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The Development and Validation of the Comprehensive Team Interdependence Scale

by

Michael E. Rossi

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts
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Dedication

I dedicate this thesis to my wife Clarissa, who has supported me in this crazy endeavor of going back to school,

And to all my friends and family, for their love and encouragement.

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I would like to acknowledge the members of my thesis committee, Drs. Russell Johnson and Marcia Finkelstein, for improving this project by sharing with me their expertise and valuable insights. I would like to extend a special thanks to Dr. Michael Covert, my thesis advisor, for his continuous guidance, support, and mentorship. Thank you also to those who made this study possible through their participation.

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ABSTRACT

The purpose of this study was to review the existing teams research which suggests that teams vary along 4 dimensions of interdependence. Task interdependence is the extent to which the task drives interactions among individuals. Resource interdependence is the extent to which individuals rely on others to provide inputs necessary to complete their portion of work. Reward interdependence is the extent to which individuals' rewards are tied into the performance of others. Finally, goal interdependence is the extent to which individuals set goals and receive feedback at the group versus individual level. A comprehensive team interdependence scale tapping into these 4 distinct dimensions was developed and tested in a cross organizational sample. Factor analytic results suggested that a 4-factor model did indeed provide the best fit for the data. A discussion of the findings, implications, limitations, and future directions is presented.

Chapter One- Introduction

It almost goes without saying in this day and age, that the use of teams or work groups has become a ubiquitous trend (Devine, Clayton, Philips, Dunford, & Melner; 1999; Guzzo & Shea, 1992; Hackman, 1992; Hyatt & Ruddy, 1997; West, Borill, & Unsworth, 1998; West, 1996). The fact that nearly every article investigating teams and their use begins with a similar sentiment provides evidence that it should indeed go without saying. Children work together in teams to compete in athletic events; students work together in teams to complete class projects; and more and more organizations structure their work in a way that forces employees to work together in teams to meet the demands of the ever competitive organizational landscape (Campion, Medsker, & Higgs, 1993; Cohen & Bailey, 1997; Guzzo & Shea, 1992). Given the widespread use of teams in society, and specifically within organizations, it is surprising that there is not one agreed upon definition of what constitutes a team or work group. Guzzo (1996) defines a team as a collection of individuals sharing a common goal, whose actions and outcomes are interdependent, and who perceive themselves, and are perceived by others as a social entity. McGrath (1984) defines a work team or crew as “a relatively small set of persons within an organization who are the role incumbents with whom a given individual interacts, and who are highly interdependent in terms of those organizational roles.” Hackman (1990) outlines three necessary attributes which must be present for a true organizational work group: they must be a *real* group with boundaries; they must have interdependence among members; there must be differentiation of roles (Alderfer, 1977);

they must have tasks to perform; and they must operate in the global organizational space. Regardless of the particular definition of what constitutes a team, most definitions either explicitly or implicitly include an element of interdependence. A team is not a team unless its members rely on each other in some fashion.

In order to evaluate teams based on their level of interdependence, it is necessary to better understand what is meant by interdependence, and to understand the various dimensions of interdependence. Again, there are several conceptualizations of interdependence and several lines of research investigating these various conceptualizations (Wageman, 1995; Van der Vegt, 2002). Existing research looks at several different forms interdependence can take: task interdependence or the degree to which task requirements drive interdependence among team members (Campion, Medsker, & Higgs 1993; Thompson, 1967; Wageman & Baker, 1997), resource interdependence or the degree to which individuals rely on other team members for resources necessary to work effectively (Fan & Gruenfeld, 1998; Johnson, Johnson, & Stanne, 1989; Ortiz, Johnson, & Johnson, 1996), reward interdependence or the degree to which an individual's reward is contingent on the performance of his or her teammates (Fan & Gruenfeld, 1998; Wageman & Baker, 1997), and goal interdependence or the extent to which goals are set and feedback is delivered at the group level (Campion, Medsker, & Higgs 1993; Johnson & Johnson, 1989; Johnson, Johnson, & Stanne, 1989). While there is certainly room for a degree of conceptual overlap between these constructs (for instance it is difficult to imagine an instance of highly interdependent rewards without some degree of interdependent goals), researchers have largely chosen to address these concepts separately.

The goal of this study was to better integrate the existing lines of team interdependence research with the ultimate goal of creating and validating a scale to measure these four dimensions of team interdependence. While the increase in organizational use of teams has precipitated an increase in research interest regarding teams and group behavior, the complexities inherent in this line of research have largely kept team research lacking proportionate to its use and importance in industry. The difficulties in recruiting individuals for experimental team research which can often require a significant time commitment from participants, the lack of necessary controls in much of field based team research, and the lack of standardized tools to conduct cross-sectional survey research are just some of the obstacles preventing researchers from investing their efforts into team research. This study sought to alleviate one obstacle, by developing and validating a new comprehensive team interdependence scale which will allow researchers to better assess existing organizational work groups on various forms of interdependence in a naturalistic setting. In essence this scale can be thought to assess a group's overall '*teamness*'. This should allow researchers to make a myriad of cross-sectional comparisons in the field which otherwise would be difficult to achieve in an artificial experimental lab-based setting, or would require extreme and impractical manipulations to enact in a controlled organizational field-based quasi experiment. Additionally, a factor analysis of the items will shed further light on the conceptual overlap between the various interdependence constructs.

Outlines of the existing lines of research regarding task, resource, reward, and goal interdependence are presented serving as the underlying theoretical background for the scale development. In addition, hypotheses regarding the underlying factor structure

are presented. A description of the method for item generation, scale development and validation along with the results of the investigation into the underlying factor structure of the scales is presented followed by a discussion of the findings, their implications, study limitations, and future directions in the study of team interdependence.

Task Interdependence

Perhaps the most widely studied and arguably the most organizationally critical form of interdependence is task interdependence. Task interdependence is an inherent function of the task design and exists when team members must share materials, information, or expertise in order to perform (Van der Vegt & Van der Vliert, 2002). Consider a manufacturing team assembling automobiles. Individuals (or subgroups) within the manufacturing team are responsible for the engine and mechanical components, others are responsible for the chassis and structural components, while still others are responsible for the interior and aesthetic components. The task of building a car cannot be completed unless each member performs their given task. The individual responsible for the engine cannot achieve the end goal of building a car without his or her teammates performing their tasks.

In their meta-analytic review of task interdependence, Johnson and Johnson (1989), found the benefits of task interdependence included improved learning, achievement, and cognitive complexity of thought, as well as increased interpersonal relationships. Certainly, the idea of task interdependence, the reliance on others to complete a task, is at the heart of what it means to be team. Without it, it is hard to conceive of a justification for a team's existence.

Early research on interdependence focused on the requirements of the task as a driver of individual interactions (Thompson, 1967). Thompson's work in organization theory while not specifically focused on the team or work group level of analysis has certainly made its contributions in the team literature. He specified three levels of task interdependence based on increasing levels of interactive complexity. Pooled interdependence is said to exist when tasks are performed by individuals separately in no particular order and with no significant specialization among members and then pooled into the resulting product. Sequential interdependence builds upon pooled interdependence with the requirement that tasks are completed in a specific order; the products of one step are the inputs into the next step requiring a level of linear coordination. Finally, reciprocal interdependence exists when there are repeated sequential interactions such that individuals or groups within the sequence perform tasks at multiple stages in the sequence requiring a degree of complex coordination among individuals and subgroups. These categories are often still used in team research when denoting levels of task interdependence.

Whereas Thompson's views on task interdependence focused on the structure and requirements of the task as the driver for the interdependence necessary to complete the task, Shea and Guzzo (1989) focused their conceptualization of task interdependence as a function of the behavior of the individuals in executing the task at hand. They would argue that individuals can choose to work cooperatively or not regardless of the structure of the task. This definition suggests that task interdependence is not necessarily strictly a function of the task and thus is not entirely within the control of the organization, but rather is in the control of the individuals comprising the work group.

Conceptually task interdependence is the most central interdependency to team functioning and as such it is the most studied and best understood of the concepts discussed in this paper. A great body of research has looked at task interdependence and its relationship with several individual and organizational outcomes such as individual motivation (Kiggundu, 1983; Wong & Campion, 1991), satisfaction (Shaw, Duffy, & Stark, 2000), performance/effectiveness (Allen, Sargent, & Bradley, 2003; Shaw, Duffy, & Stark, 2000; Wageman, 1995; Van der Vegt & Van de Vliert, 2002) and contextual performance/organizational citizenship behavior (Allen, Sargent, & Bradley, 2003; Pearce & Gregersen, 1991).

The relationship between task interdependence and performance is largely dependent on the nature of the task. More complex tasks which require a variety of skills and knowledge bases reap the benefit of teams designed with high task interdependencies in the form of increased performance. Less complex tasks gain less performance benefit from interdependent team design. Given this almost definitional connection between task interdependence and performance, researchers have largely focused their efforts toward interaction effects that lead to an enhanced task interdependence to performance relationship. In a study of university students interacting in long term groups to complete projects/assignments throughout the semester, Shaw, Duffy, & Stark (2000), found that preference for group work, a dimension of the individualism-collectivism construct produced a crossover interaction between task interdependence and performance such that those with a low preference for group work performed significantly better when they perceived task interdependence to be low whereas those high in preference for group

work performed significantly better when they perceived a high level of task interdependence.

