Multilevel Social Dynamics Considerations for Project Management Decision Makers: Antecedents and Implications of Group Member Tie Development

Elliot Bendoly† and Dominic Thomas
Emory University, Goizueta Business School, 1300 Clifton Road, Atlanta, GA 30322-2710, e-mail: elliot_bendoly@bus.emory.edu, dominic_thomas@bus.emory.edu

Monica Capra
Emory University, Department of Economics, 1602 Fishburne Drive, Atlanta, GA 30322-2710, e-mail: mcapra@emory.edu

ABSTRACT
Successful projects represent the effective culmination of management skills, planning, and individual project member strengths. In operations management, such strengths are often viewed predominantly from the perspective of skill base. However, it has become increasingly evident that behavioral traits associated with individuals play a very significant, if not ultimately dominating, role in the effectiveness of certain group projects. Our aim in this study is to look into how certain individual attributes viewed as relevant to these project contexts may lead to social networking decisions that have impacts spanning multiple levels of analysis. Such insights are likely to prove valuable to decision makers managing project teams as well. We employ a controlled 4-month investigation of multiple projects, for which we are able to consider both objective, and subjective pre-, in situ, and postproject data. Our results demonstrate that the issues of perceived control, confidence, and conscientiousness are relevant not only in driving individual perceptions of the value of within-group interactions, and hence the development of associated ties, but are also ultimately relevant in helping to drive higher levels of group performance.

Subject Areas: Group Dynamics, Project Management, and Team Effectiveness

INTRODUCTION
While task definition and scheduling remain important skills for effective project management, knowledge-oriented, globally distributed work has placed an increasing emphasis on the need to understand how to cohere and use technologies to enable productive relationships among project team members (Meredith, 2002; Bendoly & Swink, 2007; Mähring & Keil, 2008; Huckman, Staats, & Upton, 2009; Thomas & Boström, 2010). Developing deeper understandings on these topics presents methodological difficulties due to the complexity of accessing and

†Corresponding author.
typifying these contexts (Kloppenborg & Opfer, 2002). At the same time, the increasing complexities related to the growth of work across multiple organizations, geographies, and knowledge silos magnify the importance of finding new ways to understand and manage people in these project contexts (Hui, Davis-Blake, & Broschak, 2008). Specifically, our aim here is to enrich the research and practitioner communities’ knowledge base on the criticality of social dynamics on project team interaction and associated management decisions during formation and execution.

In part, our study follows very much in step with recent works that focus on project-group dynamics. These works study the context through fairly broad approaches that involve attempting to account for performance subject to a wide range of what has been considered in the past as externalities, such as bundles of project team design elements and practices that associate with different outcome goals (Scott-Young & Samson, 2008) or effects of team familiarity and role experience on performance (Huckman et al., 2009). Issues previously considered as critical to project performance (e.g., technical skills of workers and fits to tasks) clearly remain crucial in decisions regarding team formation and management. Beyond these factors, social dimensions drive the project success in knowledge-oriented, human decision-intensive work contexts (Cohen & Bailey, 1997; Schmidt, Montoya-Weiss, & Massey, 2001; Keil, Depledge, & Rai, 2007).

In this study, we introduce the consideration of issues relating to the dynamics of group work heretofore not sufficiently examined in the literature: namely, control, confidence, and conscientiousness within project teams. In part the pre-existing gap in the literature is due to the fundamental difficulty of retrospectively capturing and interpreting such behavioral factors in real-world projects. Yet, paradoxically it is the performance of the implicitly social unit of the team as a whole that remains the primary metric for organizational assessment. Hence, there is a clear motivation from a research perspective to dive deeper. We consider multiple levels of analysis, including not only individual dynamics but also group dynamics, with the analysis of individual group member dyads serving as fundamental bridging mechanisms between these levels. With this in mind, and in contrast to a strict retrospective examination, we conduct a 4-month controlled experiment involving multiple comparable projects allowing us to capture and consider both preproject and in situ project dynamics, as well as final project outcomes. In particular, we study individual group members in these projects, their decisions to interact with each other, and subsequent project performance.

To do so, we collect data that are relevant to multiple levels of analysis to help bridge our understanding of multilevel interdependencies in project management settings. In turn, these data and analyses provide critical insights into the decisions made both by project team members as well as to those ostensibly positioned to manage these groups. In knowledge-intensive work, project managers must take steps to facilitate productive interaction, including actions to manage trust and relationships (Thomas & Bostrom, 2010). In this regard, our findings suggest that project managers deciding how to staff their teams and what to do when interaction breaks down can better understand why individuals would or would not interact and motivations that might convince them to interact successfully. These decisions become even more important as teams become more self-managing (Druskat &
Wheeler, 2003; Morgeson, 2005), because project managers will need to create a team environment in which members initiate and maintain their own interactions.

The following sections examine the particulars associated with our research agenda. After presenting the theory and past research that we use to substantiate our hypotheses at the various levels of analysis of interest here, we go into detail on the specific methods we employ to gather and provide checks to our data. Sections that follow describe our formal analysis and findings. We conclude with a discussion of our contributions to both research and practice, as well as thoughts on future work.

THEORY AND HYPOTHESES

For more than five decades, researchers have sought to characterize the complete conditions necessary to predict successful project work and assign appropriate staffing for effective interaction (Hackman, 2002; Thelen, 1954). Researchers have tried to build more effective social factors decision models for leaders based on group member knowledge levels (Beheshtian-Ardekani & Mahmood, 1986; Kaiser & Bostrom, 1982), goal incongruence and management (Abdel-Hamid, Sengupta, & Swett, 1999; Levitt et al., 1999), and role management (Huckman et al., 2009; Mennecke & Bradley, 1998), for example. As this body of knowledge about social factors influencing project success has grown, researchers have begun to recognize that group member knowledge levels or goal incongruence primarily become pertinent when teams face complex, interdependent knowledge tasks, because these contexts increasingly require expertise integration and team member–led initiation of interaction (Hahn, Moon, & Zhang, 2008; Tiwana & McLean, 2005).

And, while project team members have increasingly higher education levels and autonomy in such contexts, with the team leader having less direct authority due to distributed membership and multiple organizational boundaries, team leaders are still tasked with the role of facilitating project success (O’Connell, Doverspike, & Cober, 2002; Piccoli & Ives, 2003; Thomas & Bendoly, 2009). As a result, research has now turned its focus on how team leaders can understand their team members and better facilitate effective ongoing interaction through techniques such as managing team empowerment to reduce demographic dysfunctions (Kirkman, Tesluk, & Rosen, 2004) or better management of technology tools matched to team tasks (Zigurs & Buckland, 1998) and interventions to improve interaction when repair is necessary (Massey & Montoya-Weiss, 2006; Thomas & Bostrom, 2010). Of particular interest among these latter studies is the current emphasis on understanding how social factors influence the process of team interaction and lead to project performance (Brown, Poole, & Rodgers, 2004; Carlile & Rebentisch, 2003; Pelled, 1996). The research suggests that improved understandings in this domain will lead to more successful projects through effective matching of team members, prediction of potential breakdowns, and effective design of interventions to get projects back on track after breakdowns.

One of the key challenges in researching the process of social factor influence on team interaction and outcomes has been isolating individual, dyadic, and group-level influences as evidenced in communications by team members (Poole, Keyton, & Frey, 1999). To do so, we need to theorize about the effects we would expect
Figure 1: Overview of multilevel data and effects considered in the project contexts.

