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DIFFERENT VIEWS OF HIERARCHY AND WHY THEY MATTER: HIERARCHY AS INEQUALITY OR AS CASCADING INFLUENCE

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Hierarchy is a reality of group life, for humans and for most other group-living species. However, there remains considerable debate about whether and when hierarchy can promote group performance and member satisfaction. We suggest that progress in this debate has been hampered by a lack of clarity about hierarchy and how to conceptualize it. Whereas prevailing conceptualizations of hierarchy in the group and organization literature have focused on inequality in member power or status (i.e., centralization or steepness), we build on the ethological and social network traditions to advance a view of hierarchy as cascading relations of dyadic influence (i.e., acyclicity). We suggest that hierarchy thus conceptualized is more likely to capture the functional benefits of hierarchy, whereas hierarchy as inequality is more likely to be dysfunctional. In a study of 75 teams drawn from a range of industries, we show that whereas acyclicity in influence relations reduces conflict and thereby enhances both group performance and member satisfaction, centralization and steepness have negative effects on conflict, performance, and satisfaction, particularly in groups that perform complex tasks. The theory and results of this study can help to clarify and advance research on the functions and dysfunctions of hierarchy in task groups.

Social hierarchy is an unavoidable reality of group life. Hierarchical forms of organizing, in which higher-ranking members have greater influence over the behavior of the group and its members than do lower-ranking members (Mazur, 1985), have been observed in species ranging from chickens to chimps to humans. In human groups, hierarchy can result from formal design (e.g., the assignment of formal authority), from informal respect and deference, or, more commonly, from a combination of the two (Magee & Galinsky, 2008; Ravlin & Thomas, 2005). Whether formally or informally determined, the end result of hierarchy is that members understand to whom they should defer and who should defer to them when it comes to decisions and actions that shape the direction of the group (Simpson, Willer, & Ridgeway, 2012).

While the literature is clear about the pervasiveness of hierarchy, it is less clear about whether hierarchical relationships in human groups are functional or dysfunctional. On one hand, theory and empirical evidence have suggested that hierarchy can compromise performance by reducing member motivation and stifling innovation (Ahuja & Carley, 1999; Bloom, 1999; Bunderson, 2003a, 2003b; Frick, Prinz, & Winkemann, 2003; Grund, 2012; Huang & Cummings, 2011; Jewell & Molina, 2004; Leonard, 1990; Richards & Guell, 1998; Rulke & Galaskiewicz, 2000; Siegel & Hambrick, 2005; Small & Rentsch, 2010). On the other hand, hierarchy has been shown to enhance performance by reducing

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conflict and facilitating coordination (Frick et al., 2003; Halevy, Chou, Galinsky, & Murnighan, 2011b; He & Huang, 2011; Main, O'Reilly, & Wade, 1993; Siegel & Hambrick, 2005). Given these contradictory findings, some have suggested that hierarchy has contingent effects on group effectiveness and have proposed moderators, particularly task complexity (Halevy, Chou, & Galinsky, 2011a). But studies of moderating effects have also yielded inconsistent results, with some studies suggesting that hierarchy is more positively related to performance for complex tasks (Frick et al., 2003; Halevy et al., 2011b) and others suggesting a negative relationship in complex tasks (Ahuja & Carley, 1999; Bloom, 1999; Grund, 2012; Huang & Cummings, 2011; Siegel & Hambrick, 2005).

Although the continued search for contingencies may indeed be part of the answer, we suggest that our ability to make progress in understanding the functions and dysfunctions of hierarchy has been limited by a lack of clarity about how to conceptualize hierarchy. Indeed, the concept of "hierarchy" is often used interchangeably with concepts like "centralization," "steepness," "dispersion," "asymmetry," "disparity," and "inequality" in group and organization research—concepts that all concern vertical differentiation within social groups, but that conceptualize and operationalize that differentiation quite differently. As a result, it is difficult to determine whether observed differences across studies in the effects of hierarchy are due to differences in study context or to differences in the conceptualization (or operationalization) of hierarchy. It may be, for example, that certain conceptualizations of hierarchy are more likely to capture its benefits whereas others are more likely to capture its costs.

In fact, that is exactly what we will propose here. We reviewed empirical research on hierarchy in the organization and management literature to understand how past studies have conceptualized social hierarchy in task groups. Our review suggested that past research has conceptualized hierarchy almost exclusively as inequality in the power, status, or privilege of group members, operationalized either as centralization (i.e., concentrated power or status) or as steepness (i.e., absolute differences in power or status). In contrast, a long tradition of research in ethology and some recent work in social networks, building on Emerson's (1962) observation that influence is a property of a relation and not of an actor, have suggested a view of hierarchy as cascading relations of dyadic influence (what we refer to as "acyclicity"). We will suggest that hierarchy-as-acyclicity is more likely to capture the functional benefits of hierarchy, whereas hierarchy-as-inequality is more likely to be dysfunctional. We further suggest that task complexity will magnify these effects. We investigate this proposition by comparing the conflict, performance, and member satisfaction consequences of hierarchy-as-inequality (i.e., centralization and steepness) and hierarchy-as-acyclicity in a sample of 75 task groups drawn from a variety of work settings.

This paper makes three key contributions to research on hierarchy in task groups. First, we demonstrate that hierarchy has been conceptualized in identifiably different ways in the literature and that different conceptualizations can have divergent consequences for group process and performance. Second, we show that the dominant conceptualization of hierarchy that has been and continues to be used by a majority of organization and management scholars—the inequality conceptualization—may underscore the costs rather than the benefits of hierarchy. And third, we highlight an alternative conceptualization of hierarchy—as cascading relations of dyadic influence—which may better capture the functional benefits of hierarchy. In short, this study clarifies and explicates the concept of hierarchy, and suggests important new directions for theory and research on the nature and consequences of hierarchy in task groups.

THEORY AND HYPOTHESES

Hierarchy as Inequality

Social hierarchy has been conceptualized in a variety of ways in the research literature, and extant reviews of the literature on social hierarchy have not yet grappled with differences in hierarchy conceptualizations across studies. As a foundation for our analysis, therefore, we undertook a review of past empirical studies that have sought to characterize the degree of hierarchy in task groups in order to better understand similarities and differences across conceptualizations. Given that past studies differ in both definitions and operationalizations of hierarchy, we grouped studies based on how they ultimately operationalize hierarchy rather than on hierarchy terms or definitions. We reasoned that two studies that operationalize hierarchy in the same way are really studying the same thing, even if they define or label it differently. We focused specifically on studies that have sought to characterize the degree of hierarchy in task groups based on member characteristics or behaviors, and did not include studies that manipulate the presence or absence of hierarchy (e.g., de Kwaadsteniet & van Dijk, 2010; Ronay, Greenaway, Anicich, & Galinsky, 2012), that utilize holistic ratings of hierarchy (e.g., Auh & Menguc, 2007; Wong, Ormiston, & Tetlock, 2011), or that focus on organization-level hierarchies (e.g., Ivancevich & Donnelly, 1975). (See the Appendix for a complete listing of studies reviewed.)

Our review suggested that the overwhelming majority of empirical studies examining hierarchy in task groups (88% of the studies we reviewed) conceptualize hierarchy as inequality in valued characteristics or outcomes. This conceptualization begins with the observation that group members often differ in indicators of power (e.g., resource control, formal authority, network centrality), status (e.g., degrees and certifications, title, majority group membership), and privilege (e.g., formal pay and benefits). Moreover, these differences are presumed to correlate with the deference and respect that is given to a particular member such that members with more of a valued characteristic have more influence within their group. To characterize social hierarchy, therefore, we must consider how and to what extent members differ on those social characteristics that signal power, status, or privilege. Larger differences between members suggest greater hierarchy, whereas smaller differences suggest less hierarchy (see Magee & Galinsky, 2008; Mazur, 1985).

Researchers adopting an inequality viewpoint have used one of two approaches to conceptualizing differences in power, status, or privilege. The first approach is typically referred to as centralization (Ahuja & Carley, 1999; Argote, Turner, & Fichman, 1989; Bunderson, 2003a) and views hierarchy as the concentration of power, status, or privilege in one member or in a small subset of the full membership of a social group (see similar definitions in Carter & Cullen, 1984; Marsh, 1992). Centralization approaches to conceptualizing hierarchy adopt what Harrison and Klein (2007) have called a "disparity" lens to characterize member differences, an approach that focuses specifically on concentrated inequality across members. The concept of centralization is prominent in social network research, where centralization is a well-established measure of "stratification or inequality in the extent to which actors are involved in relations" (Ibarra, 1992: 170). Centralization is operationalized using measures of concentration, such as the Freeman (1979) index or Gini (1936) coefficient, which quantify the distance between the highest scoring actor and all other actors on some dimension (see Harrison & Klein, 2007). Centralization is therefore maximized when one actor scores at the maximum and all other actors score at the minimum on some dimension, and is minimized when all actors have the same score.

A second, less common, approach to conceptualizing intra-group hierarchies is what some scholars have referred to as "steepness" (Anderson & Brown, 2010). Like centralization, steepness is concerned with inequality across members in power or status. However, whereas centralization focuses on the concentration of these valued characteristics in one or a few members, steepness is simply concerned with aggregate differences across members on these characteristics (Anderson & Brown, 2010: 56). Steepness therefore adopts what Harrison and Klein (2007) have called a "separation" lens to characterize member differences. However, whereas Harrison and Klein explicitly view separation as concerned with differences in "value, belief, and attitude" (i.e., horizontal differences), steepness focuses more specifically on vertical differences—i.e., differences in power, status, or privilege. Steepness is operationalized using measures such as the standard deviation or mean Euclidean distance, which get at the size of the absolute differences between members on some characteristic (De Vries, Stevens, & Vervaecke, 2006: 585). Steepness is therefore maximized when half of a group scores at the theoretical maximum on some dimension and the other half scores at the minimum.

