete time process of iterated weighted averaging of individuals' positions on an issue,

$$y_i^{(t+1)} = (1 - w_{ii}) \sum_{j=1}^n w_{ij} y_j^{(t)} + w_{ii} y_i^{(1)}, (i = 1, 2, \dots, n; t = 1, 2, \dots) \quad (1)$$

where $y_i^{(1)}$ for each group member i is the initial position the group member on an issue. The self-weights $\{w_{11}, w_{22}, \dots, w_{nn}\}$ may be heterogeneous. For an individual i with $w_{ii} = 1$, the initial position of the individual is not subject to interpersonal influence, and the settled position of the individual is the individual's initial position. For an individual i with $w_{ii} = 0$, the initial position of the individual is subject to interpersonal influence, and at each time $t + 1$ the individual's position is a weighted average of the time t positions of those group members to whom i has accorded influence,

$$y_i^{(t+1)} = \sum_{j \neq i}^n w_{ij} y_j^{(t)}.$$

For an individual i with $0 < w_{ii} < 1$, the initial position of the individual makes a continuing direct contribution to the time $t + 1$ influenced position of i , depending on the extent to which the individual is open or closed to interpersonal influence (the value of w_{ii}). The system of equations for the influence system on a specific issue is described by the matrix equation

$$\mathbf{y}^{(t+1)} = \mathbf{A}\mathbf{W}\mathbf{y}^{(t)} + (\mathbf{I} - \mathbf{A})\mathbf{y}^{(1)} \quad (t = 1, 2, \dots) \quad (2)$$

where $\mathbf{A} = [a_{ij}]$ is a diagonal matrix, with $a_{ii} = 1 - w_{ii}$ values on the main diagonal and zeros elsewhere, and \mathbf{I} is the identity matrix (with ones on the main diagonal and zeros elsewhere). Note that \mathbf{A} is determined by group members' self-weights in \mathbf{W} and that the matrix \mathbf{W} is a group-level construct derived from the mechanism specified by the theory. The influence network is a social cognition structure assembled by the weights that the group members accord to themselves and others. These accorded weights may be conditioned by norms and other variables. Social influence network theory begins with \mathbf{W} and is concerned with the implications of the influence process that unfolds on its basis.

The process of interpersonal influence, which unfolds in the influence network \mathbf{W} , may involve direct and indirect influences. The direct influences, at each time t , are described by Eq. (1). Indirect interpersonal influences on an individual arise when the position of a particular group member j , to whom i has accorded influence, has been affected by some other group member k . When the influence process has an equilibrium, the model presents a control matrix, $\mathbf{V} = [v_{ij}]$, that describes the total (direct and indirect) influences of each group member's initial issue position on other group member's settled positions on an issue:

$$y_i^{(\infty)} = \sum_{j=1}^n v_{ij} y_j^{(1)}, \quad (3)$$

for all i , where $0 \leq v_{ij} \leq 1$ for all i and j , and

$$\sum_{j=1}^n v_{ij} = 1$$

for all i . Each v_{ij} is the relative total contribution of group member j 's initial position to the settled position of group member i . The system of equations involved in Eq. (3) is described by the matrix equation

$$\mathbf{y}^{(\infty)} = \mathbf{V}\mathbf{y}^{(1)}. \quad (4)$$

For a specific issue on which the influence process unfolds in a fixed \mathbf{W} and reaches an equilibrium, which may be a settled pattern of disagreement or a consensus, the equilibrium matrix equation of the process is

$$\begin{aligned} \mathbf{y}^{(\infty)} &= \mathbf{A}\mathbf{W}\mathbf{y}^{(\infty)} + (\mathbf{I} - \mathbf{A})\mathbf{y}^{(1)} \\ &= \mathbf{V}\mathbf{y}^{(1)} \end{aligned}$$

An analytical solution for the control matrix \mathbf{V} is available when $\mathbf{I} - \mathbf{A}\mathbf{W}$ is nonsingular,

$$\mathbf{V} = (\mathbf{I} - \mathbf{A}\mathbf{W})^{-1}(\mathbf{I} - \mathbf{A}), \quad (6)$$

and a numerical solution is available when $\mathbf{I} - \mathbf{A}\mathbf{W}$ is singular,

$$\mathbf{V}^{(1)} = \mathbf{A}\mathbf{W} + (\mathbf{I} - \mathbf{A}) \quad (7a)$$

$$\mathbf{V}^{(t+1)} = \mathbf{A}\mathbf{W}\mathbf{V}^{(t)} + (\mathbf{I} - \mathbf{A}) \quad (t = 1, 2, \dots), \quad (7b)$$

on which basis \mathbf{V} is defined as the limit of the above recursion, when such a limit exists.⁴

In this formalization, the control matrix \mathbf{V} is strictly a function of \mathbf{W} . It arises as a derived implication of the specified endogenous interpersonal influence process that occurs in a group on a particular issue, $\mathbf{W} \rightarrow \mathbf{V}$. The formalization is supported by findings obtained on small-group discussions of specific issues in experimental settings (Friedkin and Johnsen, 2011) and field settings (Childress and Friedkin, 2012).

A Sequence of Issues

When social influence network theory is extended to a group process in which a sequence of issues is being considered by a group, the extension is a formal theory on the state transitions of influence networks, \mathbf{W}_s , across a sequence of issues, $s = 1, 2, \dots$. In the influence network transition process considered,

⁴ At each time t , during the influence process on an issue, we have $\mathbf{y}^{(t+1)} = \mathbf{A}\mathbf{W}\mathbf{y}^{(t)} + (\mathbf{I} - \mathbf{A})\mathbf{y}^{(1)} = \mathbf{V}^{(t)}\mathbf{y}^{(1)}$.

