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Including the "I" in Virtuality and Modern Job Design: Extending the Job Characteristics Model to Include the Moderating Effect of Individual Experiences of Electronic Dependence and Copresence

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This paper extends the job characteristics model (JCM) to address virtual work design. We argue that the effects of critical job characteristics (task significance, autonomy, and feedback) on psychological states (experienced meaningfulness, responsibility, and knowledge of results) differ depending on two important elements of virtuality and their interactions with important social mechanisms: individual experiences of electronic dependence and its interaction with intimacy and the interaction of copresence with identification. Findings across 177 workers from a variety of settings varying in industry, size, and structure supported several moderating effects of virtuality and three-way interactions that included intimacy and identification, suggesting important modifications of the JCM. In addition, effects were not uniformly parallel for both elements of virtuality, emphasizing the need to differentiate between the effects of electronic dependence and copresence. We discuss the implications of these findings for theory and practice.

Key words: virtual work; job design; intimacy; identification
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> With the virtual tools that we have right now and the people that we have managing those fixes, it is going to be really bad. Two hundred years from now it will be a great system. We are in the crawling stage on the virtual technology stuff. It happened so fast, it is a cultural shock. When they bring the tools in here, you want your culture to try to react to those and keep up with those machines, but we aren't prepared for that yet. The tools that they are inventing are good ideas, but we need time to settle down and let the humans catch up.
>
> *—Project manager working virtually on a multibillion dollar aerospace program*

Electronically enabled and geographically dispersed "virtual" activity has emerged as a critical organizational form for structuring work on a global scale (Martins et al. 2004). Confronted with the growing challenges of global competition, increasing complexity, and rapid change, many organizations have chosen to utilize virtual work designs to increase flexibility, yet many remote collaborators report negative experiences such as feeling detached and alienated from colleagues because of the lack of face-to-face contact (Gibson and Gibbs 2006). Electronic dependence and a lack of copresence—two individual perceptions that coincide with fundamental dimensions of virtual work—may make it hard to design work to create a positive psychological experience for members and thus may impede work effectiveness. But these difficulties are not insurmountable; as we will argue, work may be designed to increase intimacy and identification to reduce the negative effects and thereby meet these challenges. Understanding how this might be accomplished requires that we revisit the basic assumptions of traditional work design theory and disaggregate core concepts into those aspects that still apply and those

that may be less relevant, given that working electronically and without copresence may create a very different psychological experience for employees.

In this article, we examine the job characteristics model (JCM) and show what aspects of the theory remain relevant when there is perceived electronic dependence and a lack of copresence, as well as what aspects need to be revised to fit this new organizational form of work. We define each of the key concepts and develop hypotheses about relationships among them based on previous research. We then look for evidence to support our emerging framework in a set of 177 field interviews. Our methodology involves multiple data sources and quantification of interview texts to statistically model proposed relationships. The investigation is unique because it combines multiple field settings, comprehensive and rich interviews, and depth of analysis of causal mechanisms. Our informants were at least somewhat geographically dispersed or electronically dependent (i.e., none were completely colocated and met solely face-to-face), and all participants were primarily focused on a given project effort, so these constitute important boundary conditions. The sample represents a variety of work settings, varying in size, duration of employment, and the number of subunits and firms involved in collaborative work. Our effects hold even after controlling for these differences, indicating that the relationships found are broadly applicable across types of geographically distributed collaborations.

Theoretical Framework

Since its development in the 1970s, the JCM of work design has generated over 200 published empirical studies and at least three comprehensive reviews (e.g., Fried and Ferris 1987, Loher et al. 1985, Roberts and Glick 1981). In essence, the model theorizes that core job characteristics influence critical psychological states of individuals, defined as features or conditions that act as internal motivating forces (Hackman and Oldham 1980). When an individual experiences these psychological states, he or she will be satisfied and productive. The five core job characteristics proposed by Hackman and Lawler (1971) and Hackman and Oldham (1976, 1980) include *skill variety* (the breadth of skills used while performing work), *task identity* (the opportunity to complete an entire piece of work), *task significance* (the impact the work has on others), *autonomy* (the depth of discretion allowed while performing work), and *feedback* (the amount of information provided about work performance). Hackman (1987, p. 324) argued that a task that (1) requires a variety of relatively high-level skills, (2) is a whole and meaningful piece of work with a visible outcome, (3) has significant consequences for other people (e.g., other organizational members or external clients), (4) provides substantial autonomy for deciding how one does the work, and (5) generates regular, trustworthy feedback about performance will result in high intrinsic motivation. These internal rewards are reinforcing to an individual and serve as incentives for continued efforts to perform well in the future.

The individual motivational states prompted by work characteristics are a key component of many work design theories (Hackman and Oldham 1976, Lawler et al. 1992, Parker et al. 2001, Spreitzer 1995, Thomas and Velthouse 1990). Hackman and Lawler (1971) and Hackman and Oldham (1976, 1980) proposed that three key motivational psychological states—*experienced meaningfulness*, *experienced responsibility*, and *knowledge of results*—are evoked by the job characteristics. To experience meaningfulness, an individual must perceive her work as important, valuable, and worthwhile. To experience responsibility, an individual must feel personally accountable for results of the work performed. Finally, to experience knowledge of results, one must have an understanding, on a fairly regular basis, of the effectiveness of one's performance. Other workplace motivation theories converge on a very similar set of experienced psychological conditions that facilitate motivation (Parker et al. 2001). In psychological empowerment theory (Sprietzer 1995, Thomas and Velthouse 1990), for instance, meaning is very similar to meaningfulness, impact is closely related to knowledge of results, and self-determination is consistent with experienced responsibility.

Hackman and Lawler (1971) proposed that experiencing all three psychological states leads to more positive responses to work in terms of both attitudinal (e.g., increased job satisfaction, decreased turnover intentions, etc.) and behavioral (e.g., increased performance, decreased turnover, etc.) outcomes. Empirical research over the last two decades largely supports this contention, with numerous studies demonstrating the positive impact of task design on outcomes (see Humphrey et al. 2007 for a recent example), and although these links have not always been empirically evident (Johns et al. 1992), a landmark series of studies by Renn and Vandenberg (1995) confirmed that the psychological states contributed significantly to the job characteristics model's explanatory power and thus are important for understanding motivation at work.

Extending the JCM to Virtual Work Design

Scholars in the arena of work design have increasingly argued for the need to develop theory that keeps pace with the changes occurring in the organizational landscape (Humphrey et al. 2007, Mohrman 2003, Parker et al. 2001). For example, Parker et al. (2001) suggest several features of work that should be considered as potentially interacting with the characteristics proposed by Hackman and Oldham (1975)—namely, cognitive demands, emotional demands, physical and social

contact, and interdependence. They also acknowledge the important role that technology availability and organization design have in determining how employees experience their work. In a recent chapter, Oldham and Hackman (2010, p. 466) suggested that a reevaluation of the JCM is critical because of fundamental changes in work, like the fact that individuals now may telecommute, work in temporary teams, and work on teams where members come from different organizations suggesting "profound implications for job design research" and that "the very thing job design researchers study is being transformed."

We take this logic one step further and argue that having been developed and examined in a collocated environment, frequent face-to-face social interaction was assumed in the JCM, and therefore the conceptualization of the job characteristics confounded changes brought about by such social interaction together with changes to task features. More specifically, the job characteristics of task significance, autonomy, and feedback included in the JCM each bundle together features of work associated with collocated social interaction, as well as features of work associated with the content of the task.[1] As pointed out by Hackman and Katz (2010, p. 1209), "[t]raditionally, group members tended to be colocated and to interact almost exclusively face to face.... An iconic group from the past would be a coal-mining team, a clearly bounded and highly stable group...who commonly spend a considerable amount of their nonwork time together as well." The shift to newer types of groups, such as research teams with members across universities and organizations that span multiple countries and time zones, requires us to "reconsider our traditional conceptual paradigms and research methodologies" (Hackman and Katzs 2010, p. 1209). Untangling potential confounds in the original model requires more attention to the social features of work. These were of less concern in the original model; according to Oldham and Hackman (2010, p. 467), "we did not view social factors as essential for fostering internal work motivation. Indeed, we thought that we had identified the core motivational properties of jobs, and that other properties were of relatively little motivational consequence. Unfortunately, we were not alone in neglecting the social dimensions of work—other researchers also tended to overlook social sources of work motivation."