Hierarchy as Acyclicity

Although the majority of empirical studies of hierarchy that emerged in our review adopted an inequality approach to conceptualizing hierarchy, there was a small number of studies that adopted a fundamentally different approach, which is grounded in research on hierarchies in the ethological and social network literatures. Research on social hierarchy has a long history in ethological research (Chase, 1980; Mazur, 1985). However, whereas inequality approaches derive hierarchy from differences in member power, status, or privilege, ethological approaches derive hierarchy from dyadic dominance; i.e., by documenting which animals defer to which other animals within a group (Chase, 1980: 907). In other words, ethological approaches embrace Emerson's (1962: 32) observation that "power is a property of the social relation; it is not an attribute of the actor." For ethologists, dyadic dominance relations are more hierarchically structured when they are more transitive or "linear;" i.e., when A dominates all other group members, B dominates all but A, C dominates all but A and B, and so forth. When dominance relations are linear, there is absolute clarity about who dominates whom. Ethologists have found evidence for linear dominance hierarchies across a wide range of animal species (Chase, Tovey, Spangler-Martin, & Manfredonia, 2002; Shizuka & McDonald, 2012).

In recent years, network scholars have used the relational approach to study hierarchies in human groups (Ahuja & Carley, 1999; Cummings & Cross, 2003; Everett & Krackhardt, 2012; Krackhardt, 1994). In doing so, they have made two important revisions to the ethological paradigm. First, they acknowledged that hierarchies in human groups are less about physical dominance and more about who has influence over whom or, put differently, who defers to whom when it comes to decisions and actions that concern the direction of the group (Joshi & Knight, 2015; Mazur, 1985). Influence and deference in human groups arise from both perceived merit (e.g., based on expertise, experience, social capital) and formal authority (Berger, Cohen, & Zelditch, 1972; Bunderson, 2003b). While it is true that members of interacting groups influence one another's cognitions, emotions, and behavior in a variety of ways as they interact, the influence relations that underlie hierarchy are based on the acceptance by one member of another member's primacy—by virtue of formal right or perceived merit—when it comes to decisions that affect the direction or operation of the group.

Secondly, network scholars have recognized that hierarchies need not be linear to be considered hierarchical. The key question in establishing hierarchy is not whether there is one A who can influence every other member, one B who can influence all but A, etc. (Martin, 2009). Rather, it is whether influence relations are "*acyclical*," such that members never have direct or indirect influence over someone who has direct or indirect influence over them (Krackhardt, 1994). Put differently, influence relations in a true hierarchy are cascading and, like water cascading over rocks, never flow upstream. Cascading or acyclical influence relations within a group suggest that there is clarity about the "chain of influence" through which members influence one another in making decisions and resolving disagreements (Hage, 1995). In network terms, a cascading hierarchy is a directed acyclic graph; i.e., a structure in which influence relations are directed (i.e., A influences B does not imply that B influences A) and where if there is a path of influence from A to D (direct or mediated), then there is not also a path from D to A (see Krackhardt, 1994; McDonald & Shizuka, 2013).

A nice example of hierarchy as acyclicity in influence relations can be found in Klein, Ziegert, Knight, and Xiao's (2006) description of leadership structures in trauma care medical teams. An attending surgeon in their study described her team's dynamics as follows:

> [T]here is a very rigid hierarchy underlying that. *The flow is one way*. The fellow can always supersede the resident, but the resident can't supersede the fellow. The attending can always supersede the fellow and the resident, but neither one of them can supersede the attending (602, emphasis added).

Klein et al. (2006) found that a clear team hierarchy set the stage for flexible and adaptive leader behaviors to emerge within these teams.

Some might argue that determining hierarchy from acyclic influence relations will ultimately reveal the same hierarchies as determining hierarchy from inequality in member characteristics that signal power or status since differences in those characteristics should predict dyadic influence (de Kwaadsteniet & Van Dijk, 2010; Ronay et al., 2012: 2). However, as Chase (1980) demonstrated, in order for differences on a given characteristic to predict even moderate linearity in dyadic influence relations, the correlation between that characteristic and dyadic influence would have to be very high (e.g., above .90)—much higher than the correlations typically observed in either animal or human research. A relational approach to conceptualizing hierarchy will therefore often lead to different conclusions about hierarchy than the inequality approach would, since influence in one dyad can be shaped by different characteristics compared to influence in another dyad (Emerson, 1962). As Magee and Galinsky (2008: 360, 363) noted, influence is a "downstream effect" of power and status, and the relationship between any indicator of power and status and actual intra-group influence is imperfect. By starting with dyadic influence relations rather than with member characteristics that presumably predict dyadic influence, a relational approach should therefore get closer to the hierarchies that ultimately shape group decisions and actions.

In response to this concern, one might point out that we could always use differences in aggregate member influence as the basis for determining centralization or steepness. This should provide a more direct comparison between inequality approaches and acyclicity, since both would then be computed from the same "downstream" measures. However, these two approaches can still lead to very different conclusions about the existence of hierarchy within a group because, again, influence is a property of a relation and not an attribute of an actor (see Emerson, 1962). As an illustration, imagine a six-person group in which each member has influence over one other member in cascading order until we reach the last member who has influence over no one; i.e., the simplest hierarchical chain of influence (A→B→C→D→E→F). Whereas the set of influence relations in such a group would be viewed as perfectly hierarchical in terms of acyclicity, they would not be viewed as even moderately hierarchical in terms of centralization or steepness, since N-1 members of this group will have the same (low) level of average influence (i.e., each has influence over just one other member).

Alternatively, one might base acyclicity on "upstream" factors by comparing relative scores on member characteristics or ranks in order to infer a relationship of deference within each dyad. However, because this approach does not look at actual dyadic deference, it still does not get at the unique and potentially idiosyncratic *influence relation* that exists between each pair of group members, which is the basis for acyclicity. Determining acyclicity by comparing member ranks on some dimension will always suggest acyclicity, since if A scores higher than B and B scores higher than C, it is impossible for C to score higher than A. In short, when we embrace Emerson's (1962) proposition that influence is a property of a social relation and not an attribute of an actor, it becomes clear why acyclicity provides a very different approach to conceptualizing hierarchy in task groups compared to the dominant inequality conceptualization.

In sum, most empirical research on hierarchy in task groups has conceptualized hierarchy as inequality in valued characteristics or outcomes, operationalized as either centralization or steepness. A few studies have adopted the relational approach employed by ethologists and network researchers in viewing hierarchy as acyclicity in dyadic influence relations. These two approaches can lead to very different conclusions about the extent to which a group is hierarchically structured. Table 1 compares acyclicity with the two inequality approaches—centralization and steepness—in terms of (a) their underlying views of hierarchy and (b) specific operationalizations. Table 1 also includes illustrations of low, medium, and high hierarchy for each hierarchy type.

The Functions of Acyclicity and the Dysfunctions of Inequality

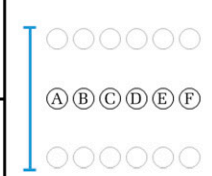
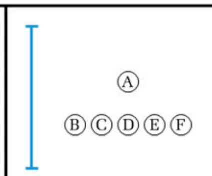
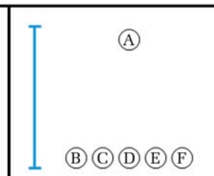
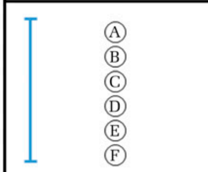
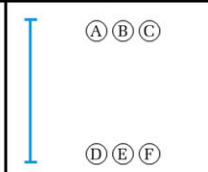
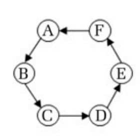
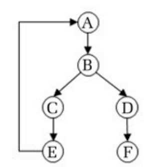
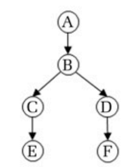
As noted earlier, the ubiquity of hierarchy across group-living species has led many researchers to conclude that hierarchy must serve adaptive and functional roles (Demange, 2004; Halevy et al., 2011a; Moosa & Ud-Dean, 2011). While past attempts to articulate these functional roles have offered various explanations, a central and recurring theme is that hierarchy provides a robust solution to conflict and coordination problems by shaping patterns of deference and influence. So, for example, Moosa and Ud-Dean (2011: 204) argued that a stable hierarchy in an animal group "reduces fighting cost for resources of both dominant and subordinate individuals compared to unstable systems where no hierarchy is present." Demange (2004: 756) developed a formal model of conflict (i.e., blocking) and coordination in hierarchical versus non-hierarchical groups and concluded that "a hierarchical decision process is shown to be . . . much more efficient in reaching stable outcomes than other processes." Ronay et al. (2012) argued that "When there is a clear hierarchy, division of labor and patterns of deference reduce conflict, facilitate coordination, and ultimately improve productivity." (See also Anderson & Brown, 2010; Greer, 2014; Magee & Galinsky, 2008; Simpson et al., 2012.)

We will suggest that hierarchy as cascading relations of dyadic influence (i.e., acyclicity) is more likely to serve these conflict-resolution and coordination functions compared to hierarchy as inequality in power, prestige, or privilege (i.e., centralization or steepness). Recall that acyclicity reaches its theoretical maximum when all influence relations within a group are cascading. In other words, there is no circularity in questions of deference and therefore no question about who has the ultimate say when disagreements arise, or when the group needs direction. In contrast, cyclical relations create an environment in which conflicts are both more likely (because it is not clear whose opinions, proposals, or directions should be given greater weight) and more problematic (because there is no accepted arbiter to resolve those conflicts). In other words, high acyclicity suggests that influence relations between and among group members are structured in a way that allows for the resolution of conflict and the coordination of effort. The following extract from Fein (2012:38) elaborates this point from an evolutionary perspective:

> Since not everyone can decide where a nomadic band should head when it is time to break camp, someone's opinion needs to dominate. Were this not the case, the group would fragment into factions. Nor would a community in which stable patterns of deference are absent have a dependable means of reducing interpersonal conflict.