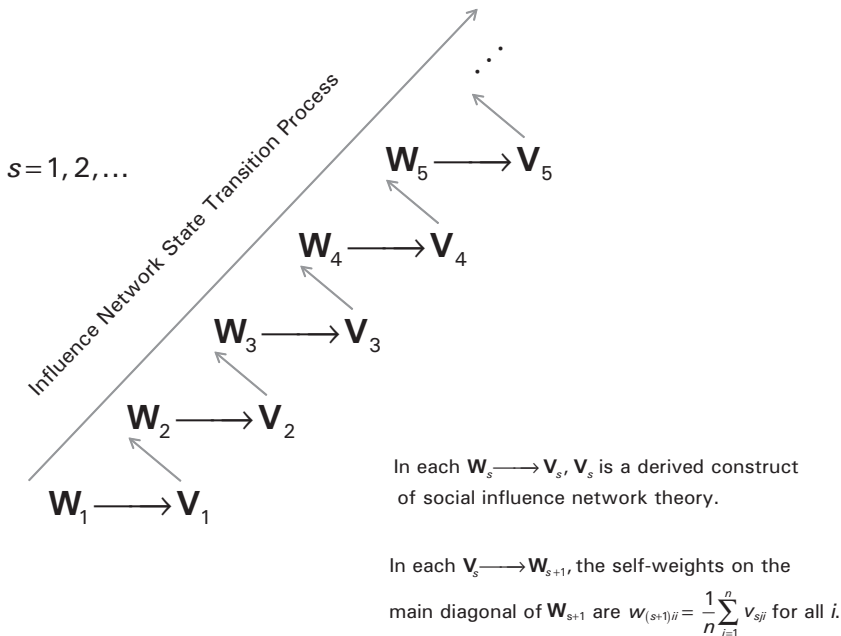
group members' self-weights transition to values that are objectively commensurate with their prior manifest power and control over the settled issue positions of other group members on issues that arise in a particular issue domain and that are dealt with in the context of a particular state of \mathbf{W} .

It is said that power corrupts, and absolute power corrupts absolutely. Here, I replace the strong term "corrupts" with a social psychological status shift, "power elevates self-weight," and also consider the other side of the coin: "lack of power dampens self-weight." Individuals' influences on previous issue outcomes modify the strength of their displayed attachment to their own initial preferences on subsequent issues that arise in a group so that, across a sequence of issues, the status of individuals (assertive advocacy vs. silence, confidence vs. uncertainty, intransigence vs. accommodation) may be modified as an adaptive response to their prior appraised power and influence.

In this way, individuals' self-weights become social constructions, as opposed to fixed personality characteristics, that depend on the implications of the influence network \mathbf{W} that is formed by group members' accorded influences to other members on specific issues. Prior successes in the form of manifest power and control over particular issue outcomes in the group enhance self-weight (foster assertiveness, confidence, and intransigence); failures in the form of little power and control over issue outcomes in the group diminish self-weight (foster silence, uncertainty, and accommodation).

Figure 2 outlines the formal framework of the influence network state-transition process for a group across a sequence of issues. Here, a particular issue in a sequence of issues considered by a group is denoted as Y_s , $s = 1, 2, \dots$. The issues in the sequence may differ in content under the scope

Figure 2. Influence network state transition process across a sequence of issues.



restriction that the positions of individuals on them are quantitative values on the real number scale. Some or all of the issues may be one-dimensional, e.g., positive-negative evaluations of an object, allocable monetary or other resource quantities, or subjective probability values. Some or all of the issues may be multidimensional. For convenience, and with no loss of generality, I describe the formalization in terms of one-dimensional issues and denote the time t positions of the group's members on a particular issue in the sequence of issues as

$$\mathbf{y}_s^{(t)} = [y_{s1}^{(t)}, y_{s2}^{(t)}, \dots, y_{sn}^{(t)}]'$$

Hence, $y_{si}^{(t)}$ is the position of group member i on issue s at time t , the vector of initial positions of the group members on issue s is

$$\mathbf{y}_s^{(1)} = [y_{s1}^{(1)}, y_{s2}^{(1)}, \dots, y_{sn}^{(1)}]'$$

and the vector of settled (equilibrium) positions of the group members on issue s is

$$\mathbf{y}_s^{(\infty)} = [y_{s1}^{(\infty)}, y_{s2}^{(\infty)}, \dots, y_{sn}^{(\infty)}]'. \quad (8)$$

In the standard model of social influence network theory, the influence network \mathbf{W} is treated as a fixed construct in which the influence process unfolds on a specific issue. Friedkin and Johnsen treated this standard model as a special case of a more general formalization in which the influence network may be modified during the influence process on a specific issue. In the present analysis, I maintain the standard assumption of a fixed \mathbf{W} for a specific issue. The available empirical evaluations of the theory have been based on this assumption, and there is no reason to abandon it. Influence networks on specific issues appear to emerge quickly in a sufficiently stable form to treat them as a fixed construct of the group process on a specific issue.

The present investigation extends the formalization provided by social influence network theory to a sequence of issues, $s = 1, 2, \dots$, that may arise in an enduring group of n members. This extension is trivial when the influence network for the process on a prior issue is maintained on subsequent issues that arise in the group. As the issues change, however, the group's structure of interpersonal influences also may change for various reasons, even when the group's composition (its size and membership) is fixed. Different issues may trigger different levels of interest among the members and involve different bases of influence. If such issue-to-issue changes are sufficiently pronounced, then the influence networks involved in a sequence of issues must be treated as separate issue-specific social constructions of the group. I advance a formalization that occupies a theoretical middle ground between the above two possibilities.