Indeed, the value of understanding the extent to which homologous theoretical frameworks and models may be appropriate at multiple levels of analysis has received some well-deserved attention among management researchers in recent years (McAdam & Lafferty, 2004; Chen, Bliese, & Mathier, 2005; Shah & Shin, 2007). Being able to discuss similar factor relationships that may be relevant to a variety of levels of consideration (e.g., individual level, business unit level, industry level, etc.) can help to facilitate understanding across findings and fields of study. Conversely, any discrepancies discovered at alternative levels of analysis help provide crucial caveats in attempts to generalize effects and guard against the misapplication of research findings and prescriptions. To quote Hitt, Beamish, Jackson, and Mathieu (2007), “Using a multilevel lens... draws our attention to the context in which behavior occurs and illuminates the multiple consequences of behavior traversing levels of social organization” (p. 1387). Aside from recent growth in the interest in the role of human behavior in operations management contexts (cf. Bendoly, Croson, Goncalves, & Schultz, 2010; Bendoly, Donohue, & Schultz, 2006; Gans & Croson, 2008; Gino & Pisano, 2008), the ability to empirically assess the connections between the dynamics of individuals and the dynamics of larger organizational units has obvious critical value with regard to structuring meaningful suggestions to practice. This is particularly salient in project management settings. Moreover, the intensity and ostensible focus of individual interactions toward project performance in these contexts help to assuage concerns over linkages between theory and analytics, “fallacies of the wrong level” as per Rousseau (1985), which might apply to broader contexts (Hitt et al., 2007). As a result, there is particular justification in project contexts to follow the lead of recent authors, such as Boh et al. (2007) who applied a multilevel technique because they recognized the necessity for analyzing highly related effects that are thought to play out at multiple levels of observation.

Figure 1 provides a broad overview of the nature of multilevel interdependencies that we are concerned with in this study. We discuss theory as it pertains to each of these levels in the following subsections.
Effects at the Individual Level

We focus on three issues particularly related to individual behavior in our multi-level model: control, confidence, and conscientiousness. These three issues appear important in the project management literature related to individual willingness to interact and follow instructions (control) (Piccoli & Ives, 2003), individual sense of self-efficacy and ability to overcome cultural inhibitions and decide to contribute (confidence) (Hardin, Fuller, & Davison, 2007), and individual sense of duty to perform work (conscientiousness) (Murray, Greg, Mitchell, & Michael, 1998). From the standpoint of influencing connections to others within a team, these three issues have been consistently discussed in related literature as critical to the value individuals place on tie strength (Howell & Shea, 2001; Lee-Kelley, 2006; Dougherty, Cheung, & Florea, 2008), where tie strength indicates an individual’s perception of capacity to trust and interact with another member of a group (Monge & Contractor, 2000). By selecting project team–relevant individual perceptions of tie strength for understanding individual propensity to contribute, we are selecting a mechanism from social network theory that has already been proven to scale across multiple levels of analysis and enables multilevel inference.

The first of these individual issues, perceived control, is positioned to influence individual valuations of interpersonal relationship by virtue of social learning theory (Rotter, 1982) as it applies to the concept of locus of control. Simply stated, those who view events in their own work context (e.g., project setting) to be controllable by internal actions will tend to appreciate the value of any involvement facilitating such actions (Bonoma & Johnston, 1979). In project groups, such a view can manifest itself in terms of greater valuation of self–other interactions that might ultimately steer a project toward greater success. Those with more externally oriented loci of control will tend to view their role as less consequential and hence devalue opportunities to interact with others in the pursuit of project performance. Further relating to the existing literature, control in itself is highly emblematic of Dougherty et al.’s (2008) core self-assessment construct, which they propose as being essential to individual-level formulations of tie-strength value in networks.

We therefore structure our first individual-level hypothesis accordingly:

H1a: The more an individual feels that performance can be internally controlled, the more they will value personal connections that can facilitate control over performance.

Confidence offers a related, though theoretically distinct, driver of valuation for interpersonal tie strength. Confidence is unique from control in that it focuses not from the notion of what kinds of systematic forces (e.g., internal vs. external) can influence project performance, but rather the extent to which individuals or groups feel that they are particularly competent (e.g., relative to others in similar settings) in achieving success (Krueger & Dickson, 1994; Ghosh & Ray, 1997). In other words, a belief in the fundamental opportunity to control project outcomes is not equivalent to the belief in one’s ability to positively (vs. negatively) impact such outcomes. Goal-setting theory further provides a nice foundation for linking the belief in one’s own positive potential to perceptions and ultimately actions taken to enhance performance (Bandura & Cervone, 1983; Earley, Northcraft, Lee, &
Lituchy, 1990). This issue is also related to potency as distinct from the role of control issues such as autonomy (Scott-Young & Samson, 2008). Assuming individuals view their ability to provide positive impacts in project work largely through interaction, we can find justification in stating our second individual-level hypothesis as follows:

**H1b**: The more an individual feels confident about their own ability to drive performance, the more they will value personal connections that can augment the ability of others.

The third individual-level issue of particular concern to us is that of conscientiousness. Conscientiousness has a long history of being viewed as an individual-level antecedent of group cohesion and effectiveness (Goltz, 1993; Murray et al., 1998). It has often been characterized as a citizenship behavior, and thus distinct from concepts relating to effect opportunity (e.g., control) and capability (e.g., confident) in that it captures the fundamental willingness to accept responsibility for one's role in group work settings (Settoon & Mossholder, 2002; Brass, Galaskiewicz, Greve, & Tsai, 2004). Along these lines, and more importantly for our work, it has also most recently been viewed as a critical determinant of the valuation of tie strength in propositions made by Dougherty et al. (2008). Their arguments for such a role stem from both social networking theory (Podolny & Baron, 1997) and the general findings of small-group personality research (Waung & Brice, 1998). Simply stated, conscientiousness drives individuals to fulfill perceived obligations to their groups. Assuming again that within-group interactions are central to group work, then regardless of perceptions of control or confidence, conscientiousness should enhance valuations of interpersonal connections within the group.

**H1c**: The more an individual feels conscientious about working toward performance, the more they will value personal connections that can encourage the conscientiousness of others.

Taking each of these first three individual-level hypotheses into account, a summary of our effects model at the individual level of analysis can therefore take the following generalized form:

\[
Value \ of \ Project \ Member \ Tie \ Strength = V_j = f(\text{Control}_j, \text{Conscientiousness}_j, \text{Confidence}_j).
\]

**Effects at the Level of the Dyad**

Numerous theories suggest that the more individuals value options the more likely they are to make decisions and take actions that make those options a reality (cf. utility theory, real options theory, etc.). Yet certain options can only be effectively pursued through joint and concerted efforts by multiple parties (Brandenburger & Nalebuff, 1996; Saeed, Malhotra, & Grover, 2005; Ross, Buffa, Droge, & Carrington, 2009). Such is the case with interpersonal interactions in project-group settings (Mathieu, Goodwin, Heffner, Salas, & Cannon-Bowers, 2000). High levels of interaction, particularly continued voluntary interactions characteristic of project work dialogues, can only be supported by a shared positive valuation of
such interactions and shared decision to pursue interpersonal connections that accompany it (Karni & Kaner, 2008; Huckman et al., 2009). With this in mind, we would anticipate the value placed on interpersonal interactions among any two individuals as being highly predictive of the extent to which they decide to actually engage in productive within-group interactions. Particular interest in the strength of ties dimension from social networking theory (Podolny & Baron, 1997), as recently applied in project management studies such as that of Oke, Idiagbon-Oke, and Walumbwa (2008), provide further justification for this line of thought. Maintaining the terminology of “ties,” we therefore position our bridging dyadic-level hypothesis as follows:

\[ H2: \text{The extent to which any two individuals value ties to other group members will jointly impact the extent to which they decide to interact with each other in group work.} \]

Robustly allowing for the potential consideration of interaction effects by the valuations held by two individuals as part of a dyad, H2 provides the following generalized form for our dyadic-level analysis model:

\[
I_{jk} = f_2(V_j, V_k, V_j \times V_k).
\]