In contrast, inequality approaches to conceptualizing hierarchy (centralization and steepness) reach

TABLE 1
Three Types of Hierarchy with Definitions, Operationalizations, and Illustrations

Hierarchy Type	View of Hierarchy	Specific Operationalization	No Hierarchy	Moderate Hierarchy	Maximum Hierarchy
Centralization	Hierarchy as inequality in member power or status.	Hierarchy as the concentration of power or status in one or a few members (e.g., Freeman or Gini indices).			
Steepness		Hierarchy as aggregate differences between members in power or status (e.g., standard deviation).			
Acyclicity	Hierarchy as cascading relations of dyadic influence.	Hierarchy as acyclicity in the network of directed influence relations (e.g., Krackhardt's hierarchy index).			

their theoretical maxima when (a) the differences between high- and low-ranking members are large and (b) some members have identical (high or low) rankings. This is a recipe for jealousy, rivalry, competition, coalition building, and conflict as those members with identical ranks jockey with one another in their attempts to secure resources, enhance status, and curry favor with more powerful members. This expectation is consistent with research suggesting that occupying a similar position within a social structure frequently breeds rivalry (Kilduff, Elfenbein, & Staw, 2010), as well as competition for status and resources (Ingram and Yue, 2008). Moreover, Harrison and Klein's (2007) review of research on disparity (which, as noted earlier, is analogous to centralization) concluded that "status, power, or pay disparity incites competition, differentiation, and (resentful) deviance among some unit members" (1206). In addition, the centralization of power and influence within a group has been shown to foster political behavior, coalition building, and upward influence (Bendersky & Hays, 2012; Eisenhardt & Bourgeois, 1988; Ibarra, 1992). These political dynamics are not only disruptive and inefficient, they also result in decisions that favor socially advantaged members (e.g., members of a demographic majority) rather than the more competent members (Bunderson, 2003a, 2003b).

In short, we expect that acyclicity will decrease and that centralization and steepness will increase the conflicts that arise as group members strive to coordinate their work. We will focus on conflict as a key consequence of hierarchy in our model, given that conflict is perhaps the most commonly cited process consequence of hierarchy in past theory and research, as noted earlier (Anderson & Brown, 2010; Demange, 2004; Greer, 2014; Halevy et al., 2011a; Magee & Galinsky, 2008; Moosa & Ud-Dean, 2011; Ronay et al., 2012; Simpson et al., 2012). We fully expect, however, that hierarchy (acyclicity or inequality) will also affect other expressions of group coordination that can be considered in future research (e.g., information sharing, cohesion).

Researchers have suggested that conflict in small groups can take a variety of forms, including conflict about the technical elements of a task (task conflict), about interpersonal relations and compatibilities (relationship conflict), about how to organize member roles, responsibilities, and relations in order to perform a group's work (process conflict), and about relative member standing in the group (status conflict) (see Behfar, Mannix, Peterson, & Trochim, 2011; Bendersky & Hays, 2012; de Wit, Greer, & Jehn, 2012; Jehn, 1997). Although one might adapt the arguments presented earlier to all four forms of conflict, we focus specifically on process conflict here for two reasons. First, as noted above, we expect that clarity around influence relations within a group will be particularly important for resolving disagreements and conflicts about how to allocate responsibility, coordinate work, and prioritize tasks—i.e., process conflicts. Second, process conflict has been shown to most consistently predict team performance in past research (Behfar et al., 2011; Greer, Jehn, & Mannix, 2008; Jehn, Greer, Levine, & Szulanski, 2008; Matsuo, 2006; see also meta-analysis by de Wit et al., 2012), making it a good candidate for explaining how and why hierarchy is functional or dysfunctional. We therefore focus our analysis on process conflict, but consider other forms of conflict in a post hoc analysis. Our formal hypotheses can therefore be stated as:

Hypothesis 1. The acyclicity of influence relations within a group will be negatively associated with process conflict within the group.

Hypothesis 2a. The centralization of influence relations within a group will be positively associated with process conflict within the group.

Hypothesis 2b. The steepness of influence relations within a group will be positively associated with process conflict within the group.

The Moderating Role of Task Complexity

Hypotheses 1 and 2 propose direct effects of acyclicity and hierarchy-as-inequality (centralization and steepness) on process conflict in groups. However, past theoretical work has suggested that the effects of hierarchy on intra-group processes are likely to be moderated by characteristics of a group's task (Anderson & Brown, 2010; Halevy et al., 2011a). For example, a number of scholars have suggested that hierarchy will have different implications for group process and performance in groups that perform simple versus complex tasks (Ahuja & Carley, 1999; Anderson and Brown, 2010; Siegel & Hambrick, 2005).

Task complexity concerns the clarity, routineness, and predictability of group tasks (Withey, Daft, & Cooper, 1983). As tasks become more complex, unforeseen problems and exceptions are more likely to arise, requiring case-by-case problem solving and decision making in order to appropriately adapt group processes and procedures to task demands. As a result, greater discretion is needed in the execution of complex tasks, which creates more opportunities for group members to disagree about the best way to resolve problems and address exceptions (Bigley & Roberts, 2001; Siegel & Hambrick, 2005). Acyclicity provides one efficient means for resolving these disagreements before they escalate into process conflicts, since acyclical relations of influence and deference leave no question about whose voice should be given greater weight when disagreements arise (see Fein, 2012). In contrast, task complexity should heighten process conflicts in centralized or steep groups, since each task exception provides a fresh opportunity for similarly ranked members to first disagree and then bicker and posture about whose voice should be given greater weight. These arguments are consistent with the findings of Ahuja and Carley (1999), Huang and Cummings (2011), and Siegel and Hambrick (2005), who found that centralization is detrimental for groups that perform more complex or novel tasks.

Simple tasks, on the other hand, offer fewer occasions for disagreement about processes, since members know what to expect from each task iteration and face fewer novel problems or exceptions to established routines (Bigley & Roberts, 2001). Thus, with fewer occasions for disagreement, the need for clearly ordered influence relations as a means for settling disagreements before they escalate becomes less pressing. We should therefore see less of a difference between the process conflicts experienced by high and low acyclicity teams when tasks are simple. Moreover, fewer occasions for disagreement also mean fewer opportunities for the unresolved ambiguities about influence and deference that exist in a centralized or steep group to escalate into conflict. We therefore expect:

Hypothesis 3. Task complexity will moderate the negative relationship between acyclicity and process conflict; the relationship will be stronger in teams that perform more complex tasks.

Hypothesis 4a. Task complexity will moderate the positive relationship between centralization and process conflict; the relationship will be stronger in teams that perform more complex tasks.

Hypothesis 4b. Task complexity will moderate the positive relationship between steepness and process conflict; the relationship will be stronger in teams that perform more complex tasks.

We should note that some past studies have similarly argued that hierarchy is more beneficial for groups when task complexity is higher, but then found support using inequality-based conceptualizations of hierarchy (e.g., Frick et al., 2003; Halevy et al., 2011b; Main et al., 1993). Those studies would seem to contradict Hypotheses 4a and 4b, as well as studies cited earlier that found detrimental effects of hierarchy-as-inequality in complex tasks. We find the theoretical rationale for our hypothesized effects to be the most compelling, but we will revisit these discrepancies in the Discussion section of the paper.

Implications for Group Performance and Member Satisfaction

Finally, we would suggest that acyclicity, centralization, and steepness will have consequences for both group performance and member satisfaction because of their effects on process conflict. Past research has demonstrated a consistent and negative relationship between process conflict and group performance (Behfar et al., 2011; Passos & Caetano, 2005; Vodosek, 2007; see meta-analysis by de Wit et al., 2012). Process conflicts compromise performance because member energy and attention are diverted from task accomplishment toward resolving debates and disagreement about *how* to accomplish tasks; i.e., who should perform what tasks, how to manage scheduling and workflow, what to do with freeriders, etc. (Passos & Caetano, 2005). As Behfar et al. (2011: 128) noted, process coordination and the avoidance of process losses lie at the heart of our theorizing about group effectiveness. We therefore hypothesize that acyclicity, centralization, and steepness will have indirect effects on group performance through their effects (direct and task-contingent) on process conflict. Formally:

Hypothesis 5. Acyclicity will have a positive indirect effect on group performance through its effect on process conflict.

Hypothesis 6a. Centralization will have a negative indirect effect on group performance through its effect on process conflict.

Hypothesis 6b. Steepness will have a negative indirect effect on group performance through its effect on process conflict.

Whereas scholars have often disagreed about whether hierarchy is good or bad for group performance, there has been considerable agreement about the effects of hierarchy on member satisfaction and morale. In short, scholars have long suggested that hierarchy undermines member satisfaction (Leavitt, 1951). In a review of group and organization research on hierarchy, for example, Anderson and Brown (2010: 65) concluded that "Taller hierarchical structures almost always predicted worse attitude-related outcomes." We suggest that these negative attitudinal effects of hierarchy may be due to inequality and not to the acyclicity of dyadic influence relations. We have suggested that centralized and steep networks foster process conflict whereas acyclicity reduces process conflict. There is strong evidence to suggest that process conflict creates a negative affective climate within a group. In their recent meta-analysis, for example, de Wit et al. (2012) found strong negative relationships between process conflict and trust, cohesion, satisfaction, commitment, identification, and organizational citizenship behavior. At the same time, they found that decreases in process conflict increased these positive attitudinal outcomes. We would therefore expect that by heightening process conflict, centralization and steepness can have negative effects on member satisfaction in groups. In contrast, by reducing process conflict and smoothing coordination, acyclicity should have a positive effect on satisfaction. We therefore hypothesize:

Hypothesis 7. Acyclicity will have a positive indirect effect on member satisfaction through its effect on process conflict.