Let the relative interpersonal accorded weights be fixed across a sequence of issues.⁵ For each \mathbf{W}_s , $s = 1, 2, \dots$, in a sequence of issues that arise in an

⁵ Given \mathbf{W} , with $w_{ij} > 0$ for each i , the relative interpersonal weights are $c_{ij} = w_{ij}/(1 - w_{ij})$ for $i \neq j$.

enduring group of n members, let the stable underlying structure of interpersonal accorded weights of \mathbf{W}_s be

$$\mathbf{C} = [c_{ij}] = \begin{bmatrix} 0 & c_{12} & \cdots & c_{1n} \\ c_{21} & 0 & \cdots & c_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ c_{n1} & c_{n2} & \cdots & 0 \end{bmatrix}, \quad (8)$$

where $c_{ii} = 0$ for all i , $0 \leq c_{ij} \leq 1$ for all $i \neq j$, and

$$\sum_{j=1}^n c_{ij} = 1$$

for all i .⁶ Let \mathbf{A}_s be the issue-specific levels of the group members' accord of influence to the displayed issue positions of other group members, i.e., $a_{sij} = 1 - w_{sij}$. Thus far, nothing has been specified that alters Friedkin-Johnsen's standard issue-specific model, since for a particular issue we have

$$\mathbf{W}_s = \mathbf{A}_s \mathbf{C} + \mathbf{I} - \mathbf{A}_s \quad (9)$$

This decomposition has been employed in situations in which it is useful to disentangle the measurement models for \mathbf{W} into separate measurement models for group members' self-weights and their relative interpersonal influences (Friedkin, 1998). Here, the decomposition is employed to isolate and examine the implications of an influence network state-transition process, evolving across a sequence of issues, which is governed strictly by changes of group members' self-weights.

The idea that drives the present analysis is that state transitions of \mathbf{W} will arise across a sequence of issues as members' self-weights transition to values that correspond to their relative control over prior issue outcomes. I operationalize a reflected appraisal mechanism, under the assumption of a group with members who are keenly interested in and able to appraise the relative power of its members, as follows. Group members form accurate appraisals their own and others' average relative power in determining the specific issue outcomes of the group's influence process and, based on these appraisals, elevate or dampen their self-weights:

$$w_{(s+1)ii} = \frac{1}{n} \sum_{j=1}^n v_{sji} \quad (s = 1, 2, \dots) \quad (10)$$

for all i . The value v_{sji} is the total influence of i on j for issue s . The summation

$$\sum_{j=1}^n v_{sji}$$

⁶ With each row sum equal to 1, the defined construct implies that each group member's self-weight is $0 \leq w_{ii} < 1$ for all i , which excludes the extreme case of a completely self-weighted individual. If, in addition, the group members' self-weights are restricted to $0 < w_{ii} < 1$, then both of the extreme cases of self-weight are excluded.

is the aggregate total influence of i on all group members, including i on issue s . Because each row of \mathbf{V}_s sums to 1, the sum total of all the values of \mathbf{V}_s is n . Hence,

$$\frac{1}{n} \sum_{j=1}^n v_{sji}$$

is the fraction of the total influences contained in \mathbf{V}_s that are i 's influences or, equivalently, the average influence of i . The self-weight of i transitions to this fraction for each i . This fraction may be taken, and has been taken, as a measure of each group member's structural centrality in the group (Friedkin, 1991). The predictions obtained with $\mathbf{y} = \mathbf{V}\mathbf{y}^{(1)}$ for a particular issues are supported by empirical investigations of small groups in experimental and field settings (Friedkin and Johnsen, 2011; Childress and Friedkin, 2012). The concurrent validity of

$$\frac{1}{n} \sum_{j=1}^n v_{ji}$$

as a measure of structural centrality is supported by its correlations with other standard measures of structural centrality (Friedkin, 1991).

From Eq. (10), the state transition of the group's influence network across a sequence of issues is based on group members' relative power on the prior issue,

$$\mathbf{W}_{s+1} = \mathbf{A}_{s+1}\mathbf{C} + \mathbf{I} - \mathbf{A}_{s+1} \quad (s = 1, 2, \dots), \quad (11)$$

where

$$a_{(s+1)ii} = 1 - \frac{1}{n} \sum_{j=1}^n v_{sji}$$

for all i . In figure 2, these state transitions are represented as $\mathbf{V}_s \rightarrow \mathbf{W}_{s+1}$, that is, based on group members' prior manifested power or control, a self-appropriation mechanism is assumed in which each group member's self-weight, $w_{(s+1)ii} = 1 - a_{(s+1)ii}$, is elevated or dampened on the next issue in a sequence of issues in correspondence with his or her power in the system of interpersonal influence that has operated on the prior issue in the sequence.

Social influence network theory is not restricted in scope to particular forms of influence networks; for example, it does not assume that all or any of the group members' positions on an issue are influenced by the issue positions of other members. The process of endogenous interpersonal influence, however, may or may not result in an equilibrium set of issue positions, depending on the influence network structure in which the process unfolds. I examine an influence network transition process across a sequence of issues that begins with influence network structures for which equilibrium issue positions do exist. The population of initial influence networks analyzed, \mathbf{W}_1 , is restricted in scope to strongly connected networks (i.e., networks in which each group member i may influence, directly or indirectly, every other group member j), for

which the process of endogenous interpersonal influence unfolding in \mathbf{W}_1 has an equilibrium control matrix \mathbf{V}_1 that manifests some inequalities of relative control among the group's members. Whether such an equilibrium control matrix \mathbf{V}_1 exists depends strictly on the structure of the initial $s = 1$ influence network \mathbf{W}_1 . There are unusual special cases of strongly connected influence networks for which \mathbf{V}_1 does not exist, and there are also special cases of influence networks that present an initially homogeneous distribution of relative control but that do not evolve. These scope restrictions are not highly restrictive. They do, however, eliminate cases of initial influence networks that, at the start, are ones in which one group member controls the issue outcomes of the group. Instead, the starting point of the influence network evolution process is a decentralized influence network of heterogeneous influences on the basis of which each group member may influence, directly or indirectly, all other group members. Such decentralized influence networks appear as an important structural foundation of effective organizations in the classical literature on organizations (Likert, 1961, 1967; Tannenbaum, 1968; Tannenbaum et al., 1974).