How might the social dimensions of job characteristics be experienced differently in virtual work settings? We focus on the psychological experience of electronic dependence (degree of reliance on electronically mediated communication) and geographic dispersion (degree of physical dispersion among individuals)—two of the most commonly investigated features of virtuality (Stanko and Gibson 2009). Prior empirical research has largely examined these separately, with effects of electronic dependence being primarily tested in lab-based experiments comparing pure electronic to pure face-to-face groups (e.g., Hollingshead 1996a, Walther 1995) and geographic dispersion assessed using case studies or surveys that focus on the degree to which individuals are located in the same or different locations (e.g., Hinds and Mortensen 2005, O'Leary and Cummings 2007). We could identify only two empirical studies (Chudoba et al. 2005, Gibson and Gibbs 2006) that formally measured both variables in the same study. Furthermore, as others have noted, features of virtuality are not dichotomous "on–off" conditions; rather, each represents a continuum (Griffith et al. 2003, Martins et al. 2004), and each likely has effects resulting from different underlying mechanisms. We attempt to bridge the largely separate research streams on electronic dependence and geographic dispersion by representing each as a continuum, testing their independent effects simultaneously in the same model, and specifying unique theoretical explanatory mechanisms for each, which helps us to untangle the potential confounds to understand how the psychological experience of virtual work influences its outcomes. Specifically, we argue below that although the JCM assumed a degree of intimacy, perceived electronic dependence makes this intimacy precarious, and that lack of perceived copresence makes the identification that was assumed in the JCM precarious. If this is true, then the interaction between electronic dependence and intimacy, and between lack of copresence and identification, changes the nature of the relationships between the work design characteristics and psychological states.

Perceived Electronic Dependence and Intimacy

Previous research has focused mainly on objective indicators of technology use, but there is growing recognition that workers may also vary in their *subjective* perceptions of how electronically connected they are with collaborators. An important contribution of our paper is in examining the subjective, psychological aspects of virtual work as they affect individual workers. Across two workers who each use e-mail with the same frequency, one may feel it is her only option, and hence feel highly reliant on that technology, whereas the other may see e-mail use as a choice among many other ways of staying in touch, including face-to-face conversation. Whereas objective aspects of technology clearly act to enable and constrain behavior, an important social element exists as well. Indeed, social constructionist views regard technologies as shaped by people, rather than vice versa (MacKenzie and Wajcman 1985), and the social influence model of technology use is premised on the notion that "media perceptions are, in part, *subjective and socially constructed*" (Fulk et al. 1990, p. 121; italics ours).

Although researchers have yet to comprehensively examine individual perceptions of electronic dependence, experimental research indicates that work involving a high degree of electronic communication is often less effective than work with a low degree, based on numerous indicators such as solution acceptance, cohesion, commitment, and overall effectiveness, and it displays slightly more errors and significantly less synergy (Potter and Balthazard 2002). Stanko and Gibson's (2009) comprehensive review suggests that computer-mediated collaboration (CMC) takes longer than face-to-face collaboration, occurs less frequently, and that CMC collaborators perceive their interaction as less effective. Yet two separate studies found a positive relationship between virtuality and decision quality (Huang et al. 2002, Schmidt et al. 2001).

The reason for the equivocal findings may be that electronic dependence is only detrimental when it results in reduced intimacy, or relational closeness, which has been found to impact communication behavior (Altman and Taylor 1973). Social penetration theory regards intimacy as a key factor contributing to the development of satisfying interpersonal relationships and predicts that intimacy is associated with greater self-disclosure and openness (Taylor and Altman 1987). Research shows that individuals in more intimate dating relationships engage in more direct and open communication, have more transparent conversations about problems, and are less likely to avoid direct discussions over conflicts (Sanderson and Karetsky 2002). For these reasons, intimate relationships tend to be more satisfying than nonintimate ones; we assume this will be the case for work relationships as well as personal relationships. Intimacy becomes precarious as perceived electronic mediation increases because such mediation leads to uneven information transfer and coordination challenges and reduces the amount of informal interaction, as the amount of casual encounters and unplanned, serendipitous conversations is much higher among collocated colleagues (Kraut et al. 2002). Cues-filtered-out (Culnan and Markus 1987) theories, such as media richness (Daft and Lengel 1986), reduced social context cues (Sproull and Kiesler 1986), and social presence theory (Short et al. 1976), regarded computer-mediated communication as less suitable for intimate relationships because of the media's information leanness and reduced social context cues and bandwidth.

Copresence and Identification

Beyond objective indicators of physical dispersion such as miles or time zones crossed, individuals working on the same project may also vary in their perceptions of distance from one another; that is, there may be individuals who are separated from colleagues by many miles or time zones yet feel as though they are "close" because of the connectedness they have established. Likewise, individuals who are only separated by a few miles (or even just a few floors) may lack feelings of copresence if they have not established connections with colleagues. Lee (2004) also argues that presence should be operationalized as a psychological rather than an objective phenomenon, and Wilson et al. (2008) acknowledge this paradox of being far but close. Here, we focus on the concept of "copresence," which refers to the subjective perception of closeness versus distance (Zhao 2003). Copresence requires a mutual awareness in which individuals become "accessible, available, and subject to one another" (Goffman 1963, p. 22).

Again, although few researchers have investigated individual perceptions of copresence, findings regarding geographic dispersion have been equivocal. Gibson and Gibbs (2006) found a negative relationship between geographic dispersion (as captured by pairwise time zone differences in a team) and innovation. Yet, when an experimental comparison group was used (distributed versus face-to-face collaborators), recent reviews suggest that distributed collaborators participated more equally than colocated ones, and results for satisfaction and user-rated effectiveness were split among findings of "higher," "lower," and "no difference" (Stanko and Gibson 2009). Edwards and Sridhar (2005) examined the perceived effect of time zone differences alongside trust, task structure, and perceptions of cultural diversity among team members on multiple outcomes. They found stronger effects of trust and task structure than time zone differences, but the sample consisted of students rather than workers in organizational settings, and hence may underestimate the potential effects of individual perceptions.

These equivocal findings may again be due to an unmeasured third variable which, when missing from social interactions, could account for the negative effects of lack of copresence. We argue this underlying mechanism may be identification, defined as a process of self-categorization with respect to others (as well as an outcome of that process) (Dutton et al. 1994) in which team members or coworkers discover common identities because of some shared social category (such as profession, gender, ethnicity, or political views). Identification among coworkers is theorized to create common ground, reduce uncertainty, and elicit positive attributions in the absence of actual data (Wilson et al. 2008). Identification becomes precarious in distributed work because collaborators lack a shared context as a result of different perspectives, norms, and temporal rhythms, and share less friendship and familiarity (Hinds and Bailey 2003, Hinds and Mortensen 2005). Virtual workers are likely to have reduced contact and exposure to strong organizational structures and processes (including organizational dress, symbols, rituals, and ceremonies) that typically foster organizational identification (Wiesenfeld et al. 2001). Distributed teams are likely to experience more task and process conflict and be fragmented by

demographic "fault lines" (Lau and Murnighan 2005), which exacerbate geographical subgroup dynamics that create rifts among team members (Cramton and Hinds 2004). Hence, developing identification is much more difficult than was the case in colocated environments in which the original JCM was developed. Having introduced the key features of the JCM that may differ in a virtual world, we elaborate on specific hypotheses below.

Task Significance and Meaningfulness

Experienced meaningfulness refers to the extent to which one believes one's work role and interactions are important vis-à-vis one's own value system (Hackman and Oldham 1976, Spreitzer 1995). The JCM predicted, and empirical evidence has demonstrated, that when workers experience high task significance (full understanding of the impact their work has on others), this helps build meaningfulness (Renn and Vandenberg 1995). As task significance increases, this sense of meaningfulness can come directly from the task itself or can come from frequent face-to-face social interactions at work (Humphrey et al. 2007). Having been developed in collocated environments with rich social interactions, we cannot be sure whether it was the task or social features that were the source of the meaningfulness in the JCM. Perhaps somewhat counterintuitively, we propose that the effect of task significance on meaningfulness will be even stronger when there is high perceived electronic dependence because there will be an even greater emphasis on the content of the task as a source of meaningfulness, given potentially fewer social rewards in a virtual world. In the (relative) absence of strong social interaction, task significance becomes an increasingly important source of meaningfulness. In fact, experimental research has demonstrated that when interacting face to face, communicators use linguistic cues to make inferences about one another that enable individuals to derive meaning from social interactions with others (Lea and Spears 1992); these social cues are not traditionally available over CMC (Maruping and Agarwal 2004), placing greater emphasis on task significance as a source of meaning. Yet development of intimacy may reduce these effects and create a dual focus on both the task and social features of the work. Empirical research has shown that as interpersonal relationships become more intimate, they are characterized by more open and direct communication (Altman and Taylor 1973). This intimacy allows for more latitude in confronting issues in the relationship and thus is likely to help overcome conflicts or misunderstandings that would diminish the social sources of meaningfulness experienced by electronic communicators. Both Warkentin et al. (1997) and Tan et al. (2000) found that among electronic collaborators in organizational settings, relational links were positively related to greater cohesion and information exchange. Reflecting these interaction effects, we propose the following.