The effects of task interdependence are also largely dependent on the diversity of skills brought by its team members. Van der Vegt and Van der Vliert (2005) found that perceived dissimilarity of team members led to increased helping behavior in teams under high task interdependence. When members of a team have diverse skills, but there is no reason to share these skills (low task interdependence), individuals do not exhibit helping behavior, and conversely when members have diverse skills and the team is structured in manner that requires cooperation (high task interdependence), individuals provide help to their teammates.

With the wide body of research investigating task interdependence, it is somewhat surprising that there is a relative lack of research into measurement of the construct. Much research relies on contrived experimental manipulations of task interdependence, or pre-existing team structures in field settings, with the occasional quasi-experimental manipulation. Existing research into the measurement of task interdependence includes Van den Ven et al's (1976) work which measured task interdependence but which was limited in its ability to be adapted to the individual employee level of assessment (Pearce & Gregersen, 1991) and Kiggundu's (1983) measure which lacked rigorous validation. This led to Pearce and Gregersen's (1991) development of their scale to assess task interdependence which while focused primarily at assessing task interdependence, includes items that may more accurately reflect another form of interdependence: resource interdependence.

Resource Interdependence

Similar to task interdependence, the concept of resource interdependence is a function of the organization of work. Resource interdependence exists when individuals working in a team perceive that they can only successfully complete their work if and only if the other individuals with whom they are linked (their team members) provide the necessary resources (Johnson, Johnson, & Stanne, 1989). These resources can take on a variety of forms: physical, informational, etc. As Fan and Gruenfeld (1998) note resource interdependence should lead to effective group problem solving as a result of increased beneficial team processes such as effective information exchange (Johnson, 1973) and team helping behavior (Spilerman, 1971). They also note the potential negative impact of high resource interdependence in that it can lead to process loss (Steiner, 1972) in the case of exceedingly complex process interactions. The more a group must interact to achieve its goals, the more attention must be devoted to organizing individual inputs, thus removing attention from the actual task execution (Fan & Gruenfeld, 1998).

The research on resource interdependence is quite limited and is not entirely in the realm of organizational research. Much of Johnson & Johnson et al's (1989, 1991) research looking at resource interdependence has been in an educational context, investigating student teams with problem solving and learning as their primary dependent variables. In one of the more organizationally relevant studies, Fan and Gruenfeld (1998) experimentally investigated resource and reward interdependence (discussed later) using three person teams involved in a card game in which the scoring rules were unknown to the players, and in which teams had two objectives: to collectively score the most points,

and to induce through trial and error the scoring rules of the game. Resource interdependence was manipulated by varying the cards available to each player. In the low resource interdependence condition, each player had access to all the cards in the deck, as such there was no need to exchange or share resources. In the high resource interdependence condition, each participant had a unique and limited set of cards which required teammates to share cards in order to play a full range of hands. The results showed a main effect for resource interdependence such that teams in the high resource interdependence condition performed better than teams in the low resource interdependence condition. The authors infer that this improvement in performance can be explained by an increased access to and use of cognitive resources driven by the cooperation engendered by the interdependent resources.

As already stated, the research on resource interdependence is quite limited. Of the types of interdependence discussed in this proposal, it is certainly the least researched. This may be a somewhat semantic issue, as the concepts of task interdependence and resource interdependence are largely related at a conceptual level with resource interdependence perhaps being an element of task interdependence. The lack of research specifically investigating resource interdependence may not be due to a lack of interest in the concept, but more a function of a preference for conceptualizing resource interdependence as a sub-component of task interdependence. This may be the case with regards to measurement of resource interdependence as there does not appear to be an existing scale focused solely on the assessment of resource interdependence. As mentioned earlier, Pearce and Gregersen's (1991) scale appears to include items that may be better described as resource interdependence items rather than strictly task

interdependence items. For example, their item “My own performance is dependent on receiving accurate information from others” appears to be more driven by resource, in this case information, rather than the task itself. In addition their use of the word “performance” suggests a shift to an outcome based focus for interdependence. Interdependencies related to outcomes include reward and goal interdependence.

Reward Interdependence

Interdependence in teams can also be a function of the outcomes of the task as opposed to the task itself or the processes employed in accomplishing the completion of the task. Reward systems can be in place such that individual rewards are based on interdependencies with coworkers. This form of interdependence is commonly referred to in the literature as reward interdependence and can be defined as the extent to which individual rewards are contingent on the behaviors and performance of coworkers (Wageman, 1995; Wageman & Baker, 1997). In a condition of high reward interdependence, individual rewards in the form of salary increases, bonuses, or pay for performance are contingent on the success of the group in performing its purpose. As such, rewards are a function of the individual’s contribution to the group, as well as the other members’ contributions to the group. In a condition of low reward interdependence, individual rewards are based purely on individual performance regardless of the design of the task and the performance of the group as a whole. Therefore it is possible to have a highly interdependent group task (i.e. high task interdependence), requiring high levels of cooperation among team members to achieve success, while still basing the reward contingencies on the performance of the individual (i.e. low reward interdependence). Reward structures can be arranged along a continuum

from highly individualistic to highly interdependent, including hybrid systems with elements of independent rewards and group rewards simultaneously in effect. (Shea & Guzzo, 1987; Wageman, 1995)

Generally, researchers and organizational behaviorists have supported the use of group rewards (high reward interdependence) when tasks are structured in an interdependent manner. (Fan & Gruenfeld, 1998; Shaw, Duffy, & Stark, 2000). A task which demands cooperation among team members necessitates a rewards system that reduces the incentive for competition which is often present in systems utilizing individual rewards. It is often the case in a system of individual rewards that individuals are forced to compete for limited rewards in the form of promotions, salary increases and bonuses. This can often result in behaviors such as withholding assistance, hoarding resources, and other anti-team behavior (Miller & Hamblin, 1963; Rosenbaum et. al., 1980). Using highly interdependent rewards limits these competitive effects and creates an environment of “common fate” (Kramer, 1993) in the form of tangible rewards, where team members truly have an incentive to cooperate.

However, there can also be a dark side to structuring rewards such that they are contingent on group performance. This can result in free-riding (Olson, 1965) or social loafing (Latane, 1986) situations where individuals do not put forth appropriate levels of effort as the affects of any one individual on the group’s performance as a whole is limited (Fan & Gruenfeld, 1998; Wageman & Baker, 1997). While this is certainly a logical and possible scenario, Wageman and Baker found little support for the free-rider effect in their experimental study of the effects of task and reward interdependence in small work teams. These findings supported previous lines of research suggesting that

free-riding may be limited by peer pressure and mutual monitoring which is usually present in small face-to-face work teams (Weitzman & Kruse, 1990; Williams, Harkins, & Latane, 1981).

The study of reward interdependence has largely been laboratory based with a few studies taking place in field based settings. Wageman and Baker (1997) studied the interactive effects of reward and task interdependence on performance in a lab based dyadic copy-editing task. Individuals in teams of two were each trained on a particular skill set necessary to perform an APA copy-editing task. Task interdependence was manipulated by varying the percentage of common versus skill set specific errors in the copy while reward interdependence was manipulated by varying the monetary reward delivered to participants, from a purely individual reward structure (pay only for errors found in the individual's own document) to a group reward structure (equal pay for errors found in the individual's own document as well as in their teammate's document). They found a main effect for the reward interdependence manipulation on dyad performance as well as an interaction effect with reward and task interdependence on performance. These results suggest that congruence between task and reward interdependence should drive the decisions to implement group reward systems. Teams working on tasks with low task interdependence do not derive the performance gains assumed under high reward interdependence. Allen, Sargent, and Bradley (2003) using a similar experimental design but investigating helping behaviors in teams found no support for this interactive effect and Fan and Gruenfeld's (1998) investigation into group problem solving using complex tasks found evidence that mixed reward conditions proved to be most beneficent. This latter result is completely contrary to earlier findings in a field based

setting using existing teams of technicians implementing purely individual, purely group, and hybrid reward payment systems which found that the purely group and purely individual teams outperformed those teams in the hybrid reward condition (Wageman, 1995).

Granted, the existing research on reward interdependence has investigated a diverse set of team based tasks and a diverse set of performance related outcome variables which makes direct comparisons between studies difficult; however, on the surface, the disparity in findings suggest that further research is certainly warranted. With no direct measures of reward interdependence existing in the literature, further research is currently limited to laboratory experiments which lack ecological validity and field based research which is difficult to conduct especially when dealing with manipulating reward systems. In order to expand the body of research regarding reward interdependence, researchers must capitalize on existing teams and existing reward structures using cross-sectional survey based research.