Hypothesis 8a. Centralization will have a negative indirect effect on member satisfaction through its effect on process conflict.

Hypothesis 8b. Steepness will have a negative indirect effect on member satisfaction through its effect on process conflict.

DATA AND METHOD

Sample and Procedures

Past research on hierarchy in teams has been conducted in a wide range of team settings, including top management teams, research teams, sports teams, student groups, boards of directors, manufacturing teams, telecommunications teams, and customer service teams (see Appendix A). Each of these past studies has tended to focus on one type of team. One explanation for the equivocal results in past research, therefore, is that the effects of hierarchy vary across types of teams. In order to mitigate this concern in the present study, we collected data from a diverse sample of teams, while utilizing a standard data collection protocol so that all teams could be studied together. Specifically, we sampled existing work teams in the field that met the following basic definition of a team: they must (a) have at least four to five members, (b) perform organizationally relevant work (not trivial tasks), (c) frequently interact face to face, (d) share resources and information, and (e) coordinate efforts toward the accomplishment of joint goals (see Kozlowski & Bell, 2003). No other selection filters were applied that could narrow the sample. In identifying teams, we relied on our team's and university's contacts (for precedents, see Ambrose, Schminke, & Mayer, 2013;

Bledow, Rosing, & Frese, 2013; Mayer, Aquino, Greenbaum, & Kuenzi, 2012).

Once teams were identified, team supervisors were invited to participate in a study of team characteristics and member interactions. Supervisors who agreed to participate provided us with additional information, such as the nature of team tasks, the size and industry sector of the organization, and the names of team members. Data were then collected using standardized instruments and procedures. Two separate surveys were distributed: a team member survey and a supervisor survey. In the team member survey, members rated dyadic influence, task complexity, process conflict, and satisfaction. Supervisors rated overall team performance only. Supervisors were not included in the team member analyses because (a) supervisors varied in how much they truly worked as part of these teams and (b) we wanted to keep performance ratings independent of team process ratings. All data were collected within a two-month period.

We initially approached 120 teams. Of these, 13 were unresponsive, six declined, and seven were considered to lead ineligible teams.[1] We therefore collected data from 94 teams. Of these, 17 were later dropped because less than 70% of the team responded, and two were dropped because we did not receive supervisor surveys. The final sample therefore consisted of 457 respondents from 75 work teams in 56 organizations. The response rate among participating teams was 94%, with an average within-team response rate of 95%. Table 2 summarizes the teams in our sample. As intended, these teams came from a wide range of settings, including 11 different industries (such as information technology, hospitality, finance, agriculture, transportation, telecommunications, education, and government services) and different disciplinary areas including sales, finance, R&D, administrative support, engineering, and marketing.[2] Twenty-eight teams (37%) worked in branch offices. In terms of organization size, 12 teams (16%) worked in organizations or branches with fewer than 20 employees, 17 (23%) in organizations or branches with 20 to 99 employees, 20 (27%) in organizations or branches with 100 to 499 employees, and 26 (35%) in organizations or branches with 500 or more employees. Thirty-four (45%) came from the not-for-profit sector.

Teams had 6.5 members on average ($SD = 2.2$), with an average team tenure of 3.95 years ($SD = 4.2$), an average age of 40.7 years ($SD = 11.5$), and with 43% females. Most (98.7%) team members had a vocational qualification or higher. Average supervisor age was 47.3 years ($SD = 9.7$); 71% were male, and all had a vocational qualification or higher. Supervisors' average team tenure was 5.1 years ($SD = 5.95$).

Measures

Acyclicity, centralization, and steepness. Acyclicity, steepness, and centralization were measured using a dyadic rating approach. Specifically, participants were given the names of all members of their team and were asked to indicate the extent to which each team member "exerts influence over me" (1 = not at all, 2 = somewhat, 3 = to a large extent). Consistent with our theoretical arguments, this measure focuses on influence relations and not on the "upstream" factors that might predict dyadic influence, such as power advantages, formal authority, or informal status and respect. We expect that influence as measured here is predicted by both formal authority and informal status or respect (we explicitly examine this expectation below). Moreover, our item measures influence from the perspective of the "influencee" rather than the "influencer." This approach acknowledges that whereas members may perceive that they have influence over others, the influence relations that underlie hierarchy are based on the acceptance by one member of another member's influence over her or him (as noted earlier).

To address concerns about the use of a single item to measure influence relations, we validated our measure against items used in Joshi and Knight (2015), using data obtained from an online sample of working professionals who were asked to reference a specific group experience ($n = 198$). Joshi and Knight (2015) conducted a similar validation study to validate their single item of dyadic deference. Their items included: "I defer to this person's work-related opinions and inputs in the lab," "When we disagree, I yield to this person's perspective," "I go along with this person's recommendation," and "I respect this person's point of view." The reliability of a scale made up of Joshi and Knight's items plus our item was .82 and all five items loaded on a single factor, with our item loading at .81 (highest loading = .85, lowest = .53).

As noted above, we expected that our influence measure would be predicted by both formal authority and informal status or respect. In our sample, influence

[1] Three did not meet the definition of a team, three had supervisors who did not work closely enough with the team to complete the supervisor survey, and one had members who did not speak the same language, thus complicating team coordination and data collection.

[2] We examined sample heterogeneity across industries and disciplinary areas using Blau's (1977) heterogeneity index. Scores exceeded .90 for both industry and discipline.

TABLE 2
Description of Teams and Tasks in the Sample

Type of team	Description of specific tasks	# Teams
Healthcare (5 teams)	Special care for disabled patients	1
	Treating (cardiology) patients	3
	Vaccination, screening, and treatment of patients with sexually transmitted diseases	1
Sales (4 teams)	Selling—dairy products, distribution techniques, cars, and flexible foils	4
Management (11 teams)	Managing day-to-day operations of a restaurant chain	4
	Managing production processes and quality control	2
	Managing 15 tire centers	1
	Scheduling, planning, and coordinating activities	4
Research and research support (6 teams)	Conducting pharmaceutical research	1
	Analyzing the chemical processes and fermentation of waste materials	2
	Updating and clearing the national archives and making them accessible	2
	Reviewing and making decisions on grant proposals, monitoring granted projects	1
Administrative support: HR, legal, policy (7 teams)	Recruiting and selecting employees, HR advice, personnel administration	3
	Administrative organization, quality control and support of staff	4
Educational (7 teams)	Developing educational program for high school students	3
	Teaching elementary school children, and organizing remedial teaching	2
	Teaching and coaching of asylum seekers	1
	Team development and training for police officers	1
Finance (5 teams)	Cost control and estimation, purchasing, and planning	4
	Managing retirement insurance	1
Consulting (7 teams)	Financial and risk management of companies, providing advice to board members	2
	Supporting the board with developing their mission, strategy, and monitoring system	2
	Providing legal advice; monitoring adherence to legal regulations by companies	3
Engineering (10 teams)	Directing the production of airplane components and assessing their quality	2
	Realizing the detailed design of wind turbines	1
	Building and testing mobile banking applications for the iPhone and iPad, using Android	3
	Maintenance of computers, technical services, and software solutions	2
	Designing, building, testing, and implementing telecommunication products	2
Marketing (4 teams)	News selection and script writing; field marketing; promoting, planning, and organizing marketing activities	4
Other (9 teams)	Purchasing oil and gas	1
	Monitoring facility management activities, maintenance planning and execution	4
	Social security-related services and activities	4
	TOTAL:	**75**

was indeed predicted by a number of status indicators, including team tenure, seniority, education level, and income (all at $p < .01$ with all variables entered). We did not assess formal authority, since team supervisors were not included in the team analyses. We did, however, explicitly examine formal and informal predictors of influence in our online validation sample. Specifically, we regressed our measure of influence on a three-item measure of formal authority (e.g., "I report to this person," "This person is my supervisor," "This person has authority over me;" $\alpha = .97$) and a three-item measure of informal respect (e.g., "This person's position is usually the correct one," "I am persuaded by this person's arguments and opinions," "I usually come around to this person's point of view"; $\alpha = .84$). The standardized β coefficient for formal authority was .45 ($p < .001$) and for informal respect it was .41 ($p < .001$) (49% total variance explained).

We used responses to our influence question to create a sociomatrix in which matrix element x_{ij} represents member i's influence over member j, as judged by member j. Given that only 14% of respondents marked "to a large extent," whereas 46% marked "somewhat," we collapsed the three response categories in order to create a dichotomous variable in which 0 = "not at all" and 1 = "somewhat" or "to a large extent." Dichotomous measures were required for our acyclicity assessment. We computed acyclicity using Krackhardt's (1994) network hierarchy measure: $1 - [V/\max(V)]$, where V is the number of pairs in the network where influence is symmetric (A influences B and B influences A, directly or indirectly) and max(V) is the total number of connected pairs (A influences B or B influences A, directly or indirectly). Acyclicity values can range from 0 (all connected pairs have symmetric influence) to 1 (all connected pairs have asymmetric influence).