HYPOTHESIS 1A (H1A). *The relationship between task significance and experienced meaningfulness is influenced by the interaction of electronic dependence and perceived intimacy such that the relationship is stronger when perceived electronic dependence is high*; *this effect is reduced when perceived intimacy is also high.*

A lack of perceived copresence in distributed settings is also likely to increase the focus on the task, enhancing the relationship between task significance and meaningfulness, because it may remove the social source of meaningfulness that exists in collocated environments. Distributed colleagues are subject to "situational invisibility" because of their inability to observe proximal environmental stimuli affecting remote work partners, which leads them to attribute negative behavior to internal rather than situational factors and reduces relational satisfaction and cohesion (Cramton et al. 2007). Conversely, research has found that proximity facilitates relationship building (Kiesler and Cummings 2002). For this reason, tasks may be prioritized and relationships deemphasized in dispersed settings, resulting in a stronger association between task significance and experienced meaningfulness. Yet, when workers have a strong sense of identification despite the lack of copresence, this may reduce the relationship between task significance and meaningfulness. Identification may help with the "lack of mutual knowledge problems" that result from geographical dispersion (Cramton 2001) by providing coworkers with common ground from which to work and share concerns and specific knowledge (Wilson et al. 2008). Case studies comparing successful and unsuccessful collaborations across time boundaries demonstrate that increasing the "mind share" (Klein and Kleinhanns 2003) that members bring to their tasks (i.e., their belief that the work is important and of high priority) increased integration and cohesion, which may in turn contribute to the meaningfulness derived from the social aspects of work (Maznevski and Chudoba 2000). This suggests the following hypothesis.

HYPOTHESIS 1B (H1B). *The relationship between task significance and experienced meaningfulness is influenced by the interaction of perceived copresence and identification among coworkers such that the relationship is stronger when perceived copresence is low*; *this effect is reduced when identification is also high.*

Autonomy and Responsibility

Experienced responsibility, a second key psychological state likely affected by virtuality, represents the degree of personal accountability an individual has for his work contributions (Hackman and Oldham 1976). The JCM predicted, and empirical evidence has demonstrated, that when workers experience autonomy, this helps build a sense of responsibility (Renn and Vandenberg 1995).

Autonomy, an essential dimension of self-determination (Deci and Ryan 2000), enables a greater sense of control, enthusiasm, and impact (Ryan and Deci 2000, Seibert et al. 2004), whereas the inability to exert influence over things (particularly those that adversely affect one's life) breeds apprehension, apathy, or despair (Bandura 1997). Teams experiencing greater levels of autonomy through self-managing work group designs have been found to demonstrate greater psychological engagement (Tesluk and Mathieu 1999).

In contrast to the aforementioned effects on the task significance, we argue that perceived electronic dependence *decreases* the effect of autonomy on responsibility. Collaborators who perceive that they are electronically dependent in their interactions with colleagues are likely to feel less personally accountable to coworkers they do not see face to face, because being "out of sight, out of mind" is likely to lead to lack of attention and effort, or a greater degree of free riding, even with decision discretion (Kiesler and Cummings 2002). A review of the research on CMC groups found that because of relative anonymity, they are marked by lower participation than face-to-face groups (Hollingshead and McGrath 1995); lower participation may mean that the increase in effort intended by increasing autonomy does not occur, hence reducing benefits to responsibility. However, development of intimacy may help to mitigate these negative effects of perceived electronic dependence. In the virtual team context, Kirkman et al. (2002) came to similar conclusions: when virtual workers in the travel services company they studied experienced positive socioemotional outcomes, they took initiative and were responsive to requests and needs of coworkers (even though many communicated primarily by e-mail). Intimacy has been negatively associated with topic avoidance in romantic relationships (Knobloch and Carpenter-Theune 2004); similarly, workers with more intimate relationships are more likely to actively confront issues and respond to requests, increasing the sense of responsibility and social obligation they feel to one another. Based on this, we propose the following.

HYPOTHESIS 2A (H2A). *The relationship between autonomy and experienced responsibility is influenced by the interaction of perceived electronic dependence and perceived intimacy such that the relationship is weaker when perceived electronic dependence is high*; *this effect is reduced when perceived intimacy is also high.*

Likewise, perceiving a lack of copresence may weaken the relationship between autonomy and experienced responsibility. Workers who perceive themselves to be highly distributed may feel less "core" to the organization, work unit, or project, and therefore less responsible, even when given decision discretion. This may be particularly true among collaborators who find themselves in the minority because they reside in a more remote location. Studies of distributed work show that noncore collaborators tend to be forgotten as a result of not participating in informal on-site discussions because time zone differences (Cramton 2001) and thus are often excluded from important decisions (Grinter et al. 1999). Remote sites may also be given less critical tasks and responsibilities, being treated as subcontractors rather than integral project members (Armstrong and Cole 2002). When a collaborator is excluded or feels on the periphery of the project (i.e., not core to its success), he is less likely to feel responsible for project outcomes (Klein and Kleinhanns 2003). Core members are also likely to feel less accountable to remote coworkers who are not physically present, even when given autonomy. Developing identification among coworkers may help to mitigate these effects because it creates an inclusive climate in which no one feels "peripheral." Identification has been associated with increased levels of loyalty and commitment (Zdaniuk and Levine 2001), and thus coworkers who identify with one another or with a common group are likely to feel more responsible to one another. Furthermore, developing identification can help overcome fault lines that form based on geographical and subgroup differences and an "us versus them" mentality (Cramton and Hinds 2004) because it makes collaborators more likely to give others the benefit of the doubt and assign positive attributions and expectations when motives or behavior are not readily visible (Cramton et al. 2007). An empirical study using a student sample found that groups sharing an identity were more likely to overcome in-group favoritism and transfer knowledge across subgroup lines (Kane et al. 2005). A shared team identity creates a psychological bond among distributed teammates that can help them bridge distance (Hinds and Bailey 2003). Based on this logic, we propose the following.

HYPOTHESIS 2B (H2B). *The relationship between autonomy and experienced responsibility is influenced by the interaction of perceived copresence and identification such that the relationship is weaker when perceived copresence is low*; *the effect is reduced when identification is also high.*

Feedback and Knowledge of Results

Finally, knowledge of results refers to the extent to which an individual knows how well she is performing (Hackman and Oldham 1976). The JCM predicted, and empirical evidence has demonstrated, that when workers receive feedback, this helps build knowledge of results, a positive motivational state (Renn and Vandenberg 1995). Yet, when feedback is given electronically, it may not be as timely (e.g., Kraut et al. 1993) or contain as many socioemotional cues (Maruping and Agarwal 2004), thus making it more difficult to interpret and lead to important insight about job performance. The more formal nature of electronic communication (Hollingshead 1996a, b) may

mean less informal feedback that may be critical for understanding the results associated with one's performance, as well as the perspective of internal and external customers. Kirkman et al. (2002, 2006) reported that general managers were reluctant to provide strong negative feedback over CMC, preferring to wait for face-to-face meetings, which were very infrequent. Because of these factors, perceived electronic dependence is likely to reduce the relationship between feedback and knowledge of results. Intimacy likely helps overcome these negative effects; that is, even when perceiving high electronic dependence, when workers develop intimacy, then feedback may enhance knowledge of results. Jarvenpaa and Leidner (1999) found that the successful teams in their sample had communication characterized by positive tone, intimacy, and appropriate feedback about contributions. As mentioned, coworkers who feel more close or intimate are more likely to engage in open and direct communication, perhaps increasing the relationship between amount of feedback and subsequent understanding of results. Based on this, we propose the following.