Goal Interdependence

Conceptually similar to resource interdependence, goal interdependence refers to the degree to which individuals within a group or team are assigned or set group level goals and therefore receive group level feedback (Van der Vegt, Emans, & Van de Vliert, 2001). Rooted in goal setting theory (Locke, 1968; Locke & Latham, 1994), goals for guiding performance can be set at the individual or group level, such that highly interconnected goals among group members represent a high level of goal interdependence (Saavedra, Earley, & Van Dyne, 1993). In the case of joint or interdependent group goals, goal attainment is a function of the performance of all

members of the group working toward a common purpose. An example might be an automotive assembly team with a performance goal of assembling 10 cars in one day. When goals are thought of in terms of extrinsic rewards, goal interdependence can be thought to be congruent with reward interdependence; however goals need not fall strictly in the domain of rewards.

Early work on goal interdependence stemmed from Deutsch's cooperation theory (1949a, 1949b) which outlines the types of interactions and relationships which may be present within the team or group context. Essentially, interactions may be independent in which case the actions of one individual have no impact on others; interactions may be competitive in which case the actions of one individual can be thought to hinder or obfuscate the actions of others; or interactions may be cooperative in which case the actions of one individual can be thought to improve or enhance the actions of others. Under Deutsch's model, how individuals judge their goal's relations to those of their other team members, dictates the dynamics of the interactions. Building on Deutsch's work, Johnson and Johnson (1989) conceptualize goal interdependence in what they refer to as outcome interdependence which specifies the dependence on team members to achieve mutual goals. They discuss positive interdependence, the perception that one's success is positively tied to that of others such that one can only succeed if one's teammates succeed (and vice versa), as well as negative interdependence, the perception that one's success is negatively tied to that of others such that one cannot succeed if one's teammates succeed (and vice versa). The former would be engendered by a cooperative team environment in which goals are set and feedback is delivered at the group or team level, whereas the latter would be engendered by a competitive team environment in

which goals are set and feedback is delivered at the individual level. Under these definitions it would follow that highly interdependent goals (positive interdependence) leads to cooperative work environments, whereas depending on the interrelatedness of tasks and the potential for mutual goal attainment (highly independent goals) can lead to independence or competition.

Goal setting theory is one of the most well-supported theories in the realm of organizational psychology (Jex, 2002). While there is no shortage of studies investigating the positive outcomes associated with goal setting in the individual context (see Klein, Wesson, & Hollenbeck, 1999; Mento, Steel, & Karren 1987 for reviews and meta-analytic findings), there is a dearth of research investigating the use of goal setting and specifically goal interdependence in the team context. Using experimental manipulations, Crown and Rosse (1995) investigated group goals in conjunction with what they termed ego-centric individual goals (goals directed at the individual intended to increase their individual output), and group-centric individual goals (goals directed at the individual but intended to increase their group output). They found that both group and group-centric individual goals resulted in considerably better performance than control conditions. In another laboratory study, Mitchell and Steel (1990) utilized a tower building task to measure performance and team member attitudes in conditions of goal absence, individual goals, group goals, and combined goals. They found that performance suffered in the individual goal conditions with team members reporting far fewer cooperative strategies compared to the group and combined goal conditions. Both studies suggest that goal interdependence has a positive link to performance outcomes,

however given the contrived nature of the tasks in the laboratory environment; it is difficult to necessarily generalize these findings to a field based setting.

From a measurement perspective, research into the goal interdependence construct, similar to the other forms of interdependence, suffers from a general lack of interest. Using previously developed scales for cooperative goals, competitive goals, and independent goals (Alper, Tjosvold, & Law, 1998), Tjosvold and Yu (2004), investigated the effects of goal interdependence in a field based setting. Employing structural equation modeling, they showed that cooperative (group interdependent) goals resulted in the applying of abilities which was related to increased team performance. In another attempt to investigate goals in the team context in an organizational setting, Rogowski (1999) using similar goal scales found that group member attitudes were dependent on goal interdependence, but supervisor perceptions on work outcomes were unrelated to the level of goal interdependence. These findings taken in concert with the previous findings suggest that goal interdependence results in increased objective performance but may not impact subjective assessments of performance. Further investigation is definitely warranted, but again the lack of readily accepted measures assessing interdependence (in this case goal interdependence) forces what little research that is being conducted to rely on artificial experimental studies, or field studies utilizing self-developed measures which may or may not tap into the complete domain of goal interdependence.

Research on the Interactive Effects of Interdependencies

As mentioned above, much of the research on interdependence has progressed beyond simply investigating the main effects of the various forms of interdependence, to looking at the interactive effects of multiple forms of interdependence on team

performance. Again this is another line of interdependence research that could benefit from an increased focus on field based research capitalizing on cross-sectional survey methods.

The majority of research on the interactive effects of team interdependencies on team performance has suggested that congruence or fit between forms of interdependence is perhaps the most important predictor of performance, more so than decisions made regarding any one form of interdependence. For example, the beneficial effects of structuring a team's work in a highly interdependent manner (high task interdependence) can be largely mitigated by enacting an individual based reward system (low reward interdependence). Interdependencies should be structured such that they all promote the same organizational goals. Tasks shouldn't be structured in a highly interdependent manner suggesting a cooperative approach is best, while rewards are structured in an individualistic manner engendering a competitive approach. This was precisely the findings in Wageman and Baker's (1997) study using the APA copy-editing experiment discussed above. Somewhat contrary to these findings are those presented by Allen, Sargent, and Bradley (2003) who found that congruence between reward and task interdependence did not lead to high levels of helping behaviors within the team. The authors explained this unexpected result in the following way, using a theory proposed by Shea and Guzzo (1987). When incongruities exist, such as between task and reward interdependence in this case, teams experience difficulties in completing their task, which necessitates the use of helping behaviors to compensate for the difficulties.

With much of the research transitioning toward interactions, a comprehensive interdependence scale is necessary to help further shed light on team interdependence in

the applied setting. It is impractical to test the many permutations of interdependence with the vast array of organizationally relevant outcome variables using primarily experimental means. If the research is to move more into the myriad of team process variables to understand the mechanisms underlying how interdependence leads to performance, then cross-sectional methods will become even more crucial.

Comprehensive Team Interdependence Scale

The relative popularity of team use in organizational settings has generated many interesting questions which have fueled not only the research presented above, but an entire field of organizational research. The field can only be improved by increasing the means by which we can study team behaviors. As evidenced above, the existing team research suggests that there are potentially four distinct dimensions of interdependence which to this point have largely been studied in experimental settings and to a lesser extent observed in the field. This relationship is expressed in Figure 1. It is also quite possibly the case that the similarities between task and resource interdependence as well as between reward and goal interdependence far outweigh their differences presented above, suggesting that 2 distinct dimensions encompassing inputs (task and resource) and outcomes (reward and goal) may better describe the team interdependence realm. This potential relationship is expressed in Figure 2.

Figure 1. Four dimension conceptualization of team interdependence

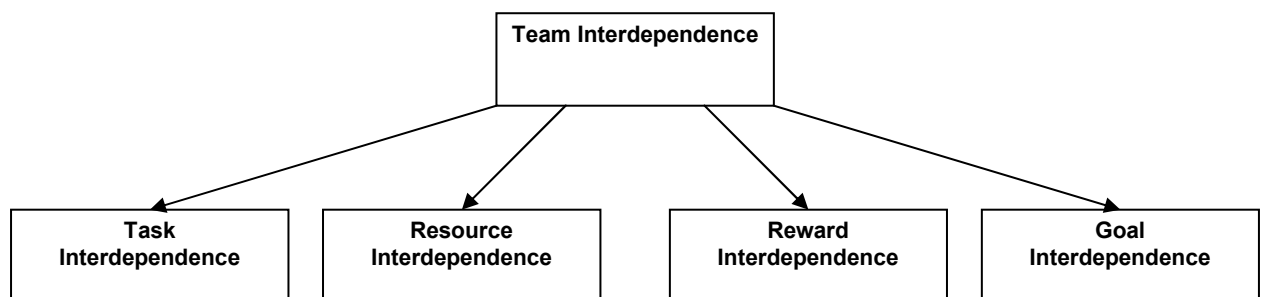
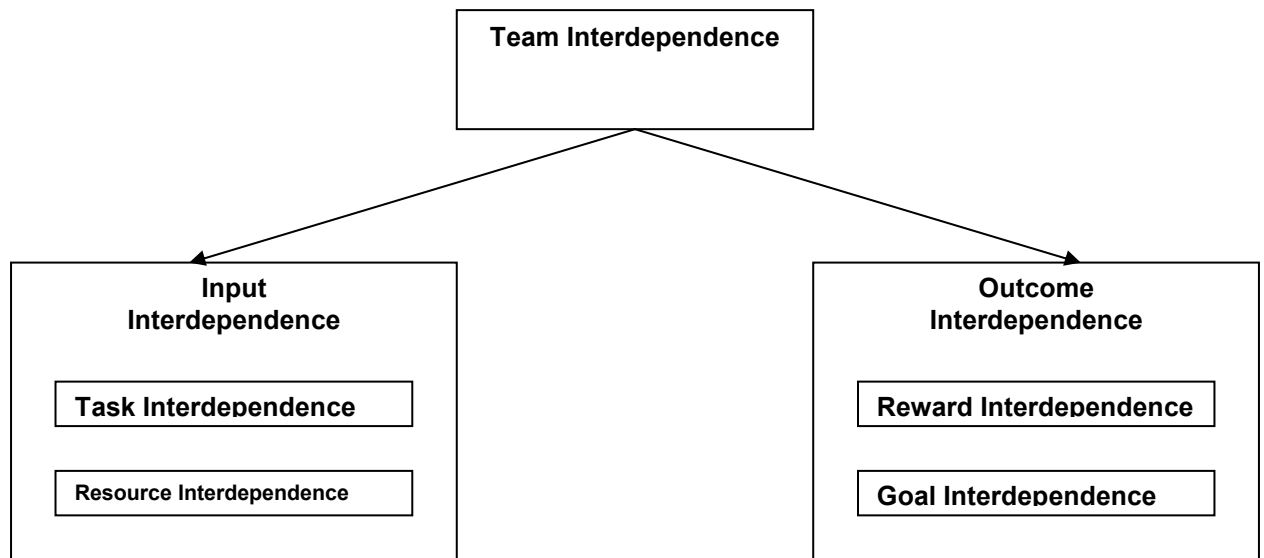