We computed centralization using Freeman's (1979) degree centralization index, $\sum(c_{max}\text{-}c_i) / (n\text{-}1)^2$, where c_i is each member's influence centrality score, c_{max} is the highest influence centrality score within the team, and n is the number of team members. Influence centrality for each member (c_i) was computed as the number of other team members who indicated that a given team member had influence over them. We computed centralization from simple degree centrality rather than alternatives such as Bonacich (1987) centrality to be consistent with past hierarchy research.[3] Steepness was computed as the standard deviation of influence centrality scores within a team. By computing centralization and steepness from the same influence ratings used to compute acyclicity, we focus our analysis on the effects of different conceptualizations of hierarchy while holding constant the underlying indicator of member power or influence.[4]

[3] Centralization as computed here and centralization computed from Bonacich centrality were correlated at .70. Analyses with centralization indices based on either Freeman or Bonacich centrality scores led to similar results.

[4] Because centralization and steepness both measure inequality, we would expect them to be correlated. To examine this expectation, we correlated centralization and steepness for all possible configurations of influence centrality in a six-person team (n = 46,656 possible configurations). The correlation was .63.

Task complexity. Task complexity was measured with eight items adapted from Withey et al. (1983). Sample items include: "We follow an understandable sequence of steps in performing our team tasks," "We use established procedures and practices to perform our team tasks," "The tasks of our team are very routine," and "There is a clearly known way to do the major types of work we normally encounter." We measured these eight items on a seven-point scale (1 = strongly disagree, 7 = strongly agree), and reverse-coded them to form a global measure of task complexity for each team member. The Cronbach's α value for the eight-item scale was .81, and aggregation statistics supported aggregation to the team level: ICC1 = .37; ICC2 = .79; $F(74,387) = 4.72$, $p < .001$; median rwg(j) = .93 ($SD = .06$) (James, Demaree, & Wolf, 1984).

Process conflict. Process conflict was measured with three process conflict items from Shah and Jehn (1993): "To what extent are there disagreements about who should do what in your work team?" "To what extent is there conflict in your work team about task responsibilities?" and "To what extent do you disagree about resource allocation in your work team?" (1 = to a small extent, 7 = to a large extent). The Cronbach's α value for the combined three-item scale was .82, and aggregation statistics supported aggregating to the team level: ICC1 = .14; ICC2 = .52; $F(74,376) = 2.07$, $p < .001$; median rwg(j) = .84 ($SD = .21$).

Team performance. Because our sample included a diverse set of work teams that pursued very different tasks and responsibilities, we used a broad measure of team performance as suggested by previous research (Ancona & Caldwell, 1992). Specifically, we asked each supervisor to compare the performance of the focal work team with that of other work teams with similar composition, tasks, and customers on the following criteria: quality, effectiveness, work speed, meeting deadlines, and performance continuity. The response set ranged from 1 (far below average) to 7 (far above average). The Cronbach's α value for the combined five-item scale was .84, suggesting that supervisors were evaluating an overall construct of team effectiveness.

Job satisfaction. Job satisfaction was measured with four items taken from Agho, Price, and Mueller's (1992) global satisfaction measure: "I find real enjoyment in my job," "I am never bored with my job," "I feel fairly well satisfied with my job," and "I would not consider taking another kind of job." The Cronbach's α value for the combined four-item scale was .91, and aggregation statistics supported aggregating to the team level: ICC1 = .13; ICC2 = .50; $F(74,377) = 2.00$, $p < .001$; median rwg(j) = .92 ($SD = .20$).

Controlling for the "treeness" of the influence network. Although acyclicity is a necessary condition for a set of relations to be considered hierarchical, Krackhardt (1994) added that an acyclical set of relations can still deviate from a hierarchical tree structure, which some see as the archetype for hierarchy (Corominas-Murtra, Goni, Sole, & Rodriguez-Caso, 2013; Demange, 2004; Izar, Ferreira, & Sato, 2006; Kemp & Tenenbaum, 2008). For example, a group's influence network may be acyclical but still include (a) isolates who do not influence and are not influenced by anyone or (b) paths of influence that trace back to more than one origin (i.e., a tree with two trunks). It is therefore important to also explicitly consider the "reachable connectedness" of an influence network (Everett & Krackhardt, 2012), or the extent to which at least one member can (directly or indirectly) influence all other members, as a potential boundary condition for the effects of acyclicity. Reachable connectedness is computed as $1 - [(V - 1)/(n - 1)]$, where V is the smallest number of actors required such that all actors in the network are reachable from this set of actors, and n is the total number of actors (Everett & Krackhardt, 2012). Reachable connectedness for the teams in this sample averaged .90 (SD = .20), and 73% had a reachable connectedness score of 1.0. In short, most of these teams had at least one member who could directly or indirectly influence all other members, and there was little variance on this measure. Nevertheless, because some teams had reachable connectedness scores lower than 1, we controlled for reachable connectedness in all models.

Krackhardt (1994) has also noted that in a classic hierarchical tree structure, every member is influenced by just one upstream member. Exceptions to this rule are "inefficient," and may introduce conflict and coordination problems—even when the network is acyclical. We would expect that influence relations in small groups will be at least somewhat inefficient since informal relations of influence often develop among multiple members. The important thing for overall group functioning is that these relations remain acyclical so that there is an ultimate arbiter. Nevertheless, we controlled for efficiency in all models to capture any possible effects on conflict. Efficiency was computed, following Krackhardt (1994), as $1 - [W / \max(W)]$, where W is the number of network ties in excess of the minimum needed for a hierarchical tree and max(W) is the maximum number of excess ties. Note that efficiency and acyclicity should be correlated since inefficient networks are more likely to include cycles.

Other controls. Given that size varied considerably across teams and we know that team size relates to cohesiveness and communication, team size was included as a control variable in all analyses (Ancona & Caldwell, 1992; Bantel & Jackson, 1989). We also ran our models with the following control variables: mean team tenure, age diversity, team tenure diversity, and gender diversity. Since none of these control variables affected the pattern of significant results, we do not include them in the final models reported in this paper, consistent with the recommendations of Becker (2005). Nevertheless, they are included in our correlation matrix.

RESULTS

Table 3 reports descriptive statistics and correlations for all study variables. We observed positive correlations between process conflict and both centralization (.24, $p < .05$) and steepness (.26, $p < .05$), and a negative correlation between acyclicity and process conflict (−.30, $p < .01$), consistent with Hypotheses 1 and 2. We also observed a strong negative correlation between member satisfaction and process conflict (−.36, $p < .01$). Centralization and steepness were also strongly correlated (.81, $p < .001$), even more so than in our simulation described above. Acyclicity was not significantly correlated with either centralization or steepness.

Table 4 reports the results of regression analyses examining the main and/or interactive effects of acyclicity, centralization, and steepness on process conflict, group performance, and member satisfaction. We ran models with centralization and steepness separately, since these two variables were highly correlated and conceptually overlapping, as noted earlier. Models 1 to 3 report results for models that include acyclicity with centralization, whereas Models 4 to 6 report results for models that include acyclicity with steepness. None of the control variables (size, reachable connectedness, or efficiency) was significant in any of the models. Hypotheses 1 and 2 (a and b) predicted that acyclicity would be negatively related to process conflict, whereas centralization and steepness would be positively related to process conflict. As predicted, acyclicity was negatively related to process conflict when controlling for both centralization ($p < .001$ in Model 1) and steepness ($p < .01$ in Model 4). In contrast, centralization and steepness were both positively related to process conflict ($p < .05$ in Models 1 and 4). Adding the independent variables and moderator explained an additional 12% of the variance in process conflict (in both Models 1 and 4). These results are consistent with Hypotheses 1, 2a, and 2b.

Hypotheses 3 and 4 (a and b) predicted that these effects would be amplified in groups that perform more complex tasks. These predictions were examined by adding interaction terms to Models 1 and 4 in Table 4. We found a significant interaction term in the case of centralization ($p < .05$, see Model 1), a marginally significant interaction term for steepness ($p = .07$, see Model 4) but no significant interaction for acyclicity (p = n.s. in Models 1 and 4). Adding the interaction terms explained an additional 7% of the variance in Model 1 and an additional 4% in Model 4. An analysis of simple slopes suggested that centralization and steepness were both significantly related to process conflict only when task complexity was high (**low task complexity**—centralization: $B = .02$, $t = .16$, n.s.; steepness: $B = .06$, $t = .47$, n.s.; **high task complexity**—centralization: $B = .43$, $t = 3.64$, $p < .001$; steepness: $B = .35$, $t = 3.09$, $p < .01$). An interaction plot (see Figure 1) provides further insight into the nature of the significant centralization interaction. Whereas centralization was essentially unrelated to process conflict when task complexity was low, it became positively associated with conflict when task complexity was high.

Hypotheses 5 through 8 predicted that acyclicity, centralization, and steepness would have indirect effects on both performance and satisfaction through their effects on process conflict. The results are presented in Table 4. Process conflict was negatively related to both performance and satisfaction after controlling for the main and task-contingent effects of acyclicity and centralization (Models 2–3), as well as the main and task-contingent effects of acyclicity and steepness (Models 5–6). Process conflict explained an additional 8% of the variance in performance in Model 2 (with centralization) and 5% in Model 5 (with steepness) and explained an additional 2% of the variance in satisfaction in Model 3 (with centralization) and 1% in Model 6 (with steepness). We examined the significance of the conditional indirect effects predicted in Hypotheses 5 through 8 using the bootstrapping procedures recommended by Preacher, Rucker, and Hayes (2007). The results are summarized in Table 5. We found that the indirect effect of acyclicity on both performance and satisfaction was positive and significant at all levels of task complexity (i.e., 95% bias corrected and accelerated confidence intervals did not include zero). These results support the indirect effects of acyclicity predicted in Hypotheses 5 and 7, but reconfirm that these indirect effects are not conditional on task complexity. We also found a negative indirect effect of centralization on both performance and satisfaction when task complexity was at average or high levels, and a negative indirect effect of steepness on satisfaction when task complexity was at average or high levels. These results are consistent with the conditional indirect effects of hierarchy-as-inequality predicted in Hypotheses 6a, 8a, and 8b. We found no significant indirect effect of steepness on performance using a 95% confidence interval. However, at a 90% level of confidence, this effect was also significant at both average and high levels of task complexity, providing cautious support for Hypothesis 6b.