HYPOTHESIS 3A (H3A). *The relationship between feedback and knowledge of results is influenced by the interaction of perceived electronic dependence and perceived intimacy such that the relationship is weaker when perceived electronic dependence is high*; *this effect is reduced when perceived intimacy is also high.*

Perceiving a lack of copresence may also weaken the relationship between feedback and knowledge of results. Armstrong and Cole (2002) found that distance inhibits "corrective feedback loops" that chance encounters provide, and managers reported difficulties coaching and assessing performance problems from afar. Members in different time zones communicating asynchronously are likely to experience long lapses between communication events, reducing the quality and immediacy of feedback (Ocker et al. 1995). Such workers may receive less feedback that provides knowledge of overarching organization or subunit accomplishments toward goals than workers with high copresence (Cramton 2001). Identification may help to overcome these challenges. Feedback alongside identification acts as a binding mechanism that integrates efforts of dispersed parties who may lack basic understanding of work processes in other locations. Identification provides common ground and reduces uncertainty about others (Wilson et al. 2008), and workers who identify with one another are likely to be more loyal to and trusting of each other (Hinds and Mortensen 2005). As a result, they are likely to be more comfortable asking follow-up questions to clarify or confirm their interpretation of feedback to have full knowledge of results. Thus, identification combined with feedback, even despite a lack of copresence, gives workers a sense of how they need to improve to increase project or unit outcomes. Thus, we propose the following.

HYPOTHESIS 3B (H3B). *The relationship between feedback and knowledge of results is influenced by the interaction of perceived copresence and identification such that the relationship is weaker when perceived copresence is low*; *this effect is reduced when identification is high.*

Methods

We investigated the hypotheses using a set of comprehensive interviews to gain a deep understanding of the psychological experience of virtual workers and provide insight into the psychosocial dynamics of work processes from the participants' perspectives. Our analyses use a systematic approach to quantify interview text data and combine it with archival data; thus our method is both qualitative and quantitative. We chose to use semistructured interviews rather than a survey to capture natural language used by interviewees and explore the diverse ways in which they made sense of their experiences (Berger and Luckman 1980) through their own rich descriptions and accounts (Miles and Huberman 1994). Our data are more "natural" than evoked (Kabanoff 1997), because they did not result from transparent questioning, and interviewees were not primed by specific questions and response categories. Thus, our textual analysis approach is less subject to response bias than self-reported survey data; it also has the advantage of combining the depth of understanding gained through interviewing and rich textual analysis with the precision and rigor of statistical analysis and modeling.

Sample and Contexts

Maximizing the diversity of the type of work performed, 16 organizations (two to three in each of these seven industries: aerospace, agriculture, automotive, information technology (IT), professional services, retail, and travel) were invited and agreed to participate in the research as part of a consortium dedicated to better understanding virtual work. Human resource and organizational development specialists in each organization identified projects in their organization willing to participate. This resulted in three to five projects (for a total of 14 projects) in each of four categories: engineering/IT (e.g., aerospace new product development), sales/marketing (e.g., selling a travel reservation system), accounting/finance (e.g., developing a procurement strategy), and professional services (e.g., consulting). We interviewed at least 90% of the workers on each project. This resulted in a total of 177 interviews. Following interviews, workers were briefed on the nature and purpose of the study and were given a report of the findings. Work performed was often highly complex and geographically dispersed, crossing numerous time zones and involving dependence on electronic communication, but

workers varied in terms of the degree to which they were physically separated from coworkers and the number of locations crossed during their work, hence providing the variance we needed on perceived copresence. Across the 177 respondents, 16 organizations, 45 organizational subunits, 32 cities, and 18 nations were represented, including the United States, Canada, Australia, Mexico, Argentina, Brazil, India, Greece, and 10 European countries. The average project tenure was 4.5 years. Thirty percent of the sample were women, and the average age was 41 years.

Procedure

Interviews were one to two hours in duration, conducted on-site and tape-recorded, and about 50% were videotaped (where allowed by the organization and agreed to by the interviewee; there was no difference in the study variables across those interviews that were videotaped and those that were not). The interviews were semistructured (McCracken 1988), with interview questions pertaining to the nature of work, communication processes, technologies used, interpersonal relationships and processes, and outcomes. The full interview protocol is available from the authors. Archival data were also collected, including background information about the organizations, e-mails or other available electronic transcripts, evaluations, project plans, and written mission statements. All interviews were transcribed verbatim and entered into a content analysis text database consisting of over 1,000 pages, including 399,474 words, with an average of 2,257 words per interview. We used ATLAS.ti, a computer program designed for content analysis (see Lewis 2004 for a review of its features), because it enables the creation of frequency distributions and inventories for specific words or categories in a text. Each interview was prepared for the software program using a coding scheme to identify each interviewee's affiliations and demographic information.

Measures

To measure the key variables in our analysis (*perceptions of electronic dependence*, *intimacy*, *copresence*, *identification*, *task significance*, *autonomy*, *feedback*, *experienced meaningfulness*, *experienced responsibility*, and *knowledge of results*), we used an interview-based approach (Fielding and Lee 1998, Roberts 1997) and then conducted construct validity analyses to demonstrate that our measures converged with other possible measures (described below). These concepts are not easy to characterize without intimate knowledge from participants' perspectives, so we captured evidence of them by examining experiences as relayed in the interviews. A similar procedure has been utilized to examine perspective taking (Mohrman et al. 2001), intercultural issues in teams (Gibson and Zellmer-Bruhn 2001), and learning (Gibson and Vermeulen 2003). The first step was to identify interview excerpts reflecting each variable. Following previous research, a list of key words pertaining to each variable was compiled. This list was based on a comprehensive review of survey instruments used to measure these variables in other studies, research articles, and a snowball synonym procedure to identify synonyms in dictionaries and thesauruses. There was substantial overlap between many of our measures and those used in prior literature (e.g., Tan et al. 2000, Hackman and Oldham 1980).

In a second step, we instructed ATLAS.ti to search for any word in a category for each variable. Subtext databases were constructed for each variable, containing excerpts including any word in the category list. A third important step was a process of in-context verification (Wolfe et al. 1993). Excerpts in each subtext database were reviewed by two independent raters and coded as 1 for reflecting the variable (e.g., true evidence of the concept) or 0 for not reflecting the variable (insufficient evidence of the concept). Any occurrence of a term that described a "lack" of a concept was coded as not reflecting the variable. An average interrater reliability coefficient of 0.85 (Cohen's kappa) was computed, indicating that there was high agreement across the raters regarding whether the excerpts provided evidence of the concepts. Discrepancies were carefully discussed and reconciled to arrive at a final set of excerpts for each variable. This in-depth analysis ensured that we captured a qualitative difference in the construct across interviewees. Our fourth step involved computing a frequency count for each informant representing the number of times a word reflecting each variable had been expressed and verified in context. Finally, to control for differences in interview length so as to reflect the emphasis on a particular variable relative to the overall interview length, we weighted the number of occurrences by total number of words in an interview transcript. These scores were used in our hypothesis tests.

Construct Validity. We conducted several tests of convergent validity for our core concepts. To test that our measure of *copresence* corresponded to geographic dispersion involving time zones, we first computed the number of time zones crossed by each individual to communicate with each coworker on a project. Next, we calculated the average number of time zones crossed by each person (min, 0, no time zones crossed; max, 6; mean, 2; standard deviation (SD), 2.32). This measure was significantly correlated with the interview-based perceptions of *copresence* ($r = -0.33$, $p < 0.001$). The time zone measure of geographic dispersion was also highly correlated with number of locations ($r = 0.65$, $p < 0.001$) and number of nations represented on the project ($r = 0.57$, $p < 0.001$). Although these correlations do not indicate perfect overlap, they do suggest some correspondence among the different measures.

Number of locations and nations are alternative ways of assessing geography, but they do not necessarily capture key virtual work challenges, which have more to do with perceived lack of presence.

Our interview-based measure of perceived *electronic dependence* was significantly correlated with an external rating of electronic dependence ($r = 0.29$, $p < 0.001$). This rating was obtained by having two independent external raters code the extent to which each interviewee relied on electronic communication using a three-point Likert scale based on overall subtext analysis of the interview transcripts, as well as records of e-mail traffic, with "1" representing a low level of electronic dependence, "2" representing a moderate level, and "3" representing a high level. These categories were inductively derived based on overall subtext analysis and comparisons across interviewees. A subset of interviewees clearly relied on CMC much more than all others; these were considered highly dependent. Likewise, a subset clearly relied on CMC much less than all others; these were considered low on electronic dependence. All others were considered moderate. Interrater reliability was high (Cohen's kappa = 0.85). However, we consider the word count measure of *electronic dependence* (based on word counts of the extent to which interviewees relied on electronic communication as expressed in an unstructured interview) more appropriate for this study, because outsiders may not be aware of the private experience of each individual.