Overview

The present investigation of power and influence in organizations is a dynamic analysis in two key respects. It is a dynamic in its treatment of the emergent relative control of group members over the outcome of a specific issue, and it is dynamic in its treatment of the evolution of a group's influence network across a sequence of issues.

First, the formalization is grounded on a discrete-time social process mechanism of endogenous interpersonal influence on specific issues unfolding in an influence network. With its emphasis on endogenous interpersonal influences of individuals' evaluative attitudes, as opposed to interpersonal influences of behaviors, it is a distinctive mechanism within the body of investigations on social contagion. Typically, models of behavioral contagion have been based on the number of significant others who have adopted the particular behavior under investigation, and a direct behavioral response to such adoptions is based on a threshold criterion (i.e., the proportion of adopters sufficient to trigger an individual's adoption of the behavior). Friedkin (2010) extended the attitude-change process specified by the Friedkin-Johnsen model to behavioral responses and cascades, emphasizing the antecedent attitudinal evaluation of a behavior that may or may not be adopted.

The theoretical foundations of the Friedkin-Johnsen approach are cognitive. The influence network construct that is involved in the mechanism is a derived construct of the specification of a "cognitive algebra" (Anderson, 1981) by which individuals integrate the attitudes of others and their own attitude. In this framework, the weights described by \mathbf{W} are components of the "within-the-skin" mechanism with which each individual synthesizes heterogeneous issue positions of other individuals and his or her own position on the issue. The direct flows of interpersonal influence occur along the lines of these accorded weights, and indirect flows of influence arise from the repetitive responses of individuals to the changing issue positions of those to whom they have accorded direct influence. In its application to organizations, this model may incorporate features of organizations as antecedent conditions that affect individuals' profiles of accorded influence. Hence, given a network of accorded

influence, the model treats the influence process that unfolds in an organization in exactly the same way as it would for an influence process that is unfolding in any other group. The difference is that the distinctive features of organizations (e.g., their formal division of labor and corresponding differentiated issue domains, their emphasis on bases of authority and expertise, and their members' locations in geographically dispersed locations) are reflected in the influence network that is formed. Although the effects of the organizational antecedents of a realized influence network is important, because such effects condition the structural features of the influence network, they are less central when the analysis focuses on the implications of realized influence networks.

Formal organizations, especially large-scale formal organizations, are unlike small informal groups in which the domain of issues considered may be unrestricted. In an informal small group, the issues that arise may deal with all dimensions of the personal and occupational life-space of individuals. The division of labor and authority structures of large-scale formal organizations differentiate issue domains and may heavily constrain the issues involved in each domain to occupation-related matters. This is a theoretically important feature in the framework of the Friedkin-Johnsen model, because the model defines a "group" as a set of individuals, each of whom has a position on a particular issue, which includes all individuals with a direct or indirect influence on the issue positions of the members of the set. Hence, for a particular issue that arises in a large-scale organization, the group may be a dyad or a larger subset of the organization's membership. Different issues may involve different groups. The same issue may involve different groups, if the same issue unfolds in separate influence networks. The potential complexity is reduced when the sequences of issues that arise in formal organizations are decomposable, or nearly decomposable, into discrete issue domains.

Second, the present investigation of power and influence in organizations is a dynamic analysis of the evolution of influence networks across issues that arise within an issue domain. The most closely related analogue to the present evolutionary perspective on power occurs in the social exchange literature (Cook et al., 1983; Markovsky, Willer, and Patton, 1988; Friedkin, 1993; Lawler and Yoon, 1993; Molm 1997). In the network-exchange paradigm, individuals are embedded in a structured network of potential exchange relations. Power inequalities emerge over time, across a sequence of trials, in the context of a fixed structure of interpersonal opportunities for social exchanges. Differential power is manifested in modifications of the value of offers tendered by individuals, which depend on individuals' levels of payoff in prior trials. Power evolves over numerous trials. The structural implications of a particular exchange network are slowly manifested in the micro-interpersonal behavior of the individuals who are situated in different structural positions of this network.

The influence network evolution process involved in the present investigation is akin to the network exchange transition process. Within a particular trial, a set of micro-dynamics unfold and result in a pattern of outcomes and appraisals of control over future outcomes. Across a sequence of such trials, outcomes and appraisals may evolve toward an equilibrium distribution of outcomes and appraised control over outcomes. In the present investigation, I assume that the appraisals of individuals of the relative influence of group members in determining issue outcomes in the issue domain of interest to the group are accurate.

EVALUATION OF THE POSTULATED RESPONSE TO POWER

I empirically evaluated the postulated response of individuals' self-weights to their prior influence on issue outcomes in a sequence of issues that arise in a group: an individual's level of prior control commensurately elevates or dampens subsequent self-weight on a new issue. The evaluation is based on 50 groups of tetrads assembled in an experimental setting.