Post Hoc Analysis: Different Forms of Conflict

We focused on process conflict as the mediator in our model given that process conflict is specifically concerned with conflicts related to the delineation of member roles, responsibilities, and relations—the very conflicts that we suggested could be resolved by acyclicity and exacerbated by centralization or steepness. It may be, however, that acyclicity and hierarchy-as-inequality also affect task, relationship, and status conflicts. We therefore re-ran Models 1 and 4 with task, relationship, and status conflict as dependent variables in place of process conflict. Task and relationship conflict were each measured using three items from Jehn (1995) and status conflict was measured using four items from Bendersky and Hays (2012). Reliability coefficients (α) for all scales were above .70, and a confirmatory factor analysis supported a four-factor model over a one-factor model (four-factor: $\chi^2 = 223.7$, $df = 59$, NFI = .97, CFI = .98, SRMR = .055, GFI = .93, AGFI = .89; one-factor: $\chi^2 = 1664.27$, $df = 65$, NFI = .85, CFI = .86, SRMR = .11, GFI = .63, AGFI = .48).

We found that centralization and steepness significantly increased all forms of conflict ($p < .05$ in every case). Acyclicity reduced task and relationship conflict, but the effect of acyclicity on status conflict, while negative, did not reach significance. Acyclicity did, however, significantly reduce status conflict for complex tasks ($p < .05$ in models with either centralization or steepness), an interaction effect that we hypothesized (Hypothesis 3) but did not find with process conflict. Task complexity also strengthened the effect of acyclicity on relationship conflict ($p = .06$ for models including centralization, $p = .07$ for models including steepness). Finally, the effects of steepness and centralization on relationship conflict were stronger for teams that performed complex tasks ($p = .06$ in the case of centralization). Simple slope analyses suggested that any significant effects of hierarchy on conflict were only observed

TABLE 3
Descriptive Statistics and Correlations

	Variable	Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Team tenure[a]	47.6	30.9													
2	Age diversity	0.20	0.09	0.23*												
3	Team tenure diversity	0.66	0.31	0.16	0.17											
4	Gender diversity	0.29	0.20	–0.02	–0.01	–0.16										
5	Team size	6.4	2.2	.02	0.09	0.14	0.17									
6	Efficiency	0.31	0.28	–0.13	–0.09	0.11	–0.01	–0.03								
7	Reachable connectedness	0.90	0.20	–0.02	0.13	–0.03	0.07	0.15	–0.66***							
8	Acyclicity	0.41	0.36	–0.07	–0.13	0.07	0.01	–0.32**	0.49***	–0.60***						
9	Centralization	0.41	0.21	–0.09	–0.00	0.01	0.20	–0.14	–0.13	0.35**	0.22					
10	Steepness	0.23	0.11	–0.02	0.09	0.03	0.15	–0.22	–0.13	0.35**	0.18	.81***				
11	Task complexity	4.2	0.69	–0.07	0.19	0.00	0.07	–0.07	–0.31**	0.23*	–0.10	–0.02	.02			
12	Process conflict	3.3	0.66	0.05	0.14	–0.14	0.17	–0.05	–0.22	0.31**	–0.30**	.24*	.26*	.15		
13	Group performance	5.2	0.76	–0.15	0.09	0.02	–0.05	0.07	–0.19	0.06	–0.08	.01	.00	.25*	–0.15	
14	Member satisfaction	5.6	0.60	0.19	0.18	0.07	–0.14	0.01	0.03	–0.16	0.11	–0.20	–0.13	.04	–0.36**	.05

Notes: $n = 75$.
[a] In months.
* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 4
Regression Results: Process Conflict, Group Performance, and Member Satisfaction

	Acyclicity and centralization			Acyclicity and steepness		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Process conflict	Group performance	Member satisfaction	Process conflict	Group performance	Member satisfaction
Covariates						
Team size	−0.09 (0.07)	0.05 (0.10)	0.01 (0.07)	−0.07 (0.08)	0.06 (0.09)	0.01 (0.08)
Efficiency	0.08 (0.10)	−0.10 (0.12)	−0.07 (0.10)	0.04 (0.10)	−0.16 (0.12)	−0.07 (0.10)
Reachable connectedness	−0.03 (0.13)	−0.20 (0.16)	−0.06 (0.13)	−0.02 (0.13)	−0.19 (0.16)	−0.12 (0.13)
Independent variables						
Acyclicity	−0.41 (0.11)***	−0.28 (0.15)$^+$	0.05 (0.12)	−0.34 (0.11)**	−0.16 (0.14)	−0.04 (0.11)
Centralization	0.22 (0.09)*	0.13 (0.12)	−0.10 (0.10)	–	–	–
Steepness	–	–	–	0.20 (0.10)*	0.09 (0.12)	−0.00 (0.09)
Moderator						
Task complexity	0.15 (0.07)*	0.27 (0.10)**	0.04 (0.08)	0.10 (0.08)	0.21 (0.09)*	0.06 (0.08)
Interactions						
Acyclicity × Task complexity	−0.05 (0.08)	0.01 (0.09)	0.07 (0.08)	−0.03 (0.08)	0.06 (0.09)	0.04 (0.08)
Centralization × Task complexity	0.20 (0.08)*	0.23 (0.10)*	−0.02 (0.08)	–	–	–
Steepness × Task complexity	–	–	–	0.14 (0.08)$^+$	0.08 (0.10)	0.03 (0.08)
Mediator						
Process conflict		−0.39 (0.15)*	−0.28 (0.12)*		−0.31 (0.15)*	−0.34 (0.12)**
Model *F*	3.42**	2.04*	1.48	2.86**	1.41	1.35
R^2	0.29	0.22	0.17	0.26	0.16	0.16

Notes: $n = 75$.
* $p < .05$
** $p < .01$
*** $p < .001$
$^+ p < .10$

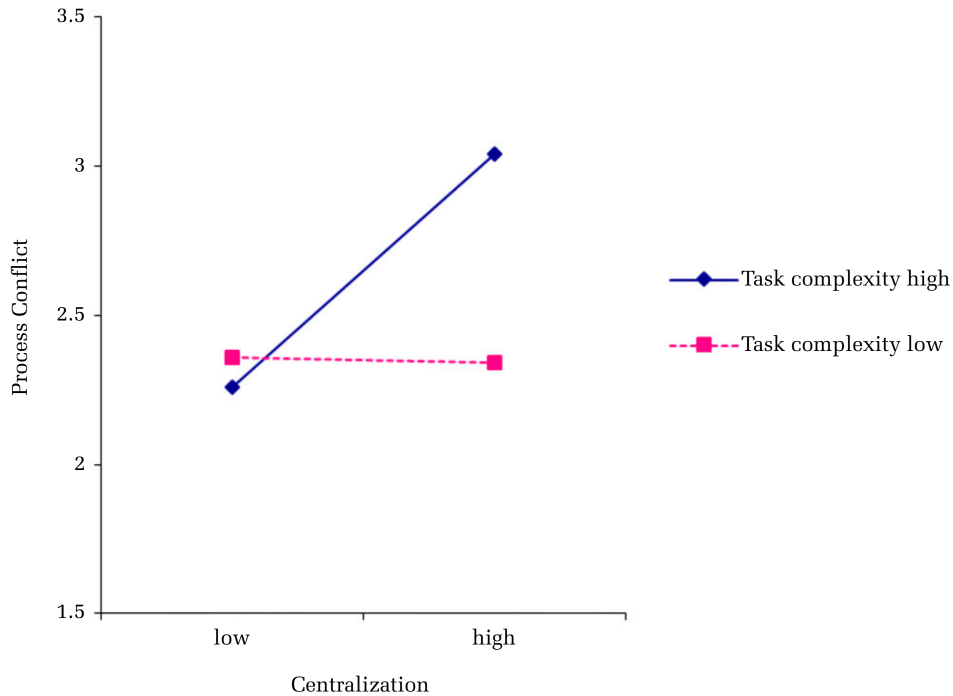
when task complexity was higher. We consider these post hoc findings in the Discussion.

DISCUSSION

We began this paper by noting that past research on the functions and dysfunctions of hierarchy has been equivocal in its conclusions about whether hierarchy in groups has positive or negative implications for group processes and performance. We suggested that one possible explanation for these equivocal results is that hierarchy has been conceptualized and operationalized in a variety of ways across past studies, without careful attention to how various conceptualizations differ and whether they might lead to divergent results. We have demonstrated that, in fact, there are substantive differences in how past researchers have conceptualized hierarchy, and that different conceptualizations can have opposite effects on conflict and performance. Specifically, we found that in a diverse sample of work teams, the dominant conceptualization of hierarchy in the organization and management literature—hierarchy as inequality (centralization and steepness)—heightened conflict and compromised performance, whereas hierarchy as acyclical influence relations reduced conflict and improved performance. These results suggest that how hierarchy is conceptualized may indeed be a key factor in determining whether researchers find functional or dysfunctional effects of hierarchy in their studies. One key implication of the present research, therefore, is that hierarchy researchers must be more mindful and explicit in how they conceptualize hierarchy, and should consider whether their conceptualizations (and operationalizations) match their theories.