Additional Controls. Because psychological experiences of work have been shown to vary across different task types (Bunderson and Sutcliffe 2002), we included dummy variables for the four categories mentioned earlier (*engineering/IT*, *sales/marketing*, *accounting/finance*, and *professional services*). Larger projects, shorter projects, those with multiple firms, and with multiple subunits may encounter greater coordination problems; thus, we also included *number of individuals involved in a project*, *project duration*, *number of firms*, and *number of subunits* represented as controls.

Level of Analysis. To ensure that the individual level of analysis and ordinary least squares (OLS) regression were appropriate, we conducted intraclass coefficient (ICC(1)) analyses for each of our variables, testing the percentage of variance residing within and between project groups (Bliese 2000). Results confirmed that all meaningful variance was at the individual level—we found no evidence of significant variance between project groups. If little or no variance resides between groups, as indicated by insignificant ICC(1) values, the assumptions of OLS regression techniques are not violated, and there is no need for multilevel modeling, such as hierarchical linear modeling, which partitions within- and between-group variance (see, e.g., Marrone et al. 2007).

Results

Pairwise Pearson correlations among the variables are presented in Table 1. Coinciding with original JCM predictions, *task significance* was positively related to *meaningfulness* ($r = 0.25$, $p < 0.001$), *autonomy* was positively related to *responsibility* ($r = 0.26$, $p < 0.001$), and *feedback* was positively related to *knowledge of results* ($r = 0.13$, $p < 0.05$). It is also interesting to note that *electronic dependence* was negatively related to *task significance* ($r = -0.20$, $p < 0.01$), *knowledge of results* ($r = -0.17$, $p < 0.05$), and *autonomy* ($r = -0.13$, $p < 0.05$), whereas *copresence* was positively related to *intimacy* ($r = 0.33$, $p < 0.001$), *identification* ($r = 0.34$, $p < 0.001$), *meaningfulness* ($r = 0.14$, $p < 0.05$), *responsibility* ($r = 0.33$, $p < 0.01$), and *knowledge of results* ($r = 0.13$, $p < 0.01$). To test the hypothesized relationships, a series of moderated multiple regressions was conducted.

Experienced Meaningfulness

Results for H1A are depicted in Table 2. At Step 2, both task significance ($b = 0.30$, $p < 0.01$) and perceived electronic dependence ($b = 0.26$, $p < 0.01$) were significant positive predictors of experienced meaningfulness after entering the controls and explained significant

Table 1 Correlations Among Key Variables Proposed in Hypotheses

$N = 177$	Mean	SD	1	2	3	4	5	6	7	8	9
1. *Electronic dependence*	0.475	0.338	1.00								
2. *Copresence*	0.095	0.111	0.16*	1.00							
3. *Experienced meaningfulness*	0.154	0.120	0.03	0.14*	1.00						
4. *Experienced responsibility*	0.430	0.318	−0.04	0.33**	0.07	1.00					
5. *Knowledge of results*	0.312	0.207	−0.17*	0.13*	0.15*	0.36***	1.00				
6. *Task significance*	0.102	0.101	−0.20**	0.10	0.25***	0.34***	0.65***	1.00			
7. *Autonomy*	0.074	0.067	−0.13*	−0.04	−0.02	0.26***	0.14*	0.02	1.00		
8. *Feedback*	0.112	0.129	0.11	−0.12	−0.17**	0.25***	0.13*	0.11	0.10	1.00	
9. *Intimacy*	0.071	0.100	−0.02	0.33***	0.10	0.15*	0.14*	0.15*	−0.06	−0.01	1.00
10. *Identification*	0.148	0.165	0.04	0.34***	0.12*	0.40***	0.34***	0.25***	0.05	0.15*	0.31***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 2 Effect of Electronic Dependence and Intimacy on the Relationship Between Task Significance and Experienced Meaningfulness

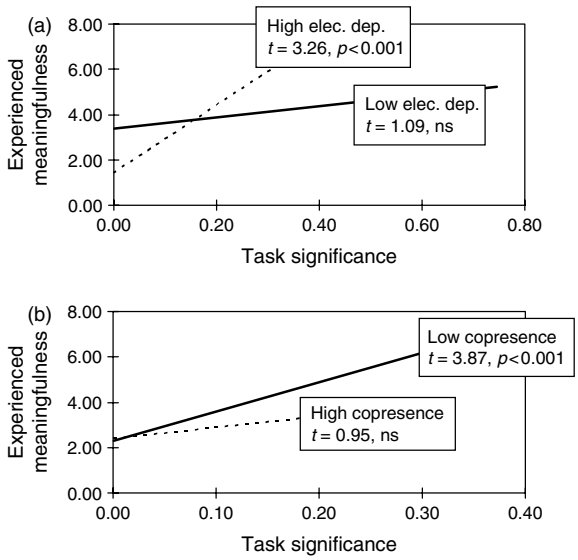
	Step 1	Step 2	Step 3	Step 4
Controls				
Dummy for project type 1	−0.23**	−0.41	−0.41***	−0.39***
Dummy for project type 2	−0.03	−0.06	−0.06	−0.06
Dummy for project type 3	−0.23**	−0.26**	−0.25**	−0.23**
Project size	0.15	0.20**	0.17*	0.15*
Project duration	−0.09	0.00	0.01	0.00
Number of firms	−0.06	−0.06	−0.06	−0.07
Number of units	0.12	0.11	0.15	0.18
Task significance		0.30**	−0.29	0.13
Electronic dependence		0.26**	0.09	0.23
Electronic dependence × Task significance			0.60*	0.29
Intimacy				1.08**
Intimacy × Electronic dependence				−0.99*
Intimacy × Task significance				−1.01*
Intimacy × Electronic depend. × Task signif.				0.79
ΔR^2		0.10	0.02	0.03
ΔF		10.49***	3.62*	1.66
Δdf		2,167	1,166	4,162
Total R^2	0.08	0.18	0.20	0.24
F	2.20	4.24***	4.23***	3.55***
df	7,169	9,167	10,166	14,162

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

variance ($R^2 = 0.18$, $F = 4.24$, $p < 0.001$). Entering the multiplicative interaction of *perceived electronic dependence* × *task significance* resulted in a significant increase in R^2 ($\Delta R^2 = 0.02$, $\Delta F = 3.62$, $p < 0.05$), and the interaction term was significant, providing partial support for H1A. The significant interaction effects were then plotted at values of *electronic dependence* one standard deviation above and one standard deviation below the mean, and we conducted additional analyses to test the statistical significance of the simple slopes (Aiken and West 1991). These plots are shown in Figure 1(a). When *electronic dependence* is low, there is no relationship between *task significance* and *meaningfulness*; when it is high, there is a strong positive relationship. On Step 4, entering the main effect for *intimacy*, the two-way interaction terms for *intimacy* × *electronic dependence* and *intimacy* × *task significance* and the three-way interaction term for *intimacy* × *electronic dependence* × *task significance* failed to significantly increase the R^2; hence, H1A is only partially supported.

Results for H1B are shown in Table 3. In Step 2, task significance was a significant predictor of *meaningfulness* after entering the controls ($b = 0.28$, $p < 0.001$), and the model explained significant variance ($R^2 = 0.17$,

Figure 1 The Relationship Between Task Significance and Experienced Meaningfulness



$F = 3.75$, $p < 0.001$), although the main effect of copresence on *meaningfulness* was not significant (ns). Entering *task significance* × *copresence* resulted in a significant increase in R^2 ($\Delta R^2 = 0.02$, $\Delta F = 4.52$, $p < 0.05$),

Table 3 Effect of Copresence and Identification on the Relationship Between Task Significance and Experienced Meaningfulness

	Step 1	Step 2	Step 3	Step 4
Controls				
Dummy for project type 1	−0.26**	−0.31***	−0.32***	−0.33***
Dummy for project type 2	−0.03	−0.03	−0.05	−0.06
Dummy for project type 3	−0.23**	−0.18*	−0.18	−0.17*
Project size	0.15	0.13	0.13	0.13
Project duration	−0.09	−0.06	−0.08	−0.09
Number of firms	−0.06	−0.01	−0.02	−0.03
Number of units	0.12	0.19	0.22*	0.23**
Task significance		0.28***	0.47***	0.32***
Copresence		0.11	0.22*	0.22*
Copresence × Task significance			−0.27*	−0.09
Identification				0.12
Identification ×Copresence				−0.12
Identification × Task significance				0.30
Identification × Copresence × Task signif.				−0.37
ΔR^2		0.09	0.02	0.02
ΔF		8.49***	4.52*	1.08
Δdf		2,167	1,166	4,162
Total R^2	0.08	0.17	0.19	0.21
F	2.20	3.75***	3.89***	3.10***
df	7,169	9,167	10,166	14,162