Figure 2. Two dimension conceptualization of team interdependence



Given the evidence supporting the existence of these forms of interdependence (task, resource, reward, and goal) it is surprising that there has been little work to develop comprehensive scales to assess these dimensions in the field. With team research suffering as a result of the difficulties inherent in both experimental laboratory based team research, and experimental field research; tools to assess team interdependencies in a less invasive and yet ecologically valid manner are a necessity. Much of the work done in organizational research begins with cross-sectional, exploratory research methods. Once a relative understanding of the construct is achieved, experimental and field based research is conducted to better understand the processes at work and to increase the external validity of findings. It is surprising that with team research, and specifically interdependence research, cross-sectional survey methods have been largely ignored. This has limited the amount and types of team research conducted. A comprehensive scale to quickly and unobtrusively assess the various interdependencies present in pre-

existing organizational work teams will allow researchers to better assess a greater variety of team structures, thus shedding light on how these interdependencies impact a greater variety of outcome and process variables. This is a case where taking a step back and conducting less rigorous cross-sectional research can allow the field of team research to advance forward.

The goal of this study is to develop a comprehensive team interdependence scale which can be used to assess the various forms of team interdependence in a cross-sectional manner. The definitions of each form of interdependence as outlined by the theoretical and empirical studies presented above will be used to generate items tapping into the various forms of team interdependence. Given the strong evidence provided above for the efficacy of each type of team interdependence, it is expected that a four factor model (conceptually expressed in figure 1) will best represent the data.

Hypothesis 1: A factor analysis of the survey data will suggest a four factor structure. The four factor model will provide for the best fit in comparison to the one factor and two factor solutions.

In addition, it is expected that the items will load on the factors for which they are being developed (i.e. items being generated to assess task interdependence will load on a factor representing task interdependence.)

Hypothesis 2a: Items generated to assess the construct of task interdependence will load on a single latent factor which will be used to represent task interdependence.

Hypothesis 2b: Items generated to assess the construct of resource interdependence will load on a single latent factor which will be used to represent resource interdependence.

Hypothesis 2c: Items generated to assess the construct of reward interdependence will load on a single latent factor which will be used to represent reward interdependence.

Hypothesis 2d: Items generated to assess the construct of goal interdependence will load on a single latent factor which will be used to represent goal interdependence.

Given the conceptual relationship between resource and task interdependence (both can be considered input related or driven) and the relationship between reward and goal interdependence (both can be considered outcome driven) a series of alternative hypotheses is presented. It is quite possible that the differences between task and resource interdependence and the differences between reward and goal interdependence are at such a fine grain of detail that items meant to represent distinct dimensions will load on the same latent factor. As such, alternative competing hypotheses are presented representing a two factor model (conceptually expressed in figure 2).

Alternative Hypothesis 1: A factor analysis of the survey data will suggest a two factor structure. The two factor model will provide for the best fit in comparison to the one factor and four factor solutions.

Alternative Hypothesis 2a: Items generated to assess the constructs of task interdependence and resource interdependence will load on a single latent factor which will be used to represent interdependence related to the structure of the work.

Alternative Hypothesis 2b: Items generated to assess the constructs of reward interdependence and goal interdependence will load on a single latent factor which will be used to represent interdependence related to the outcomes of the work.

Given the goal of this study to create and validate a comprehensive team interdependence scale that can be used to better assess teams in an organizational setting, cross-sectional survey methods will be used to assess the efficacy of the items developed and the hypotheses regarding the underlying factor structure. Items will be pilot tested to

determine the most appropriate items to include in the final scales. The final items will be factor analyzed to determine the underlying factor structure representing the constructs, and reliability analysis will be conducted to establish the efficacy of the scale for future use in assessing team interdependencies.

It is expected that either the 4-factor model (Hypothesis 1) or the 2-factor model (Alternative Hypothesis 1) will provide the best fit to the data. Existing research and theory clearly supports at the very least a distinction between inputs and outcomes (as depicted in Figure 2). If no support is found for either of the proposed models, a theoretical argument will be presented to explain this discrepancy.

Chapter Two- Method

Item Generation

The process for generating items to measure each of the forms of interdependence was borrowed from that used in Hinkin and Schriesheim (1989). A total of 63 items were generated by a team of three trained researchers based on the theoretical definitions presented above (see Appendix A for consolidated definitions). This pool of items was evaluated for conformity to the definitions, as well as for redundancy.

This preliminary list was then presented to a panel of 10 judges blind to the purposes of this study who classified the randomly ordered items into the four dimensions (task interdependence, resource interdependence, reward interdependence and goal interdependence) based on the theoretical definitions of interdependence (Appendix A). Items on which there was 80% agreement across the panel of judges and which were in agreement with the a priori assessment were retained for use in the pilot phase of the study. This resulted in a pool of 50 retained items which are listed in Appendix B.

Pilot Study

In order to evaluate the new interdependence scales, the items were first pilot tested to determine if the items behaved as expected and to determine which items should be included in the final version of the study. The full list of items (Appendix B) were administered via an online survey application and data were collected to assess the internal reliability of the scales as well as to assess the redundancy of items with the goal

of paring down the original 50 item pool into a more manageable number of items for the final scales.

Given the nature of this study, it was important that individuals be recruited from a variety of job types with differing interdependence structures. This necessitated a multi-organization sampling procedure. In order to recruit individuals from multiple organizations, the StudyResponse service was utilized for recruiting survey participants (Stanton & Weiss, 2002). The StudyResponse service is a nonprofit service that matches researchers with willing survey participants. In return for utilizing the service, the StudyResponse group collects data regarding the survey methodology (e.g. survey design and length) and survey effectiveness (e.g. response rates)(Piccolo & Colquitt, 2006). In return for participating in surveys, individuals were entered into a drawing to receive a gift certificate for use on Amazon.com.

For the pilot phase of this study, 360 employed individuals were recruited via the StudyResponse project for participation in the study. Useable responses were received from 61 participants representing a 16.5% response rate. The gender breakdown of the final pilot sample was 26 males (43%), 34 females (56%), 1 missing. Individuals ranged in age from 18 to 60 ($M=37.25$, $SD=11.07$) with the sample primarily consisting of Caucasians (67%) followed by Asian/Pacific Islanders (20%), African-Americans (5%), Hispanics (3%) and those indicating Other or not indicating race (6%). All participants were employed with the majority employed full time (62%), in a variety of industries including accounting/financial (10%), education/training (10%), retail (7%), administration support (5%), banking (5%), health (5%), law enforcement (5%), marketing (5%), and technology (5%).

A comparison of those responding to the survey compared to the subset of the larger pool from which StudyResponse survey participants were drawn reveals that those responding are significantly older ($M = 37.25$, $SD = 11.07$) than the larger pool ($M = 33.57$, $SD = 10.42$) ($t(637) = 2.581$, $p < .05$). The samples do not differ significantly on gender ($\chi^2(1) = 1.41$, ns). Given that this study is focused on the development and validation of a scale which theoretically should not be impacted by age this difference representing a proxy for non-response bias is not of concern.

Scale reliabilities for the generated items were in the acceptable range for the 14 item task interdependence scale ($\alpha = .92$), the 11 item resource interdependence scale ($\alpha = .79$), the 13 item reward interdependence scale ($\alpha = .84$), and the 12 item goal interdependence scale ($\alpha = .83$). While the scales displayed strong reliability in their existing form, a review of the inter-item and item-total correlations revealed redundant and poorly functioning items. Removal of the problematic items resulted in the final reduced scales presented in Appendix C with 7 items measuring task interdependence, 5 items measuring resource interdependence, 6 items measuring reward interdependence, and 6 items measuring goal interdependence.