Effects at the Project-Group Level

Interpersonal connections have been viewed as particularly useful when jobs require creativity, as is common in project management settings (Perry-Smith & Shalley, 2003). At the same time, however, the importance of interpersonal interactions cannot be interpreted without a joint appreciation of the kinds of personalities involved in such interaction. More plainly stated, interpersonal interactions provide conduits through which individual traits can be realized and leveraged on a multiparty scale. The network effect of multiple individuals interacting with one another and bringing their own motivation (driven by issues such as perceived control and confidence) and conscientious work ethic to bear can have significant impact on group outcomes such as those relevant to project work (Schmidt et al., 2001; Hoegl, Parboteeah, & Munson, 2003). Such interaction also helps reduce ambiguity and uncertainty related to interdependent activities (Tatikonda & Rosenthal, 2000) and facilitates further learning among workers and the group as a whole, with associated positive gains in project efficacy (Edmondson, 1999; Edmondson, Bohmer, & Pisano, 2001; Huckman et al., 2009). Capitalizing on the theoretical rationale for the proposed homologous roles of certain factors on performance at various levels of analysis, and given the theoretical support for the impact of interpersonal interactions on project performance, we therefore further position the role of control, confidence, and conscientiousness as relevant to performance at the group level.

\[ H3a: \text{The overall performance of the group is driven by the extent to which group members who feel they have control over performance interact with one another}. \]
H3b: The overall performance of the group is driven by the extent to which group members who are confident about their own ability to drive performance interact with one another.

H3c: The overall performance of the group is driven by the extent to which group members who are conscientious about performance interact with one another.

Once again, the full complement of these hypotheses can be summarized formulaically:

\[
\text{Group Performance} = f(\sum_k \Sigma_j Control_j I_{jk}, \Sigma_k \Sigma_j \text{Confidence}_j I_{jk}, \Sigma_k \Sigma_j \text{Conscientiousness}_j I_{jk}).
\] (3)

To conclude our theoretical discussion, we posit that project managers will benefit by better understanding social factors influencing individual propensity to contribute and drive performance in project teamwork characterized by knowledge intensity, task interdependence, and distributed teams. Such an understanding will enable them to improve their predictions about where and when to support their teams and the likely efficacy of certain mixes of team members. They will also be able to improve their interventions, by taking advantage of key levers for influencing improvement in interaction if they know what those levers are and how they work, as guided by this research.

METHOD

Data collection for our planned program of study presented certain challenges. Uncontrolled field settings are typically nonconducive (often for proprietary reasons) to the high levels of visibility in interaction needed for a rich picture of group dynamics. At the same time, continuous monitoring of group activity may, of course, be subject to bias (e.g., the Hawthorne Effect). Furthermore, it has been well established that data regarding individual and multiparty behavioral dynamics can be extremely prone to bias when gathered strictly retrospectively (Menneer, 1978; Huber & Power, 1985). For these reasons, we took a great deal of care in employing a highly structured timeline for data collection that allowed for checks against possible biases in our methods. We further made sure that subjects were fully aware that any in-process project data would only be made available for analysis on a voluntary basis after projects had been completed.

We collected data on subject characteristics, preferences, dyadic activity, and measures of group performance at multiple time points and through the use of multiple objective and subjective methods across a 4-month project time frame, hence ameliorating concerns for common-source and common-method biases (Podsakoff & Organ, 1986). The projects were process improvement–consulting projects, which have been routinely conducted as part of an ongoing course every semester for more than 5 years. The projects begin with early group-project work focusing on background data collection about the client and industry environment requiring a 20-page summary report (approximately). Next they proceed to in-depth
process modeling, data collection, and techniques for process analysis. They lead to presentations and 50-page reports (approximately) with evidence-backed recommendations. At each stage, project teams must draw on the combined inputs of all members (size ranging from five to eight members; median: seven members), indicating substantial interdependence, and each team had to coordinate with its own client. Examples of clients included the Social Security Disability Claims regional office, a branch of a large bank, a major manufacturer of carpet, and a theatrical company. Given that the team members are simultaneously taking two to four other courses and most had never worked with their teammates before, their context of partial attention to the project directly matched the sort of project contexts in which social factors become critical. An overview of our data-collection protocol is provided in Figure 2. We will touch on each of the methods and measures used in this protocol in turn.

**Protocol Stages**

**Demographics and individual traits (preproject)**

Our sample consisted of enrollees in a business management program offered by a top-ranked academic institution. Participants were offered credit for participation in the projects studied, as a function of performance on these projects. The male–female ratio of participants in the study was 96–52 (65–35%). Students were assigned to project teams to reduce any biases due to preexisting relationships and to ensure equal skills on each team. The balance of skills was based on a measure of technological experience programming and using new technologies as well as personality characteristics from a Myers–Briggs instrument. Each team was ensured to have at least one person with strong interest and capability concerning technologies and numbers of introverts versus extroverts, thinkers versus feelers, and sensors versus intuitors were equivalent on all teams.

The registration data for our subject pool did not differ significantly from the general population of individuals enrolled in this program. Furthermore, past studies showed the general characteristics of enrollees at this school do not differ significantly from the general characteristics of managers in the metropolitan area. Aside from standard registration data (e.g., gender, age, work experience), we inquired as to specific experiences thought to be potentially relevant to the dynamics we were interested in here. For example, answers to questions getting at individual experiences in developing social ties in modern online environments as well as traditional social environments were collected. Similarly, questions relating to the general amount of time individuals devoted to building and sustaining such relationships for either social or work-related interests were elicited. We also collected
preproject traits thought to be relevant to our work, specifically perceptions of control (specific to project settings), conscientiousness, and confidence. The structure of these specific measures will be outlined in our section on measures. These same traits were also collected after the completion of projects in order to check on any changes, at least in perception, that may have occurred over the 4-month period.

**Bidding and ranking experiments for value of tie-strength assessments (mid-project)**

Several tactics were used to assess individual valuations of tie strength. The rationale for using a multimethod approach for this assessment stemmed from its relatively central position in bridging the individual-level traits measured to the dyadic interactions we would be assessing, and ultimately to the overall group-level performance considerations. Ultimately, we chose to pursue both objective (continuous and ordinal) and subjective approaches to assessment. Our primary objective approach utilized a bidding experiment based on the classical Becker–DeGroot–Marschak (BDM) methodology (Becker, DeGroot, & Marschak, 1964; Rousu, Monchuk, Shogren, & Kosa, 2005). BDM generally involves presenting individuals with one or more options for which they are allowed to place bids, without knowing what the actual cost of those options are. Bids that happen to exceed the cost of options provide the potential for those options to be “won” in trade for the cost of the option (a value equal to or less than the actual bid). Bids that are less than the actual cost of the option make the option unavailable to the individual.

In our experiment, we provide subjects with cash upfront ($45, a quantity pretested in pilot work and shown to be a reasonable upper bound on these bids). The intended use of this money is to place bids on the opportunity to network with a set of eight professionals in their field, not known by name but rather characterized by a range of traits including the nature of their connections to a professional network in that field (e.g., strong ties vs. weak ties, numerous ties vs. few, varied vs. focused). Bidding is noncompetitive, and hence the chance to win an option is unrelated to any action taken by anyone else in the experiment. The bids that an individual makes are also entirely independent across the options that they face; that is, they are given the same amount of money ($45) with which to bid on each potential contact (hence they are not facing trade-offs due to any net budgetary constraints). They are told, however, that no matter what the outcome of their bids is, all of their prospective contacts (even those they lost bids on) will be placed in their own personal bag, and only one will be drawn or activated in a sense. The end result is a prize equivalent to either the full $45 they were initially granted or $45 less the cost of the contact drawn along with the opportunity for a personal face-to-face meeting with that contact. What we gain as researchers from this exercise is the ability to compare the valuation of various options, in a somewhat similar vein to that of conjoint analysis surveys but with the added ability to directly observe self-specified monetary valuations (rather than needing to rely on indirect extrapolations of such).