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 4 Moderating Effects of Electronic Dependence and Intimacy on the Relationship Between Autonomy and Experienced Responsibility

	Step 1	Step 2	Step 3	Step 4
Controls				
Dummy for project type 1	0.14	0.04	0.05	0.11
Dummy for project type 2	0.07	0.05	0.06	0.07
Dummy for project type 3	0.12	−0.02	−0.02	−0.03
Project size	0.06	0.07	0.06	0.04
Project duration	0.32***	0.40***	0.37***	0.32***
Number of firms	0.01	0.03	−0.01	−0.01
Number of units	−0.08	−0.12	−0.12	−0.09
Autonomy		0.28***	0.61***	0.48**
Electronic dependence		0.21*	0.30**	0.16
Electronic dependence × Autonomy			−0.36*	−0.36*
Intimacy				−0.03
Intimacy × Electronic dependence				0.06
Intimacy × Autonomy				−0.24
Intimacy × Electronic depend. × Autonomy				0.51*
ΔR^2		0.08	0.02	0.07
ΔF		8.33***	4.51*	4.23**
Δdf		2,167	1,166	4,162
Total R^2	0.13	0.20	0.23	0.30
F	3.55***	4.86***	4.91***	4.99***
df	7,169	9,167	10,166	14,162

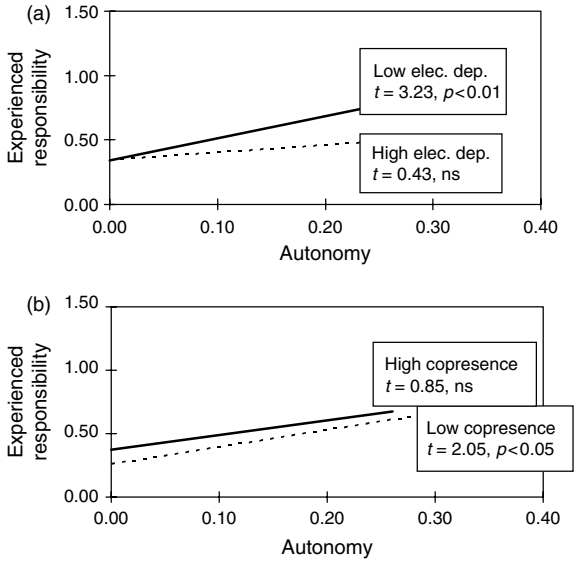
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

and the interaction term was significant, providing partial support for H1B. Plots at values of *copresence* one standard deviation above and below the mean are shown in Figure 1(b). When *copresence* is low, there is a positive and significant relationship between *task significance* and *meaningfulness*; when *copresence* is high, there is no relationship. In Step 4, entering the main effect for *identification*, the two-way interaction terms for *identification* × *copresence* and *identification* × *task significance* and the three-way interaction term for *identification* × *copresence* × *task significance* failed to result in a significant increase in R^2; hence H1B is only partially supported.

Experienced Responsibility

Results for H2A are depicted in Table 4. On Step 2, both *autonomy* ($b = 0.28, p < 0.001$) and *electronic dependence* ($b = 0.21, p < 0.05$) were significant positive predictors of *experienced responsibility* after entering the controls and explained significant variance ($R^2 = 0.20, F = 4.86, p < 0.001$). Entering *electronic dependence* × *autonomy* on Step 3 resulted in a significant increase in R^2 ($\Delta R^2 = 0.02, \Delta F = 4.51, p < 0.05$), and the interaction term was significant, providing partial support for H2A. Plots at values of *electronic dependence* one SD above the mean and one SD below the mean are shown in Figure 2(a). When *electronic dependence* is low, there is a positive relationship between *autonomy* and *responsibility*; when *electronic dependence* is high, there is no relationship. On Step 4, entering the main effect for *intimacy*, the two-way interaction terms for *intimacy* × *electronic dependence* and *intimacy* × *autonomy* and the three-way interaction term for *intimacy* × *electronic dependence* × *autonomy* resulted in a significant increase in R^2 ($\Delta R^2 = 0.07, \Delta F = 4.23, p < 0.01$), and the three-way interaction term was significant, providing additional support for H2A. Post hoc analyses indicated that *intimacy* magnifies the relationships. The strongest positive relationship between *autonomy* and *responsibility* ($r = 0.63, p < 0.01$) occurs when *electronic dependence* and *intimacy* are both high (i.e., one standard deviation above the mean). When *electronic dependence* is high and *intimacy* is low (i.e., one standard deviation below the mean), the relationship between *autonomy* and *responsibility* is negative ($r = -0.20, p < 0.10$). When *electronic dependence* is low, the relationship between *autonomy* and *responsibility* is strong and positive regardless of the level of *intimacy* (i.e., $r_{\text{low intimacy}} = 0.46, p < 0.01$; $r_{\text{high intimacy}} = 0.50, p < 0.01$). These results provide full support for H2A.

Figure 2 The Relationship Between Autonomy and Experienced Responsibility



Results for H2B are shown in Table 5. On Step 2, both *autonomy* ($b = 0.29, p < 0.001$) and *copresence* ($b = 0.38, p < 0.001$) were significant predictors of *responsibility*, and the overall model was significant ($R^2 = 0.32, F = 8.80, p < 0.001$). Entering *autonomy* × *copresence* resulted in a significant increase in R^2 ($\Delta R^2 = 03, \Delta F = 6.50, p < 0.01$), and the interaction term was significant. Plots at values of *copresence* one standard deviation above the mean and one standard deviation below the mean are shown in Figure 2(b).

Table 5 Effect of Copresence and Identification on the Relationship Between Autonomy and Experienced Responsibility

	Step 1	Step 2	Step 3	Step 4
Controls				
Dummy for project type 1	0.14	0.09	0.09	0.07
Dummy for project type 2	0.07	0.07	0.06	0.07
Dummy for project type 3	0.12	0.02	0.02	0.01
Project size	0.06	−0.07	−0.06	−0.03
Project duration	0.32***	0.41	0.41***	0.32***
Number of firms	0.01	0.09	0.07	0.03
Number of units	−0.08	−0.03	−0.01	0.05
Autonomy		0.29***	0.15	0.29**
Copresence		0.38***	0.24**	0.37***
Copresence × Autonomy			0.25**	−0.11
Identification				0.47**
Identification × Copresence				−0.48**
Identification × Autonomy				−0.38*
Identification × Copresence × Autonomy				0.66***
ΔR^2		0.19	0.03	0.09
ΔF		23.82***	6.50**	6.47***
Δdf		2,167	1,166	4,162
Total R^2	0.13	0.32	0.35	0.44
F	3.56	8.80***	8.83***	8.99***
df	7,169	9,167	10,166	14,162

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 6 Moderating Effects of Electronic Dependence and Intimacy on the Relationship Between Feedback on Knowledge of Results

	Step 1	Step 2	Step 3	Step 4
Controls				
Dummy for project type 1	0.04	0.01	−0.20	−0.20
Dummy for project type 2	0.02	0.05	−0.11	−0.11
Dummy for project type 3	−0.10	−0.13	−0.13	−0.14
Project size	0.03	0.19	0.14	0.15
Project duration	−0.10	0.23*	−0.21*	−0.24*
Number of firms	−0.21	−0.25*	−0.18	−0.19
Number of units	−0.17	−0.06	−0.27*	−0.24*
Feedback		0.26*	1.92***	1.97***
Electronic dependence		−0.13	0.77**	0.77**
Electronic dependence × Feedback			−2.03***	−2.09***
Intimacy				0.10
Intimacy × Electronic dependence				−0.05
Intimacy × Feedback				−0.13
Intimacy × Electronic depend. × Feedback				0.22*
ΔR^2		0.03	0.08	0.02
ΔF		2.89*	15.95***	1.10
Δdf		2,167	1,166	4,162
Total R^2	0.07	0.10	0.18	0.20
F	1.85	2.12*	3.67***	2.94***
df	7,169	9,167	10,166	14,162