Participants

For the experimental phase of this study, 2600 employed individuals were recruited via the StudyResponse project for participation in the study. Useable responses were received from 369 participants representing a 14.2% response rate. This response rate is statistically different from that of the pilot study ($\chi^2(1) = 10.05$, $p < .05$). This is not entirely surprising given that the final survey was longer in length than the pilot survey, and no reminder emails were sent out with the final survey. The low response

rates in both phases of the study are not unexpected given the StudyResponse claim of 10%-30% response rates on average. Piccolo and Colquitt (2006) attained similar response rates using StudyResponse group in a study of transformational leadership.

The gender breakdown of the final experimental sample was 156 males (42%), 206 females (56%), 7 missing. Individuals ranged in age from 18 to 69 ($M=37.70$, $SD=10.52$) with the sample primarily consisting of Caucasians (68%) followed by Asian/Pacific Islanders (18%), Hispanics (5%), and African-Americans (1%) and those indicating Other or not indicating race (6%). All participants were employed with the majority employed full time (66%), in a variety of industries including administration support (8%), health (9%), retail (7%), technology (6%), education/training (6%), banking (5%), accounting/financial (4%), management (4%), and government (4%).

A comparison of those responding to the survey compared to the subset of the larger pool from which StudyResponse survey participants were drawn reveals that those responding are significantly older ($M = 37.70$, $SD = 10.52$) than the larger pool ($M = 34.14$, $SD = 10.54$) ($t(5197) = 6.196$, $p < .05$). In addition the samples differ significantly on gender ($\chi^2(1) = 6.91$, $p < .05$) with there being more females (56%) in the responding sample than the larger subset which had (50%) females. Again, given that this study is focused on the development and validation of a scale which theoretically should not be impacted by age or gender this non-response bias is not of major concern.

Measures

Comprehensive Team Interdependence Scale: The final reduced scales presented in Appendix C and described above were administered. Reliabilities for each dimension were all at acceptable levels in the experimental sample. (Task Interdependence - $\alpha =$

.875; Resource Interdependence - $\alpha = .823$; Reward Interdependence - $\alpha = .837$; Goal Interdependence $\alpha = .770$)

Reciprocal Interdependence Scale: In order to partially assess the validity of the new scales the following existing scales were administered to perform convergent and divergent validity assessments. Pearce and Gregersen's (1991) reciprocal interdependence scale (See Appendix D for items) was used to assess convergent validity with the new task and resource scales and to assess divergent validity with the new reward and goal scales. Internal consistency for this scale in the final sample was acceptable ($\alpha = .866$).

Goal Interdependence Scale: A modified version of Tjosvold, Andrews, & Struthers (1992) scale based on Tjosvold, Andrews, & Jones (1983) was used to assess convergent validity with the new reward and goal scales and to assess divergent validity with the new task and resource scales. These items are focused on interdependence between worker and supervisor. Supervisor specific items were excluded and the remaining items were rephrased to reflect overall co-worker interdependence as opposed to the dyadic relationship between individual and supervisor (See Appendix D for items in the revised scale). The scale reflects acceptable internal consistency with coefficient alphas of .919 for the cooperation subscale, .909 for the competition subscale, and .855 for the independence subscale. Given the relative lack of scales tapping into the various specific forms of team interdependence further validation was not possible.

Procedure

Participants were contacted via email by StudyResponse project and asked to participate in a purely anonymous online survey which would take no more than 10 to 15

minutes of their time. Those choosing to participate were provided a link to the online survey. Instructions for completion of the survey were provided along with an informed consent message when first entering the survey. At the completion of the survey individuals were thanked for their time and consideration. Individuals choosing to participate in the study were entered into a raffle by StudyResponse project to receive a gift certificate to Amazon.com. Using sample size estimates provided by MacCallum, Browne, and Sugawara (1996), the minimum sample size to attain a power of .80 given a conservative estimate of degrees of freedom of 100¹, would be 132 useable surveys. Since the final scale consists of 24 items, the 369 responses should be more than enough to achieve appropriate power in both samples.

¹ If 14 total items are retained to investigate 4 latent variables this would result in a $df=101$. This represents a conservative estimate as more than 14 items will likely be retained.

Chapter Three- Results

In order to best assess the underlying factor structure of team interdependence, the final sample was randomly split into two samples. An exploratory factor analysis was conducted on the smaller developmental sample (N=169) and a confirmatory factor analysis was conducted on the larger cross-validation sample (N=200). The entire sample was used for the correlational analysis for investigating validity evidence. Results of each analysis are presented below.

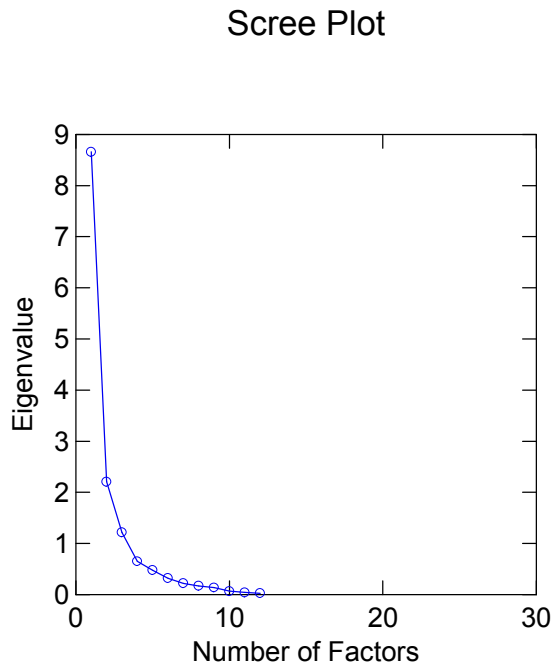
Exploratory Factor Analysis

An exploratory factor analysis was conducted using iterated principal axis factoring with oblimin rotation on the developmental sample (N=169). Iterated principal axis was chosen as the method of estimation as it starts with a principal components solution and then iteratively solves for communalities. The oblimin rotation procedure was chosen as it specifies values of oblique (non-orthogonal) rotations. Since it is expected that these interdependence factors will be correlated, an oblique rotation method is preferred.

Results of the exploratory factor analysis suggest that the 3-factor and 4-factor solutions are reasonable. Figure 3 displays the plot of eigenvalues. Three factors had eigenvalues greater than one, a commonly used heuristic for determining the number of factors. In addition, a review of the scree plot suggests a leveling off of the eigenvalues (or a bend in the curve of the scree plot) at 3 or 4 factors. In addition the rotated 3-factor and 4-factor solutions explain similar amounts of total variance with the 3-factor

explaining 50% of the total variance and the 4-factor explaining 55% of the total variance.

Figure 3. Scree plot of eigenvalues from exploratory factor analysis



Given that the evidence outlined above suggested a 3-factor or 4-factor solution, exploratory factor analysis was run looking at each of these models. Table 1 presents the rotated factor loadings of the 3-factor solution and Table 2 presents the rotated factor loadings of the 4-factor solution. A review of the rotated factor loadings for the individual items in the 3-factor model show that the items appear to be loading as intended. In the 3-factor model the task and resource items load on a single factor, the reward items on a single factor, and the three of goal items on a single factor. With the exception of four problematic items discussed below, in all cases the factor loading on

the intended factor was at least .380 with the vast majority of the loadings in the .5 to .7 range. In addition there were no cross loadings greater than .4. There was one problematic item on the resource interdependence scale (RES1) which did not load strongly on any factor. In addition, three of the items intended to measure goal interdependence loaded more strongly on the reward factor (GOAL1, GOAL2, & GOAL6). A review of the items shows that these three items appear to be focused on performance and/or supervisor evaluation which may be why they are relating more strongly to the reward factor. Inter-factor correlations for the 3-factor solution are presented in Table 3.

Table 1: Factor loadings from 3-factor EFA

Item	Factor 1	Factor 2	Factor 3
TASK1	0.562	-0.129	0.368
TASK2	0.506	-0.022	0.400
TASK3	0.690	-0.118	0.278
TASK4	0.641	-0.061	0.277
TASK5	0.577	0.031	0.377
TASK6	0.532	0.186	-0.096
TASK7	0.740	0.087	-0.001
RES1	0.259	0.257	0.205
RES2	0.699	0.087	-0.023
RES3	0.784	0.015	-0.207
RES4	0.646	0.201	-0.283
RES5	0.762	-0.026	0.010
REW1	0.002	0.681	-0.148
REW2	-0.046	0.742	0.017
REW3	-0.078	0.876	-0.080
REW4	0.198	0.686	-0.018
REW5	-0.050	0.510	0.081
REW6	-0.004	0.674	0.258
GOAL1	0.095	0.380	0.190
GOAL2	0.262	0.403	0.146
GOAL3	0.209	0.356	0.431
GOAL4	-0.048	0.179	0.572
GOAL5	0.045	0.089	0.632
GOAL6	0.290	0.566	0.044