Experimental Design

The tetrads experiment involved 50 four-person groups of college students: 25 all female groups and 25 all male groups. Group members were asked to attempt to resolve their initial differences of attitude on five issues considered in sequence. Subjects were randomly assigned to positions in one of five different communication networks. Along with the chain (1-2-3-4), which was not involved in the experiments, these five networks included all the non-isomorphic connected graphs that can occur in a four-person group. During the experiment, neither the structure of the communication network nor individuals' positions in the network were altered. Each group member occupied a private room and was given an issue to consider in isolation from the other three group members. Each person was asked to record an initial attitude on the issue. Group members then discussed their attitudes using a simple telephone system. Each subject's telephone displayed the names of persons with whom direct communication was possible. Only dyadic communication was permitted and (depending on the network) only certain communication channels could be activated by each subject.

Group members were instructed that they could communicate with other members of the group as frequently as they liked but that they must communicate at least once with each person whose name was listed on their telephones. Group members were given up to 20 minutes to discuss the assigned issue. Each group was instructed that attaining consensus was feasible and desirable. Upon reaching group consensus or a deadlock, group members recorded their final attitudes on the issue and judged the direct relative influence of each group member on him or her, i.e., each group subject i provided a direct subjective allocation of weights $\{w_{i1}, w_{i2}, w_{i3}, w_{i4}\}$. The group then moved on to the next issue of the sequence. Three issues dealt with risk assessment (so-called risky-shift issues) and two issues dealt with monetary awards. The experimental design was balanced, including rotations of the issue sequence such that each issue appeared with equal frequency in the 1st, 2nd, ..., 5th positions of the sequence. To conserve space, I do not report further details on the experiment. The details are available upon request, or they may be found in prior publications (Friedkin, 1999, Friedkin and Johnsen, 1999).

Measures

For this analysis, I drew on subjects' initial $\mathbf{y}^{(1)}$ and end-of-trial $\mathbf{y}^{(\infty)}$ positions for each issue, and their matrix of accorded interpersonal influences \mathbf{C} . A behavioral measure of self-weight, conditional on \mathbf{C} , may be derived from social influence network theory,

$$\frac{(1 - w_{ij})^2}{w_{ij}} = \frac{y_i^{(\infty)} - y_i^{(1)}}{\sum_{j \neq i} c_{ij} y_j^{(\infty)} - y_i^{(\infty)}}, \quad (12)$$

for which the solutions have been detailed by Friedkin and Johnsen (1999). No observed change of issue position $y_i^{(\infty)} - y_i^{(1)}$ corresponds to maximum self-weight, $w_{ij} = 1$, and an observed change of issue position corresponds to minimum self-weight, $w_{ij} = 0$, when the amount and direction of the change is equivalent to the position of an individual relative to the weighted average of other group members' final positions. In a group that has reached consensus (for which the denominator of the derived expression for self-weights is zero), a subject's self-weight is strictly determined by the observed occurrence or non-occurrence of a position change. With these behavioral self-weights, a group's issue-specific influence network \mathbf{W} is obtained via Eq. (9), the group's control matrix \mathbf{V} is obtained via Eq. (6) or Eq. (7), and the predicted end-of-trial issue positions $\hat{\mathbf{y}}^{(\infty)} = \mathbf{V}\mathbf{y}^{(1)}$ are obtained with Eq. (5). The accuracy of the prediction, based on Eq. (12), is supported in previous publications (Friedkin, 1999; Friedkin and Johnsen, 1999, 2011).

Findings

Here, findings are reported on the effects of the prior relative power of an individual,

$$\frac{1}{n} \sum_{j=1}^n v_{sji},$$

controlling for the individual's prior self-weight, w_{sij} , on the subsequent self-weight, $w_{(s+1)ij}$, of the individual on the next issue in a sequence of five issues. With 50 groups, each with four members, the sequence of five issues generates 16 instances of within-group responses (four per member) and a total of 800 cases for the 50 groups. A multilevel mixed-effects linear regression analysis is presented in table 1, with each set of 16 cases nested in a particular group. The analysis is limited to an evaluation of the postulated, Eq. (10), individual-level response mechanism. The individual-level equation regresses subjects' self-weights $w_{(s+1)ij}$ on their levels of control,

$$\frac{1}{n} \sum_{j=1}^n v_{sji},$$

Table 1. Regression of Subjects' Self-weights on an Issue on Their Self-weights and Levels of Control in the Prior Issue*

Variable	Coefficients	S.E.	<i>p</i>
Control on prior issue	.199	.079	.011
Self-weight on prior issue	-.124	.054	.021
Constant	.198	.021	.000

* Multilevel mixed-effects regression, Stata 10, with 800 observations, 50 groups, and 16 observations per group; log likelihood = -393.649.

on the prior issue in the sequence of issues, controlling for their prior self-weight w_{sij} . The findings indicate that individuals' issue $s + 1$ self-weights are negatively associated with their issue s self-weights, controlling for individuals' influence on the issue s outcome. Extreme self-weights (low or high) tend to be moderated from issue to issue. The key finding is that individuals' issue $s + 1$ self-weights are positively associated with their prior influence on the issue s outcome, controlling for individuals' self-weights on issue s . On average, the individual's level of prior control elevates or dampens subsequent self-weight on a new issue, controlling for prior self-weight.

Hence, the available evidence supports the postulated social psychological mechanism on the effects of power, Eq. (10). The mechanism is one in which individuals respond to their relative success or failure to influence the group's issue outcomes: success generates a self-appropriation of the power that they have been accorded, via enhanced self-weights (greater assertion, confidence, and intransigence) that reduce their accord of influence to others; failure lowers self-efficacy, via diminished self-weights that shift the locus of control to others. Here, what has been referred to as a "becalming" (Zald and Ash, 1966) or, more strongly, as an "incompetence of the mass" (Michels, 1962), corresponds to a socialization phenomenon, emergent across a sequence of issues, in which individuals' silence, uncertainty, and accommodation on issues increase as it becomes evident that they have not been accorded influences by others that allow them to affect group issue outcomes.