Ultimately, the money granted to individuals in this exercise is theirs to use as they wish. They can place $0 bids on all contact options and guarantee
themselves $45 in pocket. In piloting, we observed this seldom to be the case and in our full study very few individuals did. Regardless, realizing the loss of meaning that accompanies multiple $0 bids, we used a secondary approach to help elicit comparative valuations for tie strength in networks. Following the BDM bid process, individuals were asked to provide a ranking of the same set of contacts that they had just been presented with. Although lacking in absolute monetary valuations, this approach nevertheless did force an ordinal description of their preferences for certain kinds of connections in a group work setting (Thomas & Watson, 2002). A final valuation tactic used requested individuals to simply provide a subjective assessment of the extent to which they felt strong ties to individuals in a group-project work setting would be viewed as valuable. In part this 7-point item could be used to help validate the bid and ranking differentials observed in the two exercises, but also allowed for a somewhat broader interpretation of the notion of value with regard to tie strength.

It should be noted that the timing of these experiments required particular attention in planning. If conducted prior to the start of group-project work, they might be argued to impact the general dynamics of the group projects—an effect that we could not easily provide checks against because prior dynamics would not be available for comparison. Furthermore, if conducted at the end of the project, it would have been highly likely that the final effectiveness of the project may have biased individuals in their assessments of the value of their group ties. As a compromise, albeit a highly calculated one, we therefore decided to conduct this experiment midway through the project time frame. While not eliminating the aforementioned threats, such timing did permit us to consider before and after effects without subjecting the experiment to end-game biases. Specifically, as will be discussed in the description of the interpersonal interactions measure to follow, we employ specific tactics to check against concerns of Hawthorne-type effects that such a mid-project assessment might have on later dynamics within the project.

Interpersonal interactions and project effectiveness assessment (postproject)

In an attempt to provide objective assessments of within-group interpersonal interactions, we decided to capitalize on the availability of a wealth of project-specific communications recorded throughout the project work time frame. This data record contained a full transcript of online dialogue among the group members (the primary mode of communication for the projects studied in this case). The groups interacted using a private communications platform integrating e-mail with threaded discussion, file storage, calendaring, instant messaging, and a variety of other tools. One of the authors had direct access to the complete activities represented in these sites, and while teams were also allowed to meet face to face, they would usually post summary notes from meetings to their team spaces because one or more members may not be there and the project guidelines asked them to do so. Self-reports and analysis of the dialogues indicated that teams met face to face three to four times on average with one meeting toward the beginning, one in the middle, and two toward the end while developing the final deliverables. After major meetings, teams tended to formalize the output of their meetings in
the team spaces and discuss their results. Thus, the team spaces captured a fairly complete view of the interactions among team members during the projects while avoiding interrupting work. The transcripts from these team spaces allowed for the identification of the individuals posting messages, the identification of who (if anyone) they were responding to, the date/time signature of their correspondence, and the full content of their messages.

**Measures**

**Perceived control and conscientiousness**

To assess both individual feelings of control and conscientiousness, we adapted items based on established preexisting scales of locus of control and conscientiousness (see Appendix A). For our conscientiousness measure, we started with Goldberg’s (1992) items and positioned them specifically with regard to project work. Our resulting Likert-type scale therefore required subjects to rate the extent to which their activity in group work could be characterized by specific descriptions such as “thorough” (as opposed to careless) or “responsible.” For our measure of perceived control, we adapted 7-point scale items used by authors such as Gharpade, Hattrup, and Lackritz (1999) and Ozer (2008). Items used in our context included “My own efforts and actions drive performance in group project work I engage in” and “Performance in group project work is determined predominantly by external issues not under my control.”

**Confidence**

In order to assess confidence, we made use of a technique suggested by Cesarini, Sandewall, and Johannesson (2006). Each individual was asked to provide a best guess as well as 90% confidence intervals (both lower and upper bounds) on their guesses for each of 10 questions regarding general business-related knowledge. Characteristic questions include “What was the volume of stocks-trades for the Dow Industrial average in 1995 (in millions of US$)?” and “What was the value of a single Euro in US dollars in 2006?” As is standard, these items were chosen to represent topics familiar to the subjects and for which they could reasonably estimate magnitude, yet whose values would typically not be known in certainty at the time of response. While there was, of course, the chance that some items would be very well understood by the subjects, it would have been unlikely that any would have full and immediate clarity on all 10 items. After providing their range estimates, individuals were then asked to follow up and, without changing their responses, estimate the number of questions for which the true answer falls within their stated range. They were also asked to estimate the average accuracy of their peers on this task.

Given the data available through this technique, multiple approaches to assessing confidence are available. The first that we focus on involves scaling each individual’s range estimates by the central estimates they provided, then taking their inverse to provide a raw measure of the subject’s predictive confidence on each question. These calculations are then standardized for each of the 10 questions, by the grand mean and standard deviations of each question across the sample, and the
full set is summated for each individual to generate a single composite. We refer to this as our objective measure of individual confidence, to help distinguish the measure from the comparatively more subjective estimate developed in our secondary technique. By contrast, this alternative approach involved calculating the ratio of their perception of their own accuracy (i.e., their estimate of the number of questions whose true answer falls within the ranges they provided) relative to their subjective assessment of the accuracy of others. While we recognize that measures of confidence such as these, relating to general business knowledge, may not be emblematic of confidence in contributions to group work, past studies have shown strong correlations between such general-knowledge assessments of confidence and other forms of subjectively measured confidence (Yates, Lee, & Shinotsuka, 1996; Klayman, Soll, Gonzalez-Vallejo, & Barlas, 1999; Cesarini et al., 2006).

Valuation of tie strength

As noted earlier, in order to assess tie strength we make use of both subjective and objective approaches. The bids provided through the BDM experiment allowed us to specifically compare the valuations of contacts for which tie strength was high to those for which tie strength was low, but for which all other characteristics were identical (e.g., identical number of ties, identical variety of ties). By calculating the pairwise differentials in these bids and averaging them across all bid pairs for an individual, we were able to generate an objective estimate of an individual’s general valuation of tie strength (Rousu et al., 2005). A similar approach was taken with the data collected from the ordinal rankings provided by our subjects to derive average ranking differentials associated with high-tie-strength scenarios. The distributions for all three measures of valuation, the two differential calculations, and the single subjective assessment were found to be indistinguishable from that of normality in Kolmogorov–Smirnov tests \(p < .05\) performed both on pilot data and our final data set.

Interpersonal interaction

The richness of communication data made available at the close of these projects allowed us to calculate frequencies of dyadic interaction (e.g., how many times individuals corresponded with one another on project-related issues). More sophisticated measures of dyadic interaction were available to us (e.g., involving qualitative coding of message content), but similar data from other studies showed the end measures derived from such approaches to be highly correlated (Klayman et al., 1999; Saeed et al., 2005). Furthermore, pilot tests of the effectiveness of this fairly objective approach to the assessment of interpersonal interaction were conducted on data from a similar group-project experiment conducted the prior year. Retrospective assessments of interpersonal interaction were highly correlated \(0.645, p < .01\) with objective measures calculated in the same fashion as used in this study. Such evidence paired with the use of similar data in well-regarded and contemporary social network research (cf. Kossinets & Watts, 2006) provided justification for this objective measurement approach.
It is worth noting that the existence of date-time stamps for all of the messages further allowed us to compare any two periods of within-group interaction. Because we were concerned with ensuring that the mid-project bidding and ranking activities did not impact interaction dynamics, we leveraged this date-time information to compare interaction levels in groups both pre- and postbidding. Paired sample t tests revealed no significant differences ($p = .524$) in the frequency of interpersonal interactions on either side of the time point of the bidding exercise. The tenor of interactions, based on qualitative coding that accounted for issues such as “constructive feedback,” “critical insights,” and “new directions” similarly showed no apparent shift, hence helping to ameliorate such concerns.