Note: Largest factor loading bolded

Table 2: Factor loadings from 4-factor EFA

Item	Factor 1	Factor 2	Factor 3	Factor 4
TASK1	0.713	-0.089	0.056	0.087
TASK2	0.778	0.031	0.027	-0.016
TASK3	0.600	-0.096	0.066	0.291
TASK4	0.528	-0.050	0.107	0.294
TASK5	0.699	0.068	0.072	0.120
TASK6	0.218	0.199	-0.110	0.371
TASK7	0.302	0.082	0.002	0.528
RES1	0.347	0.273	0.054	0.033
RES2	0.057	0.025	0.137	0.691
RES3	-0.042	-0.046	0.014	0.838
RES4	-0.078	0.165	-0.081	0.704
RES5	0.187	-0.068	0.110	0.644
REW1	-0.068	0.682	-0.111	0.052
REW2	-0.073	0.698	0.065	0.030
REW3	-0.063	0.874	-0.065	-0.019
REW4	0.038	0.669	0.019	0.187
REW5	-0.150	0.461	0.200	0.082
REW6	0.192	0.665	0.141	-0.093
GOAL1	0.193	0.377	0.099	-0.013
GOAL2	0.354	0.434	-0.028	0.033
GOAL3	0.426	0.353	0.225	-0.039
GOAL4	0.036	0.076	0.680	-0.026
GOAL5	0.004	-0.075	0.940	0.062
GOAL6	0.218	0.576	-0.032	0.156

Note: Largest factor loading bolded

Table 3: 3-Factor EFA Inter-Factor Correlations

Scale	1	2	3
Task/Resource Factor	-		
Reward Factor	.436	-	
Goal Factor	.348	.225	-

A review of the 4 factor solution again indicates that for the most part items are loading as intended. The splitting of the task and resource items into their own factors resulted in 3 items (TASK6, TASK7, RES1) loading on the opposite factor (i.e. task items loading on the resource factor and vice versa). In addition the goal factor is again problematic with only 2 of the goal items loading on the intended factor. Inter-factor correlations for the 4-factor solution are presented in Table 4.

Table 4: 4-Factor EFA Inter-Factor Correlations

Scale	1	2	3	4
Task Factor	-			
Resource Factor	.326	-		
Reward Factor	.377	.289	-	
Goal Factor	.544	.402	.218	-

Given the exploratory results indicating a 3 or 4 factor solution in the developmental sample, consistent with the proposed models, I proceeded with a confirmatory factor analysis of the cross-validation sample investigating the proposed and alternative models.

Confirmatory Factor Analysis

Structural equation modeling (SEM) was conducted on the final 24 item scale using LISREL 8.53 (Joreskog & Sorbom, 1993) and a maximum likelihood method for parameter estimation. The 3-factor model and 4-factor models suggested by the exploratory factor analysis were tested along with the proposed 2-factor model in addition to a 1-factor model. Fit indices for the tested models are presented in Table 5. Inter-factor correlations are provided in Table 6 and standardized factor loadings are presented in Table 7. A review of the indices suggests that the 4-factor model provides the best fit of the explored models with a significant difference in χ^2 between the 3-factor and 4-factor models ($\chi^2 = 71.67, p < .05$). While the 4-factor model provides the best fit of the investigated models, the inflated RMSEA values (all $> .10$ suggesting misfit) give pause to interpreting the 4-factor model as providing good overall fit to the data. However, given the developmental nature of this study and the relatively strong values for the other fit indices (Normed Fit Index, Tucker-Lewis Index, and Comparative Fit Index) the data appear to support the hypothesized 4-factor model. In addition, the

standardized root mean-square residual (SRMR) value for the 4-factor model indicates the best fit of the observed models and appears to suggest acceptable fit. A review of the modification indices for the estimated parameters suggests that the items appear to be loading properly on the proposed factors; however the residual or error terms appear to be correlated which appears to be the primary source of misfit in the model.

Table 5: Fit indices for the tested models

Model	X ²	df	RMSEA	SRMR	ECVI	NFI	TLI	CFI
Null Model	7911.60	276	--	--	--	--	--	--
1-Factor Model	1103.91	252	0.151	0.098	7.50	0.86	0.88	0.89
2-Factor Model	902.00	251	0.126	0.088	5.73	0.89	0.91	0.91
3-Factor Model	856.70	249	0.125	0.082	5.62	0.89	0.91	0.92
4-Factor Model	785.03	246	0.113	0.081	4.91	0.90	0.92	0.93

Table 6: 4-Factor CFA Inter-Factor Correlations

Scale	1	2	3	4
Task Factor	-			
Resource Factor	.81	-		
Reward Factor	.55	.63	-	
Goal Factor	.80	.73	.85	-

Table 7: Factor loadings from 4-factor CFA

Item	Factor 1	Factor 2	Factor 3	Factor 4
TASK1	0.650	-	-	-
TASK2	0.740	-	-	-
TASK3	0.840	-	-	-
TASK4	0.860	-	-	-
TASK5	0.770	-	-	-
TASK6	0.710	-	-	-
TASK7	0.850	-	-	-
RES1	-	0.520	-	-
RES2	-	0.890	-	-
RES3	-	0.990	-	-
RES4	-	0.910	-	-
RES5	-	0.880	-	-
REW1	-	-	0.640	-
REW2	-	-	0.820	-
REW3	-	-	0.950	-
REW4	-	-	0.870	-
REW5	-	-	0.520	-
REW6	-	-	0.860	-
GOAL1	-	-	-	0.630
GOAL2	-	-	-	0.750
GOAL3	-	-	-	0.690
GOAL4	-	-	-	0.380
GOAL5	-	-	-	0.470
GOAL6	-	-	-	0.860

Given the exploratory factor analysis results suggesting some problematic items an additional confirmatory factor analysis was run on a reduced set of items eliminating the problematic items (TASK6, TASK7, RES1, GOAL1, GOAL2, and GOAL6). This set of analysis was run as a purely exploratory step to see how a future reduced version of the scale may fare. Fit indices for the reduced models are presented in Table 8. Again the 4-factor model appears to provide the best fit to the data. Again the RMSEA value of the 4-factor model is still high (.09), but now is approaching the acceptable range. In addition the other fit indices are also more encouraging.

Table 8: Fit indices for the reduced models

Model	χ^2	df	RMSEA	SRMR	ECVI	NFI	TLI	CFI
Null Model	4355.73	153	--	--	--	--	--	--
1-Factor Model	734.65	135	0.169	0.110	4.90	0.83	0.84	0.86
2-Factor Model	542.24	134	0.136	0.088	3.53	0.88	0.89	0.90
3-Factor Model	483.52	132	0.130	0.100	3.23	0.89	0.90	0.92
4-Factor Model	343.70	129	0.090	0.097	2.12	0.92	0.94	0.95

Validity Analyses

Means, standard deviations and correlations among the scales are provided in Table 9. A review of the correlations between the new interdependence scales reveals that all four scales are highly correlated with the task and resource scales highly correlated. This is not surprising given the 3-factor exploratory factor analysis results suggesting they load on a single factor. Given the high correlations between scales, discriminant validity was assessed using a procedure outlined by Anderson and Gerbing (1988) in which the correlation between two of the studied factors is fixed at 1.00 and compared using the χ^2 value to the model in which the correlation is allowed to be freely estimated. If the χ^2 value for the measurement model is significantly less when the correlation is fixed at 1.00 then discriminant validity is shown. This procedure is repeated for all sets of factor correlations, in this case 6 distinct correlations. In all cases the model with the fixed correlation produced significantly worse fit (as determined by the χ^2) than the original 4-factor model allowing all factor correlations to be freely determined. This suggests the new interdependence scales, while highly correlated, do display discriminant validity.

An investigation of the highly significant correlations between the task and resource scales with the reciprocal interdependence scale suggests that the new scales display convergent validity measuring a similar construct to the one outlined by Pearce

and Gregersen's (1991). Similarly an investigation of the goal and reward scales correlations with the cooperation subscale of Tjosvold, Andrews, & Struthers (1992) measure indicates strong correlations suggesting convergent validity with this measure.

The assessment of divergent validity is not as clear cut given the strong correlations among all the related scales. The task and resource scales were significantly correlated with the cooperation scale thus not displaying divergent validity with this scale. In addition the goal and reward scales were correlated with the reciprocal interdependence scale again indicating a lack of divergent validity. Given the strong relationships between the distinct factors it is not surprising that I am unable to provide evidence regarding divergent validity with the studied scales.

Table 9: Means, SDs and Correlations among study variables

Scale	N	Mean	SD	1	2	3	4	5	6	7	8
Task Interdependence	369	3.41	0.838	(.875)							
Resource Interdependence	369	3.12	0.866	0.739**	(.823)						
Reward Interdependence	369	2.61	0.876	0.451**	.524**	(.837)					
Goal Interdependence	369	3.34	0.749	0.639**	.562**	.660**	(.770)				
Reciprocal Interdependence	369	3.64	0.824	0.760**	.632**	.329**	.535**	(.866)			
Cooperation Scale	363	3.45	0.703	0.470**	.390**	.407**	.583**	.520**	(.919)		
Competition Scale	369	2.55	0.839	0.178**	.275**	.318**	.091	.099	-.232**	(.909)	
Independence Scale	369	2.78	0.696	-0.119*	.050	.188**	-.090	-.155**	-.343**	.756**	(.855)

Note: * significant at $p < .05$, ** significant at $p < .01$

Chapter Four- Discussion

The purpose of this study was to develop a comprehensive team interdependence scale which could be used to assess the various forms of team interdependence in a cross-sectional manner. It was hypothesized that in order to comprehensively measure team interdependence, scales would need to tap into four dimensions of interdependence: task interdependence or the extent to which the task drives interactions among individuals, resource interdependence or the extent to which individuals rely on others to provide inputs necessary to complete their portion of work, reward interdependence or the extent to which individuals' rewards are tied into the performance of others, and goal interdependence or the extent to which individuals set goals and receive feedback at the group versus individual level. Using the existing literature as a driver, definitions of each dimension were created and items intended to tap into each dimension were generated, and evaluated on their consistency with the definitions. These items were pilot tested and reduced to the final scale presented in Appendix C. This final scale was then administered to a large cross organizational sample for the purposes of exploring the factor structure and validity of the new comprehensive team interdependence scale.