The theory and results presented here also provide initial evidence to suggest that a conceptualization of hierarchy as cascading relations of dyadic influence (i.e., acyclicity) may better capture the functional benefits of hierarchy than a conceptualization of hierarchy as inequality in power, status, or influence. Several questions remain to be addressed, however, before we can fully evaluate the relative merits of acyclicity versus inequality in examining group processes and

FIGURE 1
The Moderating Effect of Task Complexity on the Relationship Between Centralization and Process Conflict



performance. First, although centralization and steepness had negative effects on conflict, performance, and satisfaction in this study, past research has been equivocal about these effects. We need to make sense of those discrepancies. Second, it is important to be clear about the boundary conditions under which the hypothesized effects of acyclicity might be expected to operate. Third, the moderating effects of task complexity require further consideration given the pattern of results (including post hoc analyses). In the following sections, we consider each of these issues and their implications for future research on different conceptualizations of hierarchy. We then conclude with a consideration of additional directions for future research and of study limitations.

Resolving Discrepant Findings

Whereas findings from a number of studies have corroborated the negative main and interactive effects of hierarchy-as-inequality on group processes, group performance, and member satisfaction that we found in this study (Ahuja & Carley, 1999; Bloom, 1999; Cummings & Cross, 2003; Grund, 2012; Huang & Cummings, 2011; Jewell & Molina, 2004; Siegel & Hambrick, 2005; Small & Rentsch, 2010), other studies have reported opposite effects. For example, several studies have found that greater pay dispersion within a team (conceptualized as centralization or steepness) is positively related to performance outcomes, particularly in teams that perform unpredictable and dynamic tasks (Frick et al., 2003; Halevy et al., 2011b; Main et al., 1993; see also He & Huang, 2011).

One possible explanation for these discrepant findings is that the effect of hierarchy-as-inequality on group functioning may depend on the specific power, status, influence, or privilege indicator that is selected as the basis for evaluating inequality. For example, whereas it is certainly the case that pay disparities are salient indicators of intra-group inequality, pay differences are distal predictors of influence and it is not at all clear that a pay advantage will always lead to influence or deference. In attempting to make sense of divergent findings, therefore, we might begin with the hypothesis that inequality indicators that get closer to actual influence or deference behavior (i.e., that are further "downstream," as suggested by Magee and Galinksy [2008]) are more likely to reveal the effects of hierarchy-as-inequality on group functioning. In fact, those studies in our review that based hierarchy on peer ratings or direct indicators of member influence or dominance tended to suggest negative effects of centralization or steepness on group

TABLE 5
Bootstrap Results for Conditional Indirect Effects—Process Conflict as Mediator and Task Complexity as Moderator

DV = GROUP PERFORMANCE

	Hierarchy as Ordered Influence			Hierarchy as Inequality					
	Acyclicity[a]			Centralization			Steepness		
Task complexity	Cond. ind. effect	BCa-L95	BCa-U95	Cond. ind. effect	BCa-L95	BCa-U95	Cond. ind. effect	BCa-L95	BCa-U95
Low	0.14	0.02	0.35	–0.01	–0.14	0.11	–0.02	–0.16	0.06
Average	0.16	0.02	0.36	–0.09	–0.25	–0.01	–0.06	–0.20	0.00
High	0.18	0.02	0.45	–0.17	–0.39	–0.02	–0.11	–0.28	0.00

DV = MEMBER SATISFACTION

	Hierarchy as Ordered Influence			Hierarchy as Inequality					
	Acyclicity[a]			Centralization			Steepness		
Task complexity	Cond. ind. effect	BCa-L95	BCa-U95	Cond. ind. effect	BCa-L95	BCa-U95	Cond. ind. effect	BCa-L95	BCa-U95
Low	0.10	0.03	0.31	–0.01	–0.12	0.06	–0.02	–0.17	0.05
Average	0.12	0.03	0.29	–0.06	–0.19	–0.004	–0.07	–0.20	–0.00
High	0.13	0.02	0.35	–0.12	–0.29	–0.01	–0.12	–0.27	–0.01

Notes: Bootstrap $n = 1{,}000$. Bias corrected and accelerated (BCa) confidence intervals are reported. BCa-L95 = 95% confidence interval lower limit. BCa-U95 = 95% confidence interval upper limit. Shaded cells indicate significant effects.

[a] Acyclicity effects are from models that included centralization.

effectiveness (Bunderson, 2003a; Grund, 2012; Rulke & Galaskiewicz, 2000; Small & Rentsch, 2010).

Boundary Conditions for the Effects of Acyclicity

In investigating the functional benefits of hierarchy-as-acyclicity, it is also important to be clear about the boundary conditions under which the acyclicity effects examined in this paper might be expected to operate. We noted above that the reachable connectedness (Everett & Krackhardt, 2012) of an influence network provides one key boundary condition for the effect of acyclicity, since a network can be acyclical but still have fragmented influence branches (i.e., two "trunks") or isolated members. Reachable connectedness had no effect on conflict, performance, or member satisfaction in any of our models. However, a clear majority of the teams in our sample (73%) had reachable connectedness scores of 1.0. In samples where reachable connectedness varies more widely (e.g., teams with sparser influence networks), it could have implications for group effectiveness or the effects of acyclicity. This possibility must, therefore, be explicitly considered in research that investigates the effects of hierarchy-as-acyclicity.

Moreover, in examining hierarchy-as-acyclicity, it is important to keep in mind that the theoretical arguments advanced here specifically concern acyclic relations of dyadic influence and deference, and should not be taken to imply that acyclicity in any dyadic relation will be beneficial for groups. For example, although some past research has viewed inequality in communication or information sharing as evidence of hierarchy (Ahuja & Carley, 1999; Huang & Cummings, 2011; Rulke & Galaskiewicz, 2000), acyclicity in dyadic communication relations may actually be detrimental to group effectiveness, particularly in groups that perform complex tasks. Acyclicity in communication relations suggests that work-related information is being "passed down" a communication chain, rather than flowing freely across members. Such restricted information sharing within a group is likely to result in delays, information distortion, and a failure to get task-relevant information where it is needed. Indeed, both Ahuja and Carley (1999) and Cummings and Cross (2003) found that acyclic communication networks are negatively associated with performance in task groups. The ideal relational structure, therefore, may be one in which influence relations are cascading and communication relations are dense.

Finally, although hierarchies of formal authority will almost invariably be acyclical (by design), we would not expect that acyclic relations of formal authority will be as strongly related to conflict, performance, or satisfaction as acyclicity in influence relations. As noted earlier, formal authority is just one "upstream" predictor of actual influence relations in task groups and, in many cases, will be a weaker predictor compared to informal factors such as reputation and respect.

The Moderating Effect of Task Complexity

We hypothesized that task complexity would strengthen the direct and indirect effects of acyclicity on conflict, performance, and member satisfaction. As predicted, we found that centralization and steepness were only associated with process conflict when task complexity was high. We found a similar task-contingent effect of centralization and steepness on relationship conflict in our post hoc analyses. Task complexity did not significantly strengthen the negative effects of acyclicity on process conflict as we expected. However, in post hoc analyses, we did find this moderating effect for both status and relationship conflict. Moreover, all of the observed effects (significant and non-significant) were in the predicted directions, with task complexity strengthening the positive effects of hierarchy-as-inequality on conflict and the negative effect of hierarchy-as-acyclicity on conflict.

On one hand, these results provide strong overall support for our expectation that the effects of different forms of hierarchy on conflict will be moderated by task complexity. In fact, simple slope analyses suggested that hierarchy forms do not result in conflict of any type when task complexity is low. On the other hand, these findings point to potential differences in the specific forms of conflict that are reduced or exacerbated by acyclicity and inequality when tasks become more complex. For example, acyclicity mitigates conflicts that arise around one's relative standing in the group (status conflicts) as tasks became more complex. Acyclicity suggests a clear ordering of member influence within a group, which may be particularly helpful in resolving conflicts around member standing—conflicts that become more prevalent as tasks become more complex. We also found that in complex tasks, hierarchy-as-acyclicity mitigated and hierarchy-as-inequality exacerbated conflicts about interpersonal relationships and compatibilities (relationship conflicts). This finding confirms that task complexity can heighten the relational ambiguity and tension that emerges in centralized or steep hierarchies, whereas cascading influence relations become even more important in clearing the path for the emergence of productive intra-group relations. Clearly, the role of task complexity in moderating the effects of hierarchy on different forms of conflict requires more theoretical and empirical attention than we can devote in this paper. This is, therefore, one important area for future research.

Future Research Directions

In our theory and analyses, we grouped centralization and steepness as alternative inequality-based conceptualizations of hierarchy that should have similar effects on conflict and performance. Our results supported that approach in that centralization and steepness were highly correlated (r = .81 in our sample, r = .63 in our simulation) and behaved similarly in our analyses. However, this pattern of results raises the question of whether centralization and steepness are simply redundant constructs, or whether there may be situations in which differences between the two constructs become important. We think there may be. For example, centralized networks have a greater unity of command than steep networks do, which may prove beneficial when quick and decisive action is needed. Further theoretical and empirical work is needed to examine the consequences of centralization versus steepness in task groups.

Our focus here has been on demonstrating the consequences of acyclicity and not on examining its antecedents. A natural question that arises from our discussion here, therefore, is how acyclicity arises in groups and whether it is something that can be deliberately managed. In examining this question, researchers might begin by considering factors that lead to dyadic power asymmetries, such as asymmetrical resource dependence (van der Vegt, de Jong, Bunderson, & Molleman, 2010). We suspect, however, that a more complete answer will require a deeper understanding of the dynamics of hierarchy formation in task groups. Once again, research by ethologists provides a very useful precedent. For example, research by Chase and colleagues (Chase, 1982; Chase & Seitz, 2011) has demonstrated that linear dominance hierarchies emerge in animal groups through predictable sequences of dyadic and triadic interaction that favor the emergence of linear over non-linear or cyclical hierarchies. This stream of work provides key insights into the dynamics of hierarchy formation that may help to address the question of how acyclical hierarchies emerge in task groups, and when they are more or less likely to do so.