**Group performance**

Final group performance is assessed based on a very structured rubric of performance that the project-group members were made well aware of prior to the start of their projects and which was reinforced throughout the 4-month time window. While recognizing the importance of the traditional triple measure set of cost, schedule, and operability (Kloppenborg & Opfer, 2002), our controlled 4-month setting ostensibly permits us to focus on the key factor of operability in this rubric, because all teams finished on time and within budget. Nevertheless exit interviews regarding group-member effort and associated work costs were also taken into consideration. The performance rubric in total involved professionally judged 7-point scale assessments of issues such as forecast appropriateness, cost effectiveness, strategic foresight, and near-term benefit among other broad items as suggested by researchers (Hackman, 1987; Shenhar, Levy, & Dvir, 1997). The rubrics also judged the teams on both their oral presentations of their work as well as the final written deliverables (see Appendix B).

**Standard controls**

In addition to the key items outlined above, several standard control variables were introduced in an attempt to clearly distinguish the effects of interest. Standard demographic attributes have been shown to relate to variation in employee attitudes and behaviors in past studies (Williams & O’Reilly, 1998). We therefore included items such as gender (0, Male; 1, Female) and program-entry score (e.g., standardized test score, a continuous score) as controls in our models. As per Marrone, Tesluk, and Carson (2007), at the group level, we include team size as a standard control because there is a reason to suspect that this issue may influence individuals’ perceptions, behaviors, and ability to contribute to success of the group as a whole. Furthermore, again as per Marrone et al. (2007), extensive challenges and/or high levels of project demands may also influence individual valuations of interpersonal ties, their development of those ties, and subsequent group-level performance (Choi, 2002). Rather than asking individual team members to rate the relative difficulty of their projects, we used a project-report coding mechanism by which professionals in practice could make such assessments and hence avoid common-source effects with respect to this control.
ANALYSIS

In total, complete data necessary for all levels of interest were gathered from 115 subjects (64% of our target pool). These individuals constituted 27 independent project groups and implied a total of 190 within-group dyads for consideration. Once again, no significant demographic differences were notable between our data sample and our target pool. Descriptive statistics of individual-level and group-level variables are provided in Table 1. Additional controls not found to be statistically significant in our analysis are excluded here for the sake of brevity.

The multi-item scales used at these levels all showed sufficient levels of construct validity. Perceived control held an alpha of .81, while conscientiousness provided an alpha of .84. The group-level controls of project demands and performance also showed high consistency across their constituent items. Confirmatory factor analyses comparative fit index showed multi-item constructs demonstrated acceptable fit levels as well, judged by goodness-of-fit indicators (minimum Tucker–Lewis Index = 0.96; minimum comparative fit index = 0.98 and maximum root mean square error of approximation = 0.07). All possible pairs of factors are compliant with Fornell and Larker’s (1981) test, indicating discriminant validity among construct measures. The only explicitly dyadic-level variable, frequency of interpersonal interactions, had a mean of 14.43 messages exchanged, and a standard deviation of 8.71.

Effects at the Individual Level

In the analysis of the individual-level effects proposed in H1a–H1c, we follow the lead of the recent work by Marrone et al. (2007) in their multilevel study of group dynamics and performance. As in our case, these authors made use of hierarchical linear modeling (HLM) due to the fundamentally nested nature of their multilevel data and hypotheses. As discussed in the commentary by Hitt et al. (2007), the use of HLM as a random coefficients modeling approach has become particularly popular among management researchers studying multilevel phenomena. In order to help justify its appropriateness at the level of individual dynamics, we conducted interclass correlation analysis and chi-square tests to check on variance in our measures of tie-strength valuation between and within groups. At least 20% of the variance in each of our three measures of valuation (BDM: \( p_{\chi^2} < 0.01 \); Ranking: \( p_{\chi^2} < 0.01 \); Subjective: \( p_{\chi^2} < 0.05 \)) seemed to significantly reside between groups, hence suggesting the need to account for group effects through a hierarchical approach. The results of our HLM for each of our three measures of valuation are provided in Table 2. In order to facilitate comparability across effects on the three measures to be predicted, we standardized each prior to running HLM.

Once again, although additional controls for issues such as age and experience were collected, these items appeared as consistently insignificant in our analysis. We therefore only show the results of models including controls revealed to be significant, along with our main independent variables.

As shown in Table 2, the block of individual-level predictors explained between 36% and 28% of the total variance depending on what measure of tie-strength valuation was considered (Bryk & Raudenbush, 1992). In all cases, the measures of perceived control and conscientiousness proved to be strong predictors of
Table 1: Descriptive statistics and correlations.

<table>
<thead>
<tr>
<th>Individual-level Variables (n = 115)</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gender (male = 0, female = 1)</td>
<td>0.53</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. GMAT score</td>
<td>691.43</td>
<td>59.31</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Perceived control</td>
<td>5.01</td>
<td>1.76</td>
<td>-0.09</td>
<td>-0.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Conscientiousness</td>
<td>4.36</td>
<td>1.44</td>
<td>0.08</td>
<td>0.21*</td>
<td>0.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Confidence (objective relative)</td>
<td>0.10</td>
<td>5.69</td>
<td>0.12</td>
<td>0.11</td>
<td>0.23*</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Confidence (subjective relative)</td>
<td>1.08</td>
<td>0.63</td>
<td>0.07</td>
<td>-0.02</td>
<td>0.21</td>
<td>0.13</td>
<td>0.30**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Tie-strength valuation (BDM-based)</td>
<td>11.57</td>
<td>8.03</td>
<td>0.13</td>
<td>0.08</td>
<td>0.23*</td>
<td>0.29**</td>
<td>0.27**</td>
<td>0.16*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Tie-strength valuation (ranking-based)</td>
<td>1.41</td>
<td>0.85</td>
<td>0.11</td>
<td>-0.10</td>
<td>0.28**</td>
<td>0.31**</td>
<td>0.20*</td>
<td>0.19*</td>
<td>0.63**</td>
<td></td>
</tr>
<tr>
<td>9. Tie-strength valuation (subjective)</td>
<td>4.56</td>
<td>1.68</td>
<td>0.06</td>
<td>0.05</td>
<td>0.18</td>
<td>0.22*</td>
<td>0.19*</td>
<td>0.15</td>
<td>0.44**</td>
<td>0.49**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group-level Variables (n = 27)</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Group size</td>
<td>4.26</td>
<td>0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Project demands</td>
<td>4.92</td>
<td>1.09</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>3. Performance</td>
<td>5.76</td>
<td>1.23</td>
<td>-0.15</td>
<td>0.11</td>
</tr>
</tbody>
</table>

*a Valuations based on average paired-bid differentials from results of Becker–Degroot–Marshack (BDM) based experiment.

*b Valuations based on differentials from ranking experiment.

*c Valuations based on subjective scale assessments (see “Methods”).

*p < .05.