It was hypothesized that the four dimensions of team interdependence would be highly correlated but that the data would be best represented by a four factor structure with items intended to measure each dimension loading on a distinct factor (see Figure 1). Given the highly related nature of the task and resource dimensions as well as the reward and goal dimensions, an alternative hypothesis that the task and resource items

would load on a single factor and that the reward and goal items would load on a single factor was put forth (see Figure 2). My results suggest that indeed the four factor solution provides the best fit to the data with the majority of items loading on the intended factors providing support for hypotheses 1 and 2. The results of the exploratory factor analysis revealed that both the proposed 4-factor solution and a 3-factor solution with the task and resource items loading on a common factor were reasonable. While not formally hypothesized, this 3-factor solution represents a blending of the hypothesized and alternative models with the reward and goal dimensions remaining distinct (per the hypothesized model) and the task and resource dimensions loading together (per the alternative model). In addition, these exploratory factor analytic results shed light on poorly performing items especially in the goal scale. The confirmatory results suggest that indeed the hypothesized 4-factor solution provides the best overall fit of the models tested including: a 1-factor model, the 2-factor alternatively hypothesized model, the 3-factor model suggested by the exploratory factor analysis, and the hypothesized 4-factor model. While the overall fit as indicated by the RMSEA value was still less than ideal, given the developmental nature of this study, and the decent fit represented by the other fit indices, I feel comfortable interpreting the confirmatory factor analytic results as indicating a 4-factor solution. To further bolster this claim, an additional set of confirmatory analyses was run on the same cross-validation sample, but using a reduced version of the scale (removing items appearing problematic from the exploratory results). Again the 4-factor solution provided the best fit this time with the RMSEA = .09 which indicates mediocre but acceptable fit (McCallum et al, 1996). Interpretation of these findings using the reduced scale should be taken with a grain of salt as the second set of

confirmatory analyses is capitalizing on the sample specific findings from the exploratory factor analysis. Taken as exploratory evidence, these results suggest that minor modifications to the scale may result in more acceptable fit levels in the future.

In addition to the factor analytic results discussed above, several tests shedding light on the validity of the scales were conducted. The new scales display internal consistency, as well as discriminant and convergent validity. Future studies utilizing these new scales should attempt to provide further validity evidence.

Research Implications:

The introduction of the new comprehensive team interdependence scale should allow researchers to better assess both existing and experimental teams in order to better provide information regarding exactly how teams interact. For too long teams research has relied on contrived experimental manipulations and field based research comparing apples and oranges. It is not enough to simply study teams and describe the task the team is tasked with completing. In order to make comparisons across teams and across studies, researchers must utilize a common descriptive language which allows a common understanding of what it truly means to be a team. By utilizing cross-sectional methods leveraging this new scale, researchers can better understand the commonalities and differences between a team from a study measuring creative performance in a series of marketing teams with that of a team from a different study measuring task performance in a set of software development teams. The current state of team research might pool these teams together for the purposes of meta-analytic study assuming that “a team is a team”, ignoring the fact that individuals in these teams may be experiencing very different team

processes driven by the interdependencies in place. Now we will have the ability to truly assess whether these teams are indeed of the same mold.

In addition to providing a cross-sectional technique for field based and survey based research, these new scales can be adapted to assess team structures in experimental research. Used as a manipulation check, these scales can provide researchers with the means to assessing whether experimentally designed studies of teams are truly engendering a sense of team in their participants. Again, it is not enough for experimenters to create a situation where people are working together, if the participants do not truly perceive a high level of interdependence with others. This tool will provide researchers with a means to ensure that their team manipulations are indeed valid and consistent across studies.

Finally, this new scale provides a new way to conceptualize what it means to be or not to be working in a team. Too often the label of team is placed on groups of individuals that are perhaps only a team in name. Similarly, it can also be the case that individuals consider themselves to be individual free agent workers within organizations when in fact the structure of the rewards systems and or the design of work suggest that they are indeed team members. Now we can move away from the organizational or the individual subjective assessment of whether teams are or are not in place and instead rely on assessments of the types of interactions in place within organization as a proxy for whether or not individuals work within teams. This seems like a trivial point, but too often groups are labeled teams when there is very little interdependence and people fail to realize they are a part of a team despite interdependencies that are in place.

Organizational Implications:

In addition to the more academic implications discussed above, I believe that a comprehensive scale of team interdependence also has practical organizational implications as well. Organizations may use these scales to assess how close employees' perceptions of the work environment match with the organizational intentions. If the organization is pushing the use of teams and exalting cooperation and teamwork as organizational objectives, but individuals do not perceive their tasks to truly require teamwork because the design of work does not dictate interdependence, then the organization's tenets are misplaced and should be revised as they are likely falling on deaf ears.

Similarly, organizations can utilize these interdependence scales to assess whether congruence exists between the dimensions of interdependence. As previously stated, much of the research on the interactive effects of the various forms of interdependence has suggested that congruence or fit between the types of interdependence is a good predictor of performance (Wageman, 1995; Wageman & Baker, 1997), such that if an organization has highly interdependent tasks with high resource interdependence, then an appropriate incentive structure would be one in which goals and rewards are also perceived to be highly interdependent. Knowing where these perceptions are incongruent will allow organizations to identify problematic job characteristics and policies in order to maximize the performance benefits of interdependence.

Limitations:

While I make the assertion that the data is best fit with the theoretically driven 4-factor model, it is difficult given the inflated RMSEA values to say with certainty that the

items are indeed measuring four distinct factors and that there is not a model with more factors, or with a different pattern of loadings that could provide better fit. Given the theoretical and empirical evidence presented in the introduction, the 4-factor model certainly makes sense. In light of the improvement in fit when looking at the reduced scale, it appears that minor additional tweaks to the scale items may result in a more parsimonious measure that may display a more appropriate level of fit.

The use of the StudyResponse project for data collection is also a potential limitation. While many studies have used the service in recent years in a variety of disciplines (Barbeite & Weiss, 2004; Dennis & Winston, 2003; Piccolo & Colquitt, 2006; Vodanovich, Wallace, & Kass, 2005), the use of individuals who self-selected into such a program and who participate in order to be entered into raffle drawings could be problematic. Since the purpose of this study was to investigate interactions that are primarily driven by job characteristics, it is not expected that characteristics of the individual should have a large impact on their response to the scales. Basically, it is expected that individuals that self-select to participate in such a service are evenly distributed across the job arrangements that this survey attempted to tap into. In essence, it is not likely that I obtained far more people with highly reward interdependent jobs as a result of this self selection; however, the possibility does still exist and as such could be a potential limitation on generalizing these results to the population of all workers.

Another characteristic of the sample that may have impacted the data is the large breadth of jobs tapped into by the StudyResponse project. While variety in organizations and job designs was a necessity as variability in the types of interdependence was key to assessing the structure of the scales, the breadth of industries and job types represented in

this sample may be cause for concern. It is certainly possible that certain industries have very specific patterns of interdependence. While this scale is not solely focused on measuring interdependence in a white-collar organizational context, perhaps limiting the focus initially for the purposes of scale development to a more defined context with an eye toward expanding the context in subsequent studies would have been a more appropriate initial approach.

Future Directions:

While useful in its current state, additional work needs to be done to continue to hone the new scales, especially with regard to the scale meant to measure goal interdependence. The exploratory results suggest that three of the goal interdependence items are not behaving as intended appearing to measure more organizational elements rather than the interdependence relationship. Future versions of this scale should not employ these items and additional scale development work is needed to add an item or two to better balance the number of items across scales. Perhaps an item like “It is difficult for me to achieve my work goals without my coworkers also achieving their work goals” would serve to augment the remaining items while still keeping the focus on interdependence. In addition to changes to the goal scale, reducing the task and resource scales removing the poor items will result in a more parsimonious and hopefully more accurate measure of the constructs.

As already stated, the use of a multi-organization sample is a good thing in the context of this study, but also raises issues. Future work utilizing this scale should look to use a more focused sampling approach. Validating the scale in single organization settings with consistent interdependencies across workers will add further support to the

efficacy of the scales. In addition, taking an even more focused approach and matching individuals within the same formal work team within organizations will provide evidence regarding how consistent individuals' perceptions are of the interdependencies that exist within a team.