EMERGENT CONCENTRATION OF POWER

I also pursued the implications of the mechanism with simulations to verify that if individuals respond in the manner specified by this form of a reflected appraisal mechanism, then there are dramatic long-term implications for the evolution of the power structure of the group. In the context of the benefits of bureaucratic forms of governance, this formalization of a social psychological perspective presents an unintended consequence, a social dilemma, in the form of an evolutionary tendency toward extreme forms of concentrated power within the differentiated issue domains of formal organizations.

Simulation Design

My analysis is based on simulations of the evolution process illustrated in figure 2. I investigated two types of initial influence networks. These types differ in their construction of the two components, **A** and **C**, of the group's initial $s = 1$ influence network, $\mathbf{W} = \mathbf{AC} + \mathbf{I} - \mathbf{A}$. The initial structural component **C** is maintained as a fixed construct across the sequence of issues, and **A** evolves according to the formalization, Eq. (11). The Type 1 networks are complete influence networks, with random positive self-weights and random interpersonal weights, in which each group member accords some direct influence to every other group member. In these networks, the density of positive (non-zero) accorded interpersonal influence is 1. The Type 2 networks are randomly structured influence networks, with random positive self-weights and random interpersonal weights, that differ from Type 1 with the introduction of random densities and arrangements of instances of no accorded interpersonal influence. The Type 2 networks are more complex than the Type 1 networks with

respect to their incomplete networks of interpersonal influence and random densities and arrangements of instances in which group member i accords no direct influence to group member j . Ten thousand systems of each type are investigated for each of the following system sizes: 5, 10, 15, 20, and 25. Given the continuous random-value construction of these systems, the probability of replicate systems is negligible.

Findings

Table 2 presents the findings of the analysis. The findings in panel (a) of the table indicate that a concentration of control arises, with rare exceptions, in the sample of 100,000 Type 1 and Type 2 influence networks. Over 98 percent of the influence networks transition to a state in which the process of endogenous interpersonal influence on specific issues will generate a consensus on the initial positions of a single heavily self-weighted group member. The end state of the network transition process is not one in which all group members concentrate their direct accord of influence on a single person; the leading member's control is based on direct and indirect influence through intermediaries. In the end state, the group consists of $n - 1$ members who have either returned to, or been reduced to, an accommodative orientation and distribution of interpersonal influence that is consistent with their distributions of accorded influence in the underlying constraint structure **C**. This end state of the evolution

Table 2. Observed Prevalence of Influence Network Evolution to a Power Structure in Which Control over Issue Outcomes Is Concentrated in a Single Group Member*

Group Size	Type of Initial Influence Network	
	Type 1 (complete)	Type 2 (structured)
(a) Proportion of systems that evolve to a single leader		
5	0.9999	0.9938
10	0.9999	0.9968
15	1.0000	0.9987
20	0.9998	0.9900
25	0.9996	0.9901
(b) Proportion of successes in predicting that the group member with the greatest level of initial control will emerge as the evolved leader of the group		
5	0.5650	0.5572
10	0.3825	0.4016
15	0.3005	0.3393
20	0.2494	0.2735
25	0.2229	0.2585
(c) Mean level of control of the member with the greatest level of control in the evolved bilateral systems		
5	0.8105	0.6984
10	0.8314	0.7259
15	—	0.7340
20	0.9773	0.6969
25	0.9992	0.7450

* Each proportion in panel (a) is based on 10,000 influence systems. The number of cases involved in panels (b) and (c) may be obtained from the proportions reported in panel (a).

has an appearance of startling robustness in the tens of thousands of trials on random networks of different sizes and densities of positive influences.

Panel (b) of the table is an analysis of the extent to which the group member with the greatest initial level of control is the same group member who emerges as the leader of the evolved influence network. Clearly, one does better than chance in predicting that the group member with the greatest initial level of control will be the same group member who emerges as the leader of the evolved influence network. The odds ratios, which are generally greater than 5 and tend to increase with group size, indicate that the initial control status of a group member is informative. The probability of an incorrect prediction on this basis, however, is substantial, and it increases with group size.

The small fractions of systems that fail to converge to a single-leader system are ones with an equilibrium bilateral power structure, i.e., a structure in which total influences are concentrated on two members. In these bilateral systems, the self-weights of the two leaders, k and m , are $w_{kk} + w_{mm} = 1$ and the total interpersonal influences of the group are concentrated on them

$$\frac{1}{n} \sum_{j=1}^n v_{jk} + \frac{1}{n} \sum_{j=1}^n v_{jm} = 1.$$

In the observed rare bilateral exceptions to a concentration of power on a single leader, the distribution of relative power is a potentially competitive circumstance in which the occurrence of conflict depends on whether the power holders advocate the same or different positions on issues. Panel (c) of the table reports the mean levels of control for the group members with the larger level of control in each bilateral system. On average, these systems involve one group member with a substantially greater level of control over group outcomes than the other influential member of the bilateral system.

DISCUSSION

Many conditions affect the formation of social networks, including networks of accorded influence. Group size may change with the addition and loss of members. Holding constant group size, the individuals involved in the group may change. The contextual conditions in which the group is situated may change. Particular events may dramatically modify group members' definition of the situation in which they are located and, in turn, trigger new issues and reorganizations of networks. The members of a group may be actively involved in efforts to transform their structural positions in a network and features of the global structure of the network in which they are embedded. Investigators in the field of social networks have become increasingly interested in the development of models that attend to the macro and micro processes that affect social network formation and change (Burt and Ronchi, 1990; Doreian and Stokman, 1997; Jackson and Watts, 2002). The model of reflected appraisals developed here takes those processes seriously.