**p < .01.
Table 2: Results of hierarchical linear modeling analysis predicting group member valuations of interpersonal tie strength.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Operationalizations</th>
<th>BDM-based(^c)</th>
<th>Ranking-based</th>
<th>Subjective Scale Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Differential Valuation</td>
<td>Differential Valuation</td>
<td>Scale Assessment</td>
</tr>
<tr>
<td><strong>Models for Various Dependent Variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Independent Variables(^b)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>0.06</td>
<td>0.76</td>
<td>0.16</td>
</tr>
<tr>
<td>GMAT score</td>
<td></td>
<td>0.17</td>
<td>2.17(^*)</td>
<td>0.02</td>
</tr>
<tr>
<td>Perceived Control (H1a)</td>
<td></td>
<td>0.23</td>
<td>2.93(^**)</td>
<td>0.28</td>
</tr>
<tr>
<td>Confidence (H1b)</td>
<td></td>
<td>0.19</td>
<td>2.42(^*)</td>
<td>0.16</td>
</tr>
<tr>
<td>Conscientiousness (H1c)</td>
<td></td>
<td>0.29</td>
<td>3.70(^***)</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>R(^2) within-group</strong></td>
<td></td>
<td>0.36</td>
<td>0.32</td>
<td>0.28</td>
</tr>
<tr>
<td><strong>Group-level Predictors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group size</td>
<td></td>
<td>-0.18</td>
<td>-2.29(^*)</td>
<td>-0.12</td>
</tr>
<tr>
<td>Project demands</td>
<td></td>
<td>0.19</td>
<td>2.42(^*)</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>R(^2) between-group</strong></td>
<td></td>
<td>0.10</td>
<td>0.12</td>
<td>0.10</td>
</tr>
</tbody>
</table>

\(^a\) Analyses were based on list-wise deletion. \(n = 115\), individual-level variables; \(n = 27\), group-level variables.

\(^b\) Individual-level predictor variables were group-mean-centered for testing individual level effects, grand-mean-centered for testing incremental effects of group-level predictors.

\(^c\) Average paired-bid differentials from results of Becker–Degroot–Marshack (BDM) based experiment (see Methods); For ease of model comparisons all three dependent variable measure were each standardized prior to this analysis.

\(^*\) \(p < .05\).

\(^**\) \(p < .01\).

\(^***\) \(p < .001\).

valuation, hence providing support for H1a and H1c. Confidence showed moderate significance in assisting to predict the first two of our valuation measures \((p < .05)\), but did not appear significant for our subjective measure of tie-strength valuation, hence providing only partial support for H1b.

**Effects at the Level of the Dyad**

With a similar rationale, HLM was also employed to test our effects models relating to dyadic (or paired-individual) level activity. Three models were again considered, given the three measures of valuation available to us. In each case, the dependent variable here was frequency of interpersonal interaction. The HLM results for this level are provided in Table 3.

Similar to our individual-level analysis, dyadic composites for age and experience did not account for any appreciable amount of variance nor did they significantly impact coefficients on our predictive composites of principal interest (joint tie-strength valuation). As noted earlier, in order to provide robust checks on the potential nature of interactions between individual valuations, both additive
Table 3: Results of hierarchical linear modeling analyses predicting group member dyadic interaction activity.

<table>
<thead>
<tr>
<th>Models of Interaction Activity Based on Three Separate Operationalizations of the Tie-Strength Valuation Predictor&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Interaction Activity&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Interaction Activity&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Interaction Activity&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variables&lt;sup&gt;b&lt;/sup&gt;</strong></td>
<td>γ</td>
<td>t</td>
<td>γ</td>
</tr>
<tr>
<td><strong>Paired-Individual Level Predictors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Σ&lt;sub&gt;Dyad&lt;/sub&gt; Gender</td>
<td>0.13</td>
<td>1.66</td>
<td>0.16</td>
</tr>
<tr>
<td>Σ&lt;sub&gt;Dyad&lt;/sub&gt; GMAT score</td>
<td>−0.01</td>
<td>−0.10</td>
<td>0.04</td>
</tr>
<tr>
<td>Σ&lt;sub&gt;Dyad&lt;/sub&gt; Valuation (V&lt;sub&gt;i&lt;/sub&gt; + V&lt;sub&gt;j&lt;/sub&gt;)</td>
<td>0.29</td>
<td>3.70***</td>
<td>0.32</td>
</tr>
<tr>
<td>Interaction (V&lt;sub&gt;i&lt;/sub&gt; × V&lt;sub&gt;j&lt;/sub&gt;)</td>
<td>0.26</td>
<td>3.31**</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Group-level Predictors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group size</td>
<td>−0.18</td>
<td>−2.29*</td>
<td>−0.21</td>
</tr>
<tr>
<td>Project demands</td>
<td>0.20</td>
<td>2.56*</td>
<td>0.19</td>
</tr>
<tr>
<td>R&lt;sup&gt;2&lt;/sup&gt; between–group</td>
<td>0.21</td>
<td>0.23</td>
<td>0.21</td>
</tr>
</tbody>
</table>

<sup>a</sup>Analyses were based on list-wise deletion; n = 190, pair-individual (dyad) level variables; n = 27, group-level variables.

<sup>b</sup>Paired-individual (dyad) predictor variables were group-mean-centered for testing paired-individual effects, grand-mean-centered for testing incremental effects of group-level predictors.

<sup>c</sup>For ease of model comparisons all three dependent variable measures were each standardized prior to this analysis.

<sup>1</sup>Valuations based on average paired-bid differentials from results of Becker–Degroot–Marshack based experiment.

<sup>2</sup>Valuations based on differentials from ranking experiment.

<sup>3</sup>Valuations based on subjective scale assessments (see “Methods”).

*<sup>p</sup> < .05.

**<sup>p</sup> < .01.

***<sup>p</sup> < .001.

and multiplicative effects of pair-individual valuation were considered. Consistently, both forms were found to be simultaneously significant. The addition of the multiplicative term provided significant R<sup>2</sup> increases of at least 10% in each case examined. Overall these tests provided strong support for H2.

**Effects at the Project-Group Level**

At the group level, nesting no longer applies in our case. Hence ordinary least squares regression is employed. Here we are simply concerned with testing the particular contribution of aggregated measures of control, confidence, and conscientiousness calculated as composites jointly predicting both individual interactions and the individual trait-driven tenor of those interactions (as theorized earlier). Significant interclass correlations showed the aggregation of these measures within groups to be suitable in this case. In order to help illustrate these contributions
Table 4: Results of regression analyses for group performance.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Step 1</th>
<th></th>
<th>Step 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\beta)</td>
<td>(t)</td>
<td>(\beta)</td>
<td>(t)</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group size</td>
<td>0.14</td>
<td>0.80</td>
<td>0.09</td>
<td>0.52</td>
</tr>
<tr>
<td>Project demands</td>
<td>−0.18</td>
<td>−1.03</td>
<td>−0.09</td>
<td>−0.51</td>
</tr>
<tr>
<td><strong>Step 2\textsuperscript{b}</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\Sigma \Sigma_{\text{Group}}) perceived control (H3a)</td>
<td>0.37</td>
<td>2.13\textsuperscript{*}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\Sigma \Sigma_{\text{Group}}) confidence (H3b)</td>
<td>0.21</td>
<td>1.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\Sigma \Sigma_{\text{Group}}) conscientiousness (H3c)</td>
<td>0.49</td>
<td>2.82\textsuperscript{**}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.09</td>
<td></td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>(F)</td>
<td>1.03</td>
<td></td>
<td>5.95\textsuperscript{**}</td>
<td></td>
</tr>
<tr>
<td>(\Delta R^2)</td>
<td></td>
<td></td>
<td>0.43\textsuperscript{*}</td>
<td></td>
</tr>
<tr>
<td>(\Delta F)</td>
<td></td>
<td></td>
<td>7.07\textsuperscript{*}</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}Analyses were based on list-wise deletion. Estimates are standardized regression coefficients. \(n = 27\).

\textsuperscript{b}Group composites developed based on dyadic interactions and individual traits (see “Methods”).