Study Limitations

Our study design has several notable strengths. For example, our data collection approach made it possible to collect data from a diverse sample of teams. In addition, we collected data from different sources (members and supervisors) using multiple data collection and aggregation approaches (peer ratings and team assessments). Nevertheless, there are aspects of our study design that should be noted as potential limitations. Firstly, we measured influence using member ratings rather than direct indicators of influence or deference. Although member ratings entail awareness and acceptance of another member's primacy within the group, which should predict deference behavior, it would be reassuring to verify that these perceptions do drive actual deference behavior within the group. Secondly, the fact that our measures were all collected at the same point in time raises the possibility that causality operates differently than we hypothesized. One might ask, for example, whether conflict leads to more centralized or less acyclical team influence networks. Although the theoretical arguments that would generate this alternative causal model are not obvious, we cannot entirely dismiss this concern with these cross-sectional data. Thirdly, it would have been interesting to consider a broader range of mediating variables (e.g., information sharing) or outcome variables (innovation, turnover, citizenship behaviors). It may be possible, for example, that acyclicity reduces conflict but narrows constructive debate and thereby stifles innovation. These questions raise important possibilities for future research. Finally, task complexity ranged from 2.7 to 5.9 on a seven-point scale (mean = 4.2, SD = .69) in this sample of teams. It may be that our effects would have been stronger if our sample had included teams with more extreme task complexity scores.

CONCLUSION

We have demonstrated that different conceptualizations of hierarchy can have very different consequences for conflict, performance, and satisfaction in groups, and that task complexity moderates these effects. We have also demonstrated that a view of hierarchy as cascading relations of dyadic influence better captures the functional benefits of hierarchy in teams compared to a view of hierarchy as inequality (centralization or steepness). The theory and results of this study provide an important conceptual and operational toolkit to assist in our efforts as researchers to identify the functions and dysfunctions of hierarchy in task groups.

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APPENDIX A:

TABLE A1
Review of Empirical Studies that Characterize the Degree of Hierarchy in Human Groups based on Member Characteristics or Behaviors[5]

Study	Basis of hierarchical differentiation	Conceptualization (and operationalization) of hierarchy	Study and findings
INEQUALITY: CENTRALIZATION *Operationalizations include the Freeman (1979) index, Gini (1936) coefficient, and coefficient of variation.*			
Gladstein & Reilly (1985)	Peer influence ratings	"Decision centrality" (degree centralization; as per Freeman, 1979)	n = 24 student groups in a management simulation. Degree of influence centralization was not affected by changes in time pressure and stakes (high vs. low).
Argote et al. (1989)	Communication frequency (number of messages sent and received)	"Centralization" (following Mackenzie, 1966)	n = 20 student groups in the lab. Groups facing high uncertainty and low threat became more centralized over time.
Main et al. (1993)	Executive compensation	"Executive team wage dispersion" (coefficient of variation)	n = 209 top management teams of public firms over five years. Executive team wage dispersion was positively related to return on assets.
Ahuja & Carley (1999)	E-mail communication	"Centralization" (degree centralization; Freeman, 1979)	n = 928 e-mail communications about different tasks in a virtual organization. Less centralized communication networks were associated with higher performance for non-routine tasks.
Bloom (1999)	Player salary	"Pay dispersion" (Gini [1936] coefficient & coefficient of variation)	n = 236 major league baseball teams, 1985–1993. Teams with more concentrated pay structures performed worse financially and on the field.
Rulke & Galaskiewicz (2000)	Combined: (a) interdependence, (b) frequency of work interaction, & (c) communication	"Network decentralization" (degree centralization; Freeman, 1979)	n = 39 MBA student teams in a simulation. Teams of specialists performed worse than teams of generalists unless they had decentralized structures.
Bunderson (2003a)	Peer influence ratings	"Power centralization" (degree centralization; Freeman, 1979)	n = 209 technicians in 35 teams. Expertise attributions were more likely to be based on valid cues in decentralized teams.
Bunderson (2003b)	Peer ratings of (a) workflow interactions and (b) decision involvement.	"Power centralization" (degree centralization; Freeman, 1979)	n = 44 management teams. Broad functional experts were more involved in team decisions when power was decentralized.

[5]This review focuses on studies that characterize the *degree* of hierarchy within human *groups* based on member *characteristics or behavior*, and does not include studies that manipulate the presence or absence of hierarchy (e.g., Kwaadsteniet & van Dijk, 2010; Ronay et al., 2012), studies that are based on holistic ratings of hierarchy (e.g., Auh & Menguc, 2007; Wong et al., 2011), or organization-level studies (e.g., Ivancevich & Donnelly, 1975).

TABLE A1
(Continued)

Study	Basis of hierarchical differentiation	Conceptualization (and operationalization) of hierarchy	Study and findings
Frick, Prinz, & Winkelmann (2003)	Player salary	"Pay inequality" (Gini [1936] coefficient)	*n* = 1,224 team-year observations across NFL, MLB, NHL, & NBA teams. NFL & MLB teams won more games when pay inequality was lower. NBA & NHL teams won more games when inequality was higher.
Jewell & Molina (2004)	Player salary	"Salary inequality" (Gini [1936] coefficient)	*n* = 438 major league baseball teams, 1985–2000. Teams with more unequal pay performed worse on the field (winning percentage).
Berdahl & Anderson (2005)	Peer ratings of leadership within the group	"Leadership centralization" (degree centralization; as per Freeman, 1979)	*n* = 29 student groups performing interdependent tasks in the lab. Leadership centralization was higher in all-male and mixed groups. Majority female groups became more decentralized over time than did majority-male groups.
Siegel & Hambrick (2005)	Executive compensation	"Top management group pay disparity" (coefficient of variation)	*n* = 67 top management groups of U.S. firms. Centralization of executive compensation was negatively related to firm performance (market-to-book and total shareholder return) for more technologically intensive firms, but not for less technologically intensive firms.
Small & Rentsch (2010)	Leadership behaviors (change-oriented, task-oriented, relations-oriented)	"Shared leadership" (degree centralization; Freeman, 1979)	*n* = 60 student teams working on a simulation. Centralization of leadership was negatively related to team performance.
He & Huang (2011)	Number of outside board memberships	"Board membership inequality" (Gini [1936] coefficient)	*n* = 530 boards of manufacturing firms, 2001-2007. Board membership inequality was positively related to firm financial performance (ROA).
Grund (2012)	Passes between professional soccer players	"Centralization of interaction" (degree centralization; Freeman, 1979)	*n* = 283,259 passes from 23 soccer teams. Centralized passing networks were negatively related to number of goals scored in a match.
INEQUALITY: STEEPNESS *Operationalizations include standard deviation and average distance.*			
Leonard (1990)	Executive compensation	"Variance & steepness of managerial pay" (variance = *SD*; steepness = ratio of pay at top to pay at the bottom)	*n* = executive groups in 439 large U.S. corporations, 1981–1985. Variance and steepness of executive compensation was unrelated to firm performance.
Richards & Guell (1998)	Player salary	"Variance of the team's salary" (variance)	*n* = 112 MLB teams, 1992–1995. Teams with more dispersed salaries did marginally worse.

TABLE A1
(Continued)

Study	Basis of hierarchical differentiation	Conceptualization (and operationalization) of hierarchy	Study and findings
van der Vegt et al. (2010)	Peer ratings of power-dependence	"Power asymmetry" (mean absolute distance in dyadic power-dependence)	n = 46 teams in the field. Power asymmetry was negatively related to learning and performance when teams received individual feedback but positively related to learning and performance when teams received group feedback.
Greer & van Kleef (2010)	Level in the organizational hierarchy	"Power dispersion" (standard deviation)	n = 42 groups in a finance firm. Power dispersion was positively related to power struggles and conflict in high-power teams but negatively related to those same outcomes in low-power teams.
Halevy et al. (2011b)	Pay, starting lineup position, & playing time	"Hierarchy" or "Dispersion" (standard deviation)	n = 254 NBA basketball teams (11 seasons). Teams with higher pay & starting lineup dispersion were more cooperative (as measured by assists, turnovers, defensive rebounds, & field goal percentage) and won more of their games.
Huang & Cummings (2011)	Knowledge-sharing behavior	"Critical knowledge centralization" (mean Euclidean distance in member centrality)	n = 177 teams in a multi-national food company. Knowledge centralization was negatively related to executive-rated team performance, especially when members came from different business units or were sharing new knowledge.
CASCADING INFLUENCE *Operationalizations include linearity and network acyclicity.*			
Ahuja & Carley (1999)	E-mail communication	"Hierarchy" (network acyclicity; Krackhardt, 1994)	n = 928 e-mail communications about different tasks in a virtual organization. Less hierarchical communication networks were associated with higher performance for non-routine tasks.
Mast (2002)	Interruptions during group discussion	"Hierarchical organization" (linearity; Strayer & Strayer, 1976)	n = 58 men & 58 women organized into 28 same-sex groups. Groups engaged in two leaderless discussions. All-male groups began the first discussion with a more linear dominance hierarchy but converged with all-female groups by the end of that discussion. This pattern was reversed during the second discussion, with female groups starting out more linear.
Cummings & Cross (2003)	Communication frequency	"Hierarchical structure" (network acyclicity; Krackhardt, 1994)	n = 182 work groups in a Fortune 500 telecommunications firm. Hierarchical communication structures were negatively associated with performance.