The empirical findings of the experiment support a reflected appraisal effect in which individuals dampen or elevate their self-weights, becoming more or less open to interpersonal influence, in correspondence with their prior relative control over group issue outcomes across a sequence of issues. The simulation

findings suggest that this reflected appraisal effect may be reinforced across a sequence of issues to generate a concentration of power in a single group member. Such reinforcement appears in modestly constrained random networks with the specified influence network evolution process. I suspect that the observed exceptions to the main tendency are not restricted to bilateral power structures, although I have not encountered any other form of exception in the domain of systems considered.

The consequences of dynamic complex systems are often not obvious. While acknowledging the importance of conflict processes, motivated by the interests and grievances of individuals and subgroups who have been unable to influence the policies and decisions that affect them, this article bears on what is arguably the more prevalent condition of groups, communities, and organizations—an accommodative passivity, acquiescence, or obedience to a developing concentration of power and control of a minority, including a minority of one. The contribution of the analysis here is its demonstration that individuals' responses to their relative control of group issue outcomes, when these responses are situated in a group dynamic, may have startling macro-level consequences for the evolving power structure of a group. The main unforeseen implication of the formalization is that influence networks evolve to a form consisting of a single completely self-weighted, inner-directed individual, a leader, whose preferences determine the outcomes of the group, in the context of other members who have transitioned to a state of other-directed accommodation. The evolved concentration of power is not a radically simple form in which all influence is directly accorded to one individual, but a more complex form in which the interpersonal influence of the leading individual may be transmitted both directly and through intermediaries, based on the network of accorded influences of the $n - 1$ other members. That is, the evolutionary tendency is not to form (a) but to form (b) below:

$$W = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 1 & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 1 & 0 & \cdots & 0 \end{bmatrix} \quad (a)$$

$$W = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ w_{21} & 0 & \cdots & w_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{n1} & w_{n2} & \cdots & 0 \end{bmatrix} \quad (b)$$

Form (b) includes form (a) as a special case, and it allows for the maintenance of an influence network among the accommodative mass of group members with zero self-weights, i.e., members 2, 3, ..., n in the above illustration.

The analysis pertains to a group engaged in a specific issue domain. In a large organization that is decomposable into different issue domains, with potentially different (disjoint or overlapping) subgroups involved, the tendency toward power concentration will occur within each of these issue domains. In the context of differentiated issue domains, a tendency toward local leaders in each domain is the expectation; and if, in turn, such local leaders form a group concerned with a broader domain of policy issues, a concentration of power in

such leadership groups may arise. For an analysis of problems of coordination and control in formal organizations, the specification of differentiated issue domains and the influence networks that pertain to each domain is warranted by social influence network theory. The normative organization of authority is a stable architecture for interpersonal influence across the sequence of routine and unexpected issues that arise in organizations. But the influence networks that are formed and enter into these issues need not be tightly constrained by the formal authority structure. This is well known. The command structure of formal organizations provides a backbone of interpersonal contacts that may be dramatically enhanced with additional contacts. The influence networks that enter into the influence process on specific issues are realizations not only of this contact network but also of all conditions that affect individuals' accord of influence to particular other individuals, whether they are in direct contact or not.

In large organizations, the existence of a large connected contact network may mask differentiated issue domains, and the nested hierarchy of issue domains, that regularly involve different, perhaps overlapping groups of individuals. The structural centrality of particular individuals in the global contact network of an organization may mask leadership roles of particular individuals in these differentiated issue domains. The present analysis suggests the prospect of emergent local, issue-domain-specific leaders in various parts of an organization. Because an individual's self-weight is a social construction in an issue domain, the local leader of a particular issue domain may appear as an accommodative member of the influence system of a different, higher-level issue domain.

Leaving aside the influence network evolution model advanced in the present article, the present work highlights a particular feature of social influence networks: individuals' self-weights. The theoretical importance of self-weights, loops on nodes of an influence network, have not been attended to. While many specifications of influence networks employ a matrix \mathbf{W} as it has been defined in this article, virtually all of these specifications are based on a \mathbf{W} without loops that correspond to individuals' self-weights. But self-weights are important: they are consonant with the classical line of work on reflected appraisals, and they appear as theoretically crucial features of social influence network theory. The outcomes of the interpersonal process that unfolds in an influence network importantly depend on group members' self-weights. In the early formalizations of social influence network theory advanced by French (1956), Harary (1959), and DeGroot (1974), self-weights appear as part of the specification of an influence network structure. In Friedkin and Johnsen's generalizations of these seminal models, the theoretical importance of the self-weight components of interpersonal influence networks has grown. These components, in essence, describe the extent to which each group member is subject to interpersonal influence. Friedkin and Johnsen (2011) provided some evidence, consistent with a speculation presented by Milgram (1974), that self-weight may take the form of a binary state "agentic" variable in groups whose members strongly value achieving consensus, i.e., a variable with values that are heterogeneously or homogeneously either $w_{ii} = 0$ or $w_{ii} = 1$ for group members $i = 1, 2, \dots, n$. Consensus pressure appears to generate a binary choice situation for each group member whether to be either completely open to interpersonal influence ($w_{ii} = 0$) or completely closed to interpersonal influence

($w_{ij} = 1$). This aspect of self-weight, if confirmed, would be an important advancement. The present analysis entertains a reflected appraisal approach to the social construction of self-weights. Interestingly, the evolution model generates an influence network that comports with the viewpoint on self-weights as binary end states, consistent with the production of consensus.