\(\textsuperscript{*}p < .10\).

\(\textsuperscript{**}p < .05\).

to accounts of variability in our group performance measure, we use a two-step procedure in which group controls are first entered. The second step introduces the full block of our three predictive aggregates. Table 4 summarizes our results at this level of investigation.

As with our individual-level analysis, both perceived control and conscientiousness appeared to contribute significantly to variance in our dependent variable, above and beyond the controls. This provided support for H3a and H3c. However, H3b was not supported, given the insignificance of the group aggregate measure of confidence.

**DISCUSSION**

The purpose of this study was to clarify the role of individual behavioral traits in driving project dynamics and performance, and hence add to decision makers’ understanding of the levers they might utilize in project management contexts. Traits such as control and conscientiousness, and to a lesser degree confidence, clearly influence both (i) perceptions of the value of interpersonal interactions in project work settings and (ii) their effects on dyad dynamics and group-level performance. In order to investigate these effects, we make use of both objective and subjective data and analysis pertaining to multiple though connected levels of project work dynamics. We demonstrate that key individual-level factors such as perceptions of control, confidence, and conscientiousness have the potential to trickle up into group-level benefits via the conduit of dyadic interactions. These interactions themselves are also a strong function of the shared appreciation
individuals have for such activity, which again is dependent in a homologous sense on these individual-level traits. The following subsections discuss research and managerial implications in turn and then limitations for interpreting our results.

**Research Implications**

As we mentioned in the introduction, current social factors project management research has begun to focus on how to enable self-managing teamwork facilitated by a team leader. The exact role of the team leader in such a context remains an important area for future research. To begin to improve our understanding in this context, we need to identify the key social factors that can be either managed as inputs to the team process or accommodated during the teamwork. This study identifies three traits that influence project performance via interpersonal interaction across project stages, namely, control, confidence, and conscientiousness.

Another research contribution is the joint and homologous application of social dynamics frameworks (e.g., social learning and networking) in tandem with goal-setting theories. In the past, such theories have been applied separately or at isolated levels of analysis. This is the first work to our knowledge that has been able to empirically demonstrate this joint appropriateness, simultaneously at both individual and group levels. This is also one of only a handful of studies to our knowledge that has attempted a rigorous investigation of how individuals’ explicit valuation of options (here interpersonal interactions) impact related actions (i.e., actual interactions in project groups), and how those actions in turn impact performance benefits.

In addition to the multilevel analysis, this study presents a mix of qualitative and quantitative methods aimed at capturing a more complete picture of the interactions within teamwork and values of the individuals. The BDM technique is often used in empirical economics literature but seldom in either operations management or information systems literature. To ensure the measurement validity of the BDM technique and ability to generalize results to other work typically employing scale or subjective measures, we applied all three in this study and found correlation among them, supporting the supposition that we have indeed tapped into traits and not moods. Such understandings have been difficult to ascertain in student-group-project research in the past (Fjermestad & Hiltz, 1999), though social factors research very clearly benefits from a multimethod approach (Goodhue, 1998). For future project-team research, this sort of multimethod application will enable richer understandings of social factor influence in team settings to be isolated and studied.

**Managerial Implications**

For practitioners, some of the findings are particularly revealing. Excellent technical skills and intuition certainly may be insufficient to drive performance if not accompanied by appropriate levels of interpersonal interaction within project groups. However, individuals that value such interactions will likely seek such interaction out, and it seems that the same individuals who believe in their ability to control and positively impact outcomes as well as feeling a sense of responsibility in group work may be the very ones most critical in driving project agendas. These may not naturally be the most skilled workers. Hence managers should not
view technical training as equivalent to the kind of training required to develop the acumen associated with understanding control, one’s own appreciation of skill and responsibility to a group. Rather, high-level managers overseeing project organization should take care to ensure a range of training opportunities exist to shore up any deficits in such individual attributes that could stymie project flow and performance.

Perhaps still greater practical implications relate to the general impact that fostered organization culture can have regarding project performance. If values such as conscientiousness are critical to decisions to pursue the kinds of ties that encourage project performance, higher-level managers might do well to encourage conscientiousness at the fundamental individual level by making clear any demonstrated correlations between self- and even peer-rated conscientiousness and group-level performance. At the managerial level, the benefit of increased transparency into the role of self-assessments of control and confidence with group performance can help guide organization-wide tactics toward recognizing and emphasizing each employee’s own strengths and potential contributions to group work (i.e., to garnish confidence) as well as explicitly outlining the degrees of freedom (control) that group members have in guiding project development and outcomes. If indeed it seems plausible that self-confidence itself should be encouraged only to a limit, again an issue requiring further study, appropriate moderation can be applied through case-based caveats of the dangers of overconfidence coupled with such confidence-building efforts.

**Limitations**

Although we take great care to control many aspects of our research to test our multilevel hypotheses, such control necessarily implies limitations as well. Certainly many real-world projects span more than 4 months and involve much larger numbers of participants and resource outlays (Thomas & Bostrom, 2010). The dynamics we are able to observe in smaller settings may not be as clearly observable in such grander contexts. Furthermore, our measure of performance, although broad by design, may not appropriately convey the most critical objectives any particular project may face. Some projects are focused on accomplishing tasks sufficiently at minimal cost. Others work within given budgets and are tasked with maximizing effectiveness. The relevance of the dynamics we examine to any single measure of performance may be very different from the findings we uncover for a broader index of performance. The projects in knowledge-intensive contexts, however, do tend to be innovation and creativity focused rather than time and budget bound, somewhat hedging the impact of this limitation.

More focused examinations using specific elements of our metric showed similar results, though our set of measures used in assessing performance is not likely a comprehensive one. More generally, future work in this area should capitalize on the dynamics observed in the present controlled setting and attempt to consider the robustness of such dynamics in the presence of other sources of variance such as project complexity, duration, and risk.

It is also worth noting that we were not able to find consistent support for our hypotheses regarding the role of confidence, regardless of the suggestiveness of existing theory. Empirically, this provides a particular contrast to the relatively
significant role that Scott-Young and Samson (2008), for example, find for their
related measure of team potency (albeit only in the case of its apparent impact on
project cost measures). It is likely that the notion of “overconfidence” has some
special role worthy of further investigation in these settings, as implied by authors
such as Krueger and Dickson (1994). When individuals view themselves as much
more capable than others, are they really likely to be concerned with strengthening
ties or are they more likely to pursue work on their own? Empirical evidence either
confirming or refuting this idea would certainly be informative for both future
research and practice. [Received: May 2009. Accepted: April 2010.]

REFERENCES
software project management: An experimental investigation. MIS Quarterly,
23(4), 531–555.

governing the motivational effects of goal systems. Journal of Personality
and Social Psychology, 45(5), 1017–1028.


of a tool for assigning students to groups for class projects. Decision Sciences,
17(1), 92–113.

Bendoly, E., & Swink, M. (2007). Moderating effects of information access on
project management behavior, performance and perceptions. Journal of Op-

Bendoly, E., Donohue, K., & Schultz, K. L. (2006). Behavior in operations man-
agement: Assessing recent findings and revisiting old assumptions. Journal
of Operations Management, 24(6), 737–752.

for research in behavioral operation. Production and Operations Manage-
ment, 19(5), forthcoming.

in software development: A multilevel analysis. Management Science, 53(8),
1315–1331.

Bonomo, T. V., & Johnston, W. J. (1979). Locus of control, trust, and decision

bleday.

Brass, D. J., Galaskiewicz, J., Greve, H. R., & Tsai, W. (2004). Taking stock of net-
works and organizations: A multilevel perspective. Academy of Management
Journal, 47(6), 795–817.