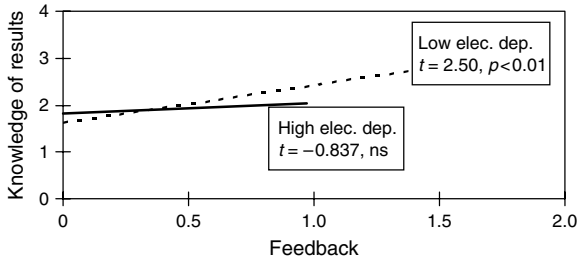
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Opposite to what was predicted in H2B, when perceived *copresence* is low, there is a positive and significant relationship between *autonomy* and *responsibility*; when *copresence* is high, the relationship is weaker. On Step 4, entering the main effect for *identification*, the two-way interaction terms for *identification* × *copresence* and *identification* × *autonomy* and the three-way interaction term for *identification* × *copresence* × *autonomy* resulted in a significant increase in R^2 ($\Delta R^2 = 0.09$, $\Delta F = 6.47$, $p < 0.001$), and the interaction term was significant. Post hoc analyses indicated that *identification* magnifies the relationships. The strongest positive relationship between *autonomy* and *responsibility* ($r = 0.68$, $p < 0.01$) occurs when *copresence* and *identity* are both high (i.e., one standard deviation above the mean). When *copresence* is high and *identification* is low (i.e., one standard deviation below the mean), the relationship between *autonomy* and *responsibility* is negative ($r = -0.33$, $p < 0.05$). When *copresence* is low, the relationship between *autonomy* and *responsibility* is similar regardless of the level of *identity* (i.e., $r_{\text{low identity}} = 0.24$, $p < 0.05$; $r_{\text{high identity}} = 0.21$, ns). These results provide partial support for H2B.

Knowledge of Results

Results for H3A are depicted in Table 6. In Step 2, feedback was a significant positive predictor of *knowledge of results* after entering the controls ($b = 0.26$, $p < 0.05$), and it explained significant variance ($R^2 = 0.10$, $F = 2.12$, $p < 0.05$). Entering *electronic dependence* × *feedback* on Step 3 resulted in a significant increase in R^2 ($\Delta R^2 = 0.08$, $\Delta F = 15.95$, $p < 0.001$), and the interaction term was significant, providing partial support for H3A. Plots at values of *electronic dependence* one standard deviation above and below the mean are shown in Figure 3. When *electronic dependence* is low, there is a positive relationship between *feedback* and *knowledge of results*; when *electronic dependence* is high, there is no relationship. On Step 4, entering the main effect for *intimacy*, the two-way interaction terms for *intimacy* × *electronic dependence* and *intimacy* × *feedback* and the three-way interaction term for *intimacy* × *electronic*

Figure 3 The Relationship Between Feedback and Knowledge of Results



dependence × *feedback* resulted in only a 0.02 increase in R^2 ($\Delta F = 1.10$, ns), but the interaction term was significant ($b = 0.22$, $p < 0.05$). Post hoc analyses indicated that *intimacy* magnifies the relationships. The strongest positive relationship between *feedback* and *knowledge of results* ($r = 0.59$, $p < 0.01$) occurs when *electronic dependence* is low (i.e., one standard deviation below the mean) and *intimacy* is high (i.e., one standard deviation above the mean). When *electronic dependence* is high and *intimacy* is low, the relationship between *feedback* and *knowledge of results* is not significant. These results support H3A.

Results for H3B are depicted in Table 7. On Step 2, *feedback* was again a significant predictor of *knowledge of results*, and the overall model was significant ($R^2 = 0.11$, $F = 2.37$, $p < 0.05$), but entering *feedback* × *copresence* failed to result in a significant increase in R^2, and the interaction term was not significant. On Step 4, entering the main effect for *identification*, the two-way interaction terms for *identification* × *copresence* and *identification* × *feedback* and the three-way interaction term for *identification* × *copresence* × *feedback* resulted in a significant increase in R^2, but this was because of the main effect of *identification* and the two-way interaction of *identification* × *copresence*, not the three-way interaction (which was insignificant); hence H3B is not supported.

Table 7 Moderating Effects of Copresence and Identification on the Relationship Between Feedback on Knowledge of Results

	Step 1	Step 2	Step 3	Step 4
Controls				
Dummy for project type 1	0.04	−0.06	−0.06	−0.05
Dummy for project type 2	0.02	0.03	0.03	0.02
Dummy for project type 3	−0.10	−0.19*	−0.20*	−0.14
Project size	0.03	0.15	0.13	0.12
Project duration	−0.10	−0.15	−0.17	−0.20*
Number of firms	−0.21	−0.25*	−0.25*	−0.26*
Number of units	−0.17	−0.09	−0.07	−0.05
Feedback		0.23*	0.18	0.21
Copresence		0.14	0.04	0.32
Copresence × *Feedback*			0.13	−0.19
Identification				0.68**
Identification × *Copresence*				−0.79**
Identification × *Feedback*				−0.16
Identification × *Copresence* × *Feedback*				0.49
ΔR^2		0.04	0.00	0.13
ΔF		3.95*	0.47	6.96***
Δdf		2,167	1,166	4,162
Total R^2	0.07	0.11	0.11	0.25
F	1.86	2.37*	2.17*	3.77***
df	7,169	9,167	10,166	14,162

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Discussion

Our findings help to (1) update job characteristics theory to better fit the modern workplace context; (2) acknowledge the important role of perceived electronic dependence, intimacy, copresence, and identification on employees' psychological experience of work; (3) integrate the literatures on virtual work and work design; and (4) offer concrete alternatives to manage virtual work so as to leverage its benefits and mitigate its costs. We discuss implications for theory, practice, and future research below.

Implications for Theory

Little work has been done on the subjective nature of virtuality and its psychological effects on workers. Our findings reveal that perceived electronic dependence and copresence are important features of work that have complex effects, interacting with perceived intimacy and identification to both magnify and dampen the associations between job characteristics and psychological states. As such, they provide important boundary conditions for the JCM in modern work contexts. Furthermore, in our sample, perceived electronic dependence and copresence were only moderately (and positively) correlated ($r = 0.16$). This makes sense given our observations that even colocated workers may be very reliant on CMC; likewise, at least one highly distributed set of collaborators rarely communicated electronically between face-to-face meetings. Both sets of workers are "virtual" to some extent, but in different ways; it is thus critical to capture both dimensions in future research.

Our results indicate some interesting modifications of the JCM. First, our results for the relationship between task significance and experienced meaningfulness indicate that JCM predictions are enhanced by virtuality features, because this relationship holds up only under conditions of high electronic dependence and low perceived copresence. An explanation may be that task significance is more strongly associated with meaningfulness in the relative absence of face-to-face communication because less meaning is derived from social interaction so that the task itself takes on more significance. The efficiency advantages of working remotely using technological tools are illustrated in the following quote from an aerospace design engineer: "For what we do, the SGI meeting is good enough. If someone stood next to you, you might have a better conversation but you also might deviate from the main subject." The lack of support for the three-way interactions in predicting meaningfulness suggests that intimacy and identification are not the mechanisms that explain the effect of electronic dependence and copresence on the relationship between task significance on meaningfulness. Other factors such as temporal rhythms, routines, and the sequence of media use may be important beyond the degree of electronic

dependence (Su and Mark 2008), and one's personality characteristics (Potter and Balthazard 2002) and the nature of the task may also influence this relationship. We see this as an important avenue for future research.

Yet, what was true for the relationship between task significance and meaningfulness was not true for the relationship between autonomy and responsibility. As predicted, electronic dependence decreases (rather than increases) the association between autonomy and responsibility. We reasoned this would be true because the relative anonymity in CMC may reduce virtual collaborators' sense of accountability to one another (Kiesler and Cummings 2002, Klein and Kleinhanns 2003). Support for the three-way interaction suggests that, as anticipated, intimacy may be underlying this relationship. That is, with high electronic dependence and high intimacy, the relationship between autonomy and responsibility is positive; however, with high electronic dependence and low intimacy, the relationship is negative.

Contrary to our prediction, a lack of copresence increased the association between autonomy and responsibility. Although this is surprising, the presence of identification among coworkers may help explain this. The strongest positive relationship between autonomy and responsibility indeed occurs (as predicted) when copresence and identification are high. But with high copresence and low identification, the relationship between autonomy and responsibility is negative, perhaps because of increased interpersonal conflict that arises in the absence of a shared identity, or simply the lack of a psychological tie that prevents collaborators from feeling responsible to one another. Hence, including identification in the model helps explain a seemingly contrary finding. These challenges are succinctly illustrated in the following quote by a retail new product designer:

> We who are spread out all over should have gotten together two more times than we did; we would have chased down fewer blind alleys, the final product would have been better; also, the motivation would have been higher—knowing the importance of what you do, that is a huge missing part, people would have responded well to that.