In the evolution process that has been considered, the reflected appraisal mechanism takes the form of a correspondence of power and self-weight. Specifically, to the extent that individuals' perceptions of the loci of control over issues and events have an objective basis, individuals without such control will accord influence to others, and individuals with such control will accord influence to themselves. If an individual has a regular noteworthy net impact on issue outcomes, then he or she and others are more likely to acknowledge that regular impact than deny it and are more likely to expect such influence on future issues in the issue domain than view such influence as a fortuitous occurrence. Individuals with such manifest control in the influence system may self-designate themselves as influential actors, take on the role of an influential actor, as defined by their culture, and expect some degree of control over the issues that arise in their social environments. By the same token, in the absence of manifest net impact on issues, the average individual's self-weight will be dampened, and the individual's issue positions will be influenced by others. Other formal specifications of a reflected appraisal mechanism are possible. In its application and extension of social influence network theory, the present investigation contributes one formal perspective on the structural foundations and micro-processes of emergent distributions of power in organizations. It is a constrained, analytically tractable, formal probe into a complex arena of effects.

A form of concentrated power arises as a near "iron law" of the influence network state-transition process that is considered in this article. The evolution to a single leader, which appears as the prevalent equilibrium of the state-transition process considered here, indicates that this outcome is, with rare exceptions, the fixed-point attractor of the evolution function toward which the dynamical system is moving. Whether this formalization provides a useful perspective on Michels' (1962) analysis of oligarchic tendencies in formal organizations is arguable. My viewpoint on the linkage of the present analysis with the line on work on oligarchy in formal organizations is restricted to the suggestion that the emergence of concentrated forms of power may be independent of the bureaucratic features of formal organizations.

Michels postulated that formal organizations inevitably develop into oligarchies in which decisions are made either by single individuals or a small subset of group members who are not influenced by the larger collectivity of individuals affected by these decisions. Bureaucratic organizations, with their divisions of labor and structures of authority, are consistent with the existence of strong formal and informal constraints on decision making at all levels that proscribe decisions by arbitrary command and prescribe meaningful consultation, negotiation, and accommodation of different concerns and interests. Michels' argument is that there is a ubiquitous tendency toward oligarchic forms in which such consultation, negotiation, and accommodation become increasingly concentrated within an individual leader or a small subgroup.

The work of the present article was not initiated to present a theory of emergent oligarchy. There have been direct efforts to formalize the mechanism

(Mayhew and Levinger, 1976). Exceptions to the tendency have been noted and analyzed (e.g., Lipset, Trow, and Coleman, 1956; Zald and Ash, 1966; Rothschild and Whitt, 1986; Osterman, 2006). The historical background of Michels' thesis and the literature related to his iron-law thesis are large and cannot be extensively covered here. The contribution of the present article to studies of oligarchic formal organizations is a demonstration that the evolution of an influence network to a concentrated form of power may be investigated with formal theories that attend to the interpersonal interactions involved in group dynamics; Mayhew and Levinger's (1976) analysis is along these lines. The present analysis is not restricted in scope to large formal (bureaucratic) organizations. If the present formalization captures a systematic tendency in the responses of individuals to their achieved levels of control over issue outcomes, then any enduring social group, formal or informal, is subject to an evolution toward concentrated power. The emergence is a nascent property of a micro-level mechanism, the end state of which may or may not be realized depending on the conditions that facilitate or inhibit the tendency or disturb the conditions under which the process is unfolding.

The present formalization presents no statement on whether a concentration of power is acceptable or unacceptable on some criterion (Leach, 2005; Osterman, 2006). The focus of the analysis is on the evolving distribution of individual-level control over group outcomes based on interpersonal influences unfolding in influence networks. Moreover, there is no demarcating threshold in the analyzed evolution process above or below which it may be said that a concentrated form of power exists or not. What can be said is this: if the specified influence network transition process continues, then its main long-term implication across an issue sequence is a concentration of power toward an end state in which issue outcomes are consistent with the uninfluenced preferences of a single person. The preferences of this emergent leader may be consonant with the majority of the group members, or not. Similarly, no distinctions are invoked on the elementary bases of the interpersonal influence and power distributions (e.g., authority, coercion, expertise, rewards, identification). Direct interpersonal influences, among the dyads in which such direct influence occurs, may be heterogeneously grounded on different multiple bases. The resultant synthesis of the bases of influence is the individual's distribution of accorded relative weights to self and to particular others. Concentrated power may be emergent on any one of these bases or on a mixture of them.

The present perspective grounds power and control on accorded influence and, as such, presents a basis on which the tendency toward power concentration may be mitigated. The tendency will disappear if group members resist a shift to a more accommodative orientation under conditions in which their manifest power is evidently modest. The tendency also will disappear if the distributions of accorded influence are regularly altered by exogenous disturbances. The tendency will be altered and reset with each such disturbance. If self-weight is a social construction, then it can be endogenously or exogenously delayed, disrupted, and deconstructed. But resistance to accommodation implies ongoing unresolved disagreements on issues that may or may not be dealt with by mechanisms, other than endogenous interpersonal influences on individuals' issue positions, such as bargaining and social choice. There are, of course, other adaptations and methods that will mitigate the concentration of

power. The responses of group members to a power structure are not restricted to the responses of those who are without power. People in positions of formal authority also are potentially important participants in adaptive responses. Such people, when they are accorded an increasing amount of influence, may resist an appropriation of influence and maintain an openness to influence from a variety of sources. Alternatively, they may act to secure and enhance direct control. A leader's behavior in this regard, and the conditioning of it, is a fundamental matter.

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