Brown, H. G., Poole, M. S., & Rodgers, T. L. (2004). Interpersonal traits, comple-
mentarity, and trust in virtual collaboration. Journal of Management Infor-
mation Systems, 20(4), 115–137.


Kirkman, B. L., Tesluk, P. E., & Rosen, B. (2004). The impact of demographic heterogeneity and team leader—team member demographic fit on team


APPENDIX A: QUESTIONNAIRE (MEASUREMENT SCALES)

1. Please indicate to what extent the following statements seem to truthfully describe you (1—Not well at all, 7—Very well)

   (a) My own efforts and actions are what will determine my results.
   (b) What I do and how I do it will determine my success.
   (c) If I succeed it will be because of my efforts.
   (d) Luck, other people and events control most of what I do.
   (e) My effectiveness is mostly in the hands of other people.
   (f) My performance is mostly controlled by external things.

2. The following questions are designed not to test your general knowledge, but rather to determine how confident you are of your own estimates relating to market and political activity in the recent past.

   For each of the following questions, please provide your “best guess” (please don’t spend time trying to Google these answers) followed by your estimate of a 90% confidence interval around those guesses in brackets. For example, if asked:

   “What was the population of Great Britain in 1997 (in millions)?”

   If you felt that the real population level was around 64 million, but at least felt that you could be 90% sure that it fell somewhere between 47 million and 80 million... your response should be:

   64 [47,80]

   In other words, for EACH question, please provide a “mean” estimate as well as the upper and lower bounds on what is YOUR OWN 90% confidence interval around that estimate in the form:

   Mean [LowerBound, UpperBound]

   (a) What was the population of New York in 1990?
   (b) What was the volume of stock-trades for the Dow Industrial average in 1995 (US$mil)?
   (c) What was the average monthly salary of a female federal employee, age 30–40 with a college degree in the year 2001?
   (d) What was the consumer-confidence level in 2005 (in%)?
   (e) What was the value of Chinese exports (in billions of US$) to the US during the period January-September 2000?
   (f) What was the average price in US dollars of an ounce of gold for the month of May 2004?
   (g) What were the pre-tax earnings (US$mil) of the Coca-Cola corporation in 2002?
(h) What was the size of the US national debt (US$bil) by October 1, 2003?

(i) What was the average value of a single Euro in US dollars in 2006?

(j) How many house seats did the Democrats hold in 1997?

3. Look back at your answers on the above 10 questions.

Looking back on the intervals (ranges) that you specified above, how many of them do you believe contain the true value asked for by their associated questions (a number, 1–10)

All participants in this study receive the same instructions as you do. On average, how many of their intervals (ranges) do you believe contain the true value? (some value between 0 and 10).

4. To what extent do you feel the following terms describe you? (opposite behaviors are provided in parentheses). [1 — I’m very much the opposite; 7 — Very strongly characteristic of me]

   a) Organized (vs. Disorganized)
   b) Responsible (vs. Irresponsible)
   c) Conscientious (vs. Negligent)
   d) Practical (vs. Impractical)
   e) Thorough (vs. Careless)
   f) Hardworking (vs. Lazy)
   g) Thrifty (vs. Extravagant)

APPENDIX B: GROUP PERFORMANCE GRADING RUBRIC

The rubric judges included the course professors as well as visiting consultants from industry.

<table>
<thead>
<tr>
<th>Grading Item</th>
<th>Improve</th>
<th>Mediocre</th>
<th>Acceptable</th>
<th>Well Done</th>
<th>Superb*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Project completed in a timely manner (within time-frame projected)</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(2) Three to five major recommendations are clearly outlined in the executive summary with bullet points?</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(3) For each recommendation is evidence based on the team’s business analysis presented and explained to justify the recommendation in the report body?</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
</tbody>
</table>

Continued
### APPENDIX B: (Continued)

<table>
<thead>
<tr>
<th>Grading Item</th>
<th>Improve</th>
<th>Mediocre</th>
<th>Acceptable</th>
<th>Well Done</th>
<th>Superb*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) At least one recommendation improves a process and is explained with clear “as is” and “to be” process models?</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(5) Constraints and competitive pressures on the client due to the business environment are clear.</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(6) Respect for the client and a diplomatic, tactful tone are maintained throughout the report so that the client will feel trust and collegial care on the part of the team?</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(7) The bottom-line impact of implementing the changes is evaluated and presented, preferably in a form that helps the reader understand which recommendations will be easiest and which will be most costly or require the most disturbance to daily operations.</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(8) Document outlines future steps and possible extensions to the work done in this project if the company were interested in carrying this work forward.</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(9) Document is professional with: (a) all pages numbered, (b) a table of contents with accurate page numbers, (c) unified paragraph styles and fonts throughout, (d) “Confidential” in a watermark or in the header on every page.</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
<tr>
<td>(10) Writing contains no more than three “however”s, nor any contractions, nor any commas with coordinating conjunctions between two nonindependent clauses, nor any sentences ending in prepositions.</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>10</td>
</tr>
</tbody>
</table>

*Superb is reserved for extraordinary performance.
Elliot Bendoly is an associate professor in information systems and operations management and the Caldwell Research Fellow at Emory University’s Goizueta Business School. Prior to academia he worked as a research engineer for the Intel Corporation. He holds a PhD from Indiana University in the fields of operations management and decision sciences, with an information systems specialization in enterprise resource planning and knowledge management. He has served as an instructor and developer of SAP implementation and ABAP/4 programming curriculum. More recently he has been involved with coursework on information technology-supported service operations and decision support system development for managers. He is an associate editor for the *Journal of Operations Management* and *Decision Sciences* and on the editorial board of *POM Journal*. Aside from these journals, he has also published in *Information Systems Research*, *MIS Quarterly*, *Journal of Applied Psychology*, *Journal of Service Research*, *European Journal of Operational Research*, *International Journal of Operations & Production Management*, and *Decision Support Systems*. He is also the co-editor of *Strategic ERP Extension and Use* (Stanford Press 2005) and the *Handbook of Research in Enterprise Systems* (Sage 2010). He is also the author of *Excel Basics to Black Belt* (Cambridge University Press 2008). His current research focuses on operational issues in information technology utilization and behavioral dynamics.

Dominic Thomas joined the Goizueta Business School in 2005 after receiving his PhD in management information systems from the University of Georgia. Prior to pursuing his PhD, he worked in education, education system reform, and international development in the United States, Russia, Japan, and Nepal. He has personally managed large, multinational projects in Nepal and Japan. He has also consulted with US AID to design a small-grants funding program and the U.S. Department of Agriculture to implement a highly sensitive research program focusing on rainwater stream buffer management and involving negotiations between environmentalists and farmers. His work in systems development projects has focused on small and medium business development and implementation of transaction processing, accounting audit and analysis, and collaboration solutions. He has served as an advisor for two large-scale information systems projects, one involving implementation of an enterprise resource planning system in a global energy company and one involving reengineering the core processes and systems with an object-oriented architecture at a government agency. He applies his background in international development and information systems specialties and deep experience in multiorganizational, cross-cultural project management and execution in pursuing his research interests in knowledge worker productivity and project management, information and communication technologies, and outsourcing and new forms of organizing work using emerging technology.

Monica Capra is an associate professor in economics at Emory University. Her areas of interest are experimental and behavioral economics. She uses laboratory experiments to study decision making in economic environments. One of her main interests is decision processes. In recent projects, she has used functional magnetic resonance imaging technology to study brain activation in an effort to better understand the process of choice. She is also interested in developing
laboratory environments that would be useful for policy. Currently, she is working on the application of laboratory methodologies for the study of entrepreneurship. She is an affiliated faculty member of Emory’s new Center for Neuropolicy and also affiliated with the Latin American and Caribbean Studies Program, the Institute for Human Rights at Emory, and the EXCEN lab at Georgia State University.