Finally, our results for the relationship between feedback and knowledge of results reveal that the JCM predictions are reduced by electronic dependence, but that perceived copresence has very little effect. Feedback is not significantly linked to knowledge of results in highly electronically dependent settings, but when workers do not depend on electronic communication (e.g., when there is more face-to-face communication, which facilitates multichannel knowledge sharing), then feedback was positively related to knowledge of results. The three-way interactions suggest only modest support for the intervening role of intimacy, as feedback and knowledge of results are associated in highly electronically dependent conditions in which intimacy is present. This suggests that electronic collaborators with more intimate relationships are likely to communicate in ways that are more similar to physical interaction. Yet, in contrast to our predictions, neither copresence nor identification affect the relationship between feedback and knowledge of results; feedback had a positive effect regardless of whether perceived copresence and identification are high or low. Why might this be true? It is telling that identification had a positive main effect on knowledge of results, and the two-way interaction between identification and copresence on knowledge of results was significant. Hence, apart from the level of feedback, developing identification, particularly among collaborators who were not copresent, enabled knowledge of results. It may be that there was *more* concerted effort (rather than less) to provide access to needed knowledge when there was identification and a lack of copresence. This is illustrated by the following quote by an automotive procurement team manager:

> During the course of time we developed a trust in each other and a confidence with each other. We traveled together. I went to Germany and we visited suppliers, and vice versa. We got past the concern of "are we going to alienate our counterpart?" We said, "okay, let's get things on the table instead of trying to be polite." I've heard some of my counterparts, saying they had trouble, but I haven't had that, we've always been able to achieve a common understanding of results.

In summary, our findings suggest that virtuality features have differentiated effects on the relationships predicted by the JCM, and intimacy and identification account for some but not all of the differences. Virtuality features had a positive effect on the relationship between task significance and meaningfulness, whereas electronic dependence had a negative effect on the autonomy–experienced responsibility and feedback–knowledge of results relationships. One possible explanation for this pattern is that the latter two job characteristics and psychological states are more social in nature and may be enhanced in traditional face-to-face settings in which more social cues are present to help interpret relational communication and one's relationship with others, in terms of a sense of responsibility or knowledge of results. On the contrary, the relationship between task significance and meaningfulness does not depend as much on one's relationship with others, and in fact it seems to be even stronger under conditions of less social interaction. This suggests the need to further differentiate and theorize the complex ways in which virtuality features impact the psychological experience of work.

Limitations and Directions for Future Research

Our analysis is based on a large number of interviews (177 individuals) and yet a relatively small sample of projects. The trade-off was depth of understanding of workers' experiences through interviews versus the breadth afforded by alternative methodologies such as surveys. We view this as justifiable given our stage of exploration of virtuality and its impact on individual psychological states. Future quantitative research based on larger samples of projects should investigate these complex relationships with more precision. Furthermore, given that the same respondents were used to derive measures for the core variables in our models, common method variance may be of concern. However, our measures were not traditional "self-report" survey measures—they were derived from interviews, and respondents were not asked directly to report on the variables in question, but rather to discuss their experiences generally, and they were blind to the constructs and hypotheses. As a result, there were fewer demand characteristics, the design is less susceptible to social desirability bias, and it would have been difficult for a halo effect to occur across variables (see Podsakoff et al. 2003). This unobtrusive and indirect means of capturing perceptions is much less open to common method variance. At the same time, an important extension of our research is to examine alternative, independent assessments of the core constructs.

We would like to reiterate that in departing from the tradition of examination of computer-mediated work in which researchers compare entirely virtual work to entirely face-to-face work, we operationalized virtuality as a continuum (Martins et al. 2004). We believe this better captures the "shades of grey" we observed in industry, yet we also realize it does not allow for strong distinctions regarding psychological states among workers who are entirely virtual compared to colocated. Equally important is examining these effects over time, which has been shown to affect the nature of virtual relationships (Walther 1995). An interesting avenue for future research is to examine the interaction style of workers as they become more virtual. Experiments have shown previously that the effect of media type (face-to-face versus electronic) tends to dissolve when interaction style is taken into account (Potter and Balthazard 2002). Constructive interactions (characterized by cooperation, creativity, free exchange of information, and respect for others' perspectives) tend to do well, and passive interactions (in which workers maintain harmony through limited information sharing, questioning, and impartiality) tend to do poorly, regardless of the media. Measuring the degree and type of social interaction will help to further unpack theorized confounds of the JCM and better understand their effects.

Furthermore, beyond job characteristics, individual characteristics likely interact with electronic dependence and copresence to determine experienced meaningfulness, experienced responsibility, and knowledge of results. Personality may be one important moderator. In their experiments, Potter and Balthazard (2002) found that extraversion led to constructive styles of interaction in computer-mediated settings and that differences in extraversion within a work unit led to passive styles. Additional research on the role of personality in reactions to, and consequences of, virtuality is an important extension of our research. Finally, although we captured psychological states, which have previously been linked to effectiveness (Renn and Vandenberg 1995), we were not able to capture measures of individual effectiveness such as productivity or customer service in our interview-based approach. We encourage researchers to confirm these linkages. Another useful extension of our work involves examining dimensions of virtuality beyond electronic dependence and geographic dispersion, such as diversity and temporality, and among workers whose attention is more divided across a range of projects, rather than focused on one primary project, as was the case here.

Implications for Practice

An important practical implication of our findings is that managers of virtual collaborations may be able to replicate affordances of face-to-face interaction through intimacy and identification, which promote psychological bonding without requiring a great deal of in-person communication. Because the perception of closeness may be more important than the objective amount of geographical distance separating coworkers (Wilson et al. 2008), remote collaborations may be well served by copresence design, or the development of technological tools to enhance perceived copresence, such as online avatars to indicate a user's availability status or added conference call features like visual representation, turn taking, or private chat (Zhao 2003).

Furthermore, interviewees mentioned not just visits of collaborators to different work locations so that everyone obtains a basic understanding of others' work contexts, but also explicit discussions of how views regarding goals, expectations, and priorities differ across contexts. Such conversations can make distributed coworkers more aware of their own and others' results and increase their sense of responsibility and accountability to others and to the project, thus removing the knowledge gaps or "situational invisibility" (Cramton et al. 2007) that exists because of geographic dispersion. One interviewee, a professional services worker, said this about the importance of these discussions:

> There are things in place that allow the right balance between joining an integrated team, but also having a

> voice . . . we must bear in mind that knowledge management is done in a totally different way in other places than we do it, so it is quite important to put all these people together and show the different focuses . . . in our knowledge management efforts, our primary objectives are to support all of our strategic groups and to change our culture to bring people together to exchange knowledge and talk with one another about their differences . . . this gives a forum where we come together and share results.

Our interviewees also suggest the importance of temporal patterns in communication for developing close working relationships with team members, describing how close working relationships developed through the frequent time patterned use of technology; one stated he had developed "quite [a] working rapport because of daily teleconferences" with team members. Developing a predictable temporal rhythm of technology use has been found to characterize effective virtual collaborations (Maznevski and Chudoba 2000), and routines or repeated patterns or sequences of media usage have implications for psychological well-being and productivity (Brdiczka et al. 2009). Managers of virtual workers play a key role in facilitating these connections and should carefully attend to how work is divided so that virtual workers understand the whole task to be performed and how it contributes to the organization's success, as well as customer requirements for overall deliverables.

Finally, an important implication of our findings for organizations is that technology and dispersion are not always a hindrance, but instead can be proactively used along with task significance and autonomy. Interviewees suggested that technology could also be used to explain goals and importance of work through techniques such as chartering activities codified on an intranet site, online performance feedback and recognition systems, and knowledge management systems such as information repositories and resource directories. Those with exposure to such systems often experienced better outcomes and were more effective based on stakeholder observations.

In summary, our research demonstrates that high levels of perceived electronic dependence and a lack of copresence that often accompanies virtual work can negatively affect critical psychological states of experienced meaningfulness, experienced responsibility, and knowledge of results. However, these deleterious effects can be mitigated through development of intimacy and identification, as well as by improving task significance, autonomy, and feedback. These findings contribute to our understanding of effects of new and emerging forms of work, and we hope they stimulate additional research to better understand how to best design such work.

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Endnote

[1]Rather than address all five job characteristics, for parsimony, we focus on three—task significance, autonomy, and feedback. The remaining two job characteristics (skill variety and task identity) share the same principles of job enrichment with task significance and hence were argued in the JCM to operate with similar mechanisms.

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