In addition to further refining and validation of the comprehensive team interdependence scale, future studies should begin to investigate individual and organizational outcomes utilizing this cross-sectional measure. While experimental and field based studies have investigated interdependencies and performance (Wageman, 1995; Wageman & Baker, 1997; Allen, Sargent, & Bradley, 2003; Fan & Gruenfeld, 1998) little research has investigated interdependencies and other outcomes of interest such as job satisfaction, organizational commitment, turnover and turnover intentions, etc. It will be interesting to see if the extant experimental and field based findings within the teams literature are supported by research focused more at employee perceptions of the interdependencies in real world organizations.

Conclusion:

The study represents a first step toward improving our ability to better study teams in their naturalistic organizational setting. To date, too much team research has relied on contrived laboratory experiments with little to no external validity and the little research that has been conducted in the field has relied on existing organizational constraints which are often not comparable across studies. With the development and validation of the comprehensive team interdependence scale, researchers will now have the ability to assess team similarities and difference across multiple organizations

allowing us as researchers to for the first time truly speak the same language when discussing what it means to truly be a team.

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Appendices

Appendix A

Interdependence Theoretical Definitions

Definitions based on information provided in Van der Vegt & Van de Vliert, 2002; Wageman, 1995

Task Interdependence – Task interdependence is a structural feature of the relations that exist between team members or co-workers. Task interdependence is an embedded function of the job design and requirements of tasks being completed. Individuals are task interdependent when they rely on others in order to complete the requirements of their job. Generally task interdependence increases with job complexity. A key distinguishing quality of task interdependence is that each member must take action in order for other members to complete their task. An example would be a surgical team where the surgeon cannot complete his or her tasks without the anesthesiologist and nurses performing their portion of the work.

Resource Interdependence – Resource interdependence is a function of the inputs required to complete work. Individuals experience resource interdependence when they rely on team members or co-workers for materials, information, or expertise in order to achieve desired levels of performance. Resource interdependence can exist in the absence of task interdependence when tasks and information is distributed. A member needs the resources provided by others, but they can complete their tasks without an actual interaction with other team members. An example would be a design team where individuals can complete their own portions of the project, but the final product cannot be complete until each member has completed their portion.

Reward Interdependence – Reward interdependence is a function of the degree to which the significant rewards and outcomes an individual receives are tied to the performance of team members or co-workers. Reward interdependence is low when rewards are based solely on the performance of the individual, and is high when rewards are based on the performance of the team or work unit.

Goal Interdependence – Goal interdependence is a function of the interdependence of goals assigned to, or generated by individuals. Goal may be set at the individual level, low goal interdependence, or at the group level, high goal interdependence. Goals set at the group level can be defined as the performance levels expected by all members working together

It is important to note that these interdependencies are distinct and mutually exclusive constructs. For example it is possible to have a job with low task interdependencies as is

the case in a marketing call center, and yet have high reward interdependence with pay-for-performance based on the sales of the entire center.

Appendix B

Pilot Interdependence Items

Task Items:

I could complete my job from a remote location with little interaction from my co-workers.

If I take a day off work, my co-workers will be unable to effectively perform their jobs without me.

I have to rely on my co-workers in order to complete my tasks.

My job is designed in such a way that I must interact with my co-workers in order to perform effectively.

Before I can start a work task, I must wait for my co-workers.

In my job, in order to get the job done, more than one individual must take action.

The nature of my job requires me to work together with my co-workers to complete specific tasks.

I often need to work directly with my co-workers in order to effectively perform my job. It is very difficult for me to finish job tasks if my co-workers do not complete their tasks well.

If I do not engage in job-related interactions with my co-workers, it is difficult to adequately perform my job.

My job requires me to coordinate my actions with those of my co-workers.

I often must wait for my co-workers to take action before I can complete my job tasks.

I am unable to perform my job effectively if certain co-workers are unavailable.

My co-workers and I depend on each other's actions in order to complete our own assignments.

Resource Items:

I cannot complete my tasks without information or other resources from my co-workers.

I do not require any resources from my co-workers.

My co-workers cannot successfully complete their jobs unless they receive information from me.

My co-workers and I depend on each other for resources to complete our jobs.

I rarely need the resources provided by co-workers to complete my work.

In order to complete my tasks, I need information or other resources from my co-workers.

My job requires that I use resources provided by co-workers in order to complete assignments.

I rely on my co-workers for information in order to achieve a desired level of job performance.

I rely on my co-workers for materials in order to achieve a desired level of job performance.

I depend on my co-workers for inputs required to complete my work.

Reward Items:

I could receive a high pay increase if my performance was average but my co-workers performed exceptionally.

Merit based pay increases in my organization are based entirely on the performance of the individual.

My organization rewards me for my individual contributions to the organization.

My organization focuses on the performance of teams or work units when allocating rewards.

My organization rewards me and my co-workers for our combined contribution to the organization.

It is difficult to be rewarded for individual performance within my organization.

I am rewarded based on the performance of my co-workers, not my individual performance.

I could receive a high pay increase, while my co-workers receive little or no increase.

Rewards in my organization are based solely on individual, not team or work unit, performance.

My salary increases and/or bonuses I receive for performance depend on the performance of my co-workers.

It would be difficult for me to receive a high pay increase if my co-workers do not perform well in their jobs.

I am rewarded for my performance regardless of the performance of my co-workers.

In my organization, pay raises are often given to teams or work units that perform well.

Goal Items:

I am often encouraged to aim for personal goals at work.

My organization/supervisor encourages its employees to focus on goals set at the team level rather than at the individual level.

I have work goals that conflict with the work goals of my co-workers.

My organization/supervisor sets goals that are contingent on the performance of multiple workers.

I cannot achieve my work goals unless my co-workers also achieve their work goals.

It is important for my work group to set achievement goals for itself.

My work goals are the same or very similar to the goals of my co-workers.

My co-workers and I have the same or similar work goals.

My co-workers and I are all working toward a common shared goal.

I am allowed to set my own performance goals.

My organization/supervisor encourages me to set individual goals.

When I set goals at work, they are often dependent on the progress of my co-workers.

Appendix C

Final Interdependence Items

Task Items:

TASK1 - My job is designed in such a way that I must interact with my co-workers in order to perform effectively.

TASK2 - The nature of my job requires me to work together with my co-workers to complete specific tasks.

TASK3 - I often need to work directly with my co-workers in order to effectively perform my job.

TASK4 - If I do not engage in job-related interactions with my co-workers, it is difficult to adequately perform my job.

TASK5 - My job requires me to coordinate my actions with those of my co-workers.

TASK6 - I am unable to perform my job effectively if certain co-workers are unavailable.

TASK7 - My co-workers and I depend on each other's actions in order to complete our own assignments.

Resource Items:

RES1 - My co-workers cannot successfully complete their jobs unless they receive information from me.

RES2 - My job requires that I use resources provided by co-workers in order to complete assignments.

RES3 - I rely on my co-workers for information in order to achieve a desired level of job performance.

RES4 - I rely on my co-workers for materials in order to achieve a desired level of job performance.

RES5 - I depend on my co-workers for inputs required to complete my work.

Reward Items:

REW1 - I could receive a high pay increase if my performance was average but my co-workers performed exceptionally.

REW2 - I am rewarded based on the performance of my co-workers, not my individual performance.

REW3 - My organization focuses on the performance of teams or work units when allocating rewards.

REW4 - My salary increases and/or bonuses I receive for performance depend on the performance of my co-workers.

REW5 - It would be difficult for me to receive a high pay increase if my co-workers do not perform well in their jobs.

REW6 - In my organization, pay raises and or bonuses are often similar in amount for individual within the same team or work group.

Goal Items:

GOAL1 - My supervisor encourages his/her employees to focus on goals set at the team level rather than at the individual level.

GOAL2 - My supervisor sets goals that are contingent on the performance of multiple workers.

GOAL3 - It is important for my work group to set achievement goals for itself.

GOAL4 - My co-workers and I have the same or similar work goals.

GOAL5 - My co-workers and I are all working toward a common shared goal.

GOAL6 - When I set goals at work, they are often dependent on the progress of my co-workers.

Appendix D

Reciprocal Interdependence Scale (Pearce & Gregersen, 1991)

I work closely with others in doing my work.
I frequently must coordinate my efforts with others.
My own performance is dependent on receiving accurate information from others.
The way I perform my job has a significant impact on others.
My work requires me to consult with others fairly frequently.

Goal Interdependence Scale (Tjosvold, Andrews, & Struthers, 1992)

Cooperation

My co-workers:

Pass on important information to me.
Seem pleased when I succeed.
Show as much concern for what I want to accomplish as for what they want to accomplish.
Help me find ways to achieve my objectives.
Give high priority to the things I want to accomplish.
Help me grow and develop on the job.
Take pride in my accomplishments.
Share their ideas and resources with me.
Are interested in the things I want to accomplish.
Help me do a good job.

Competition:

My co-workers:

Give high priority to the things they want to accomplish and low priorities to things I want to accomplish
Seem threatened when I am highly effective.
Like to show that they know more than I do.
Seem to be threatened when I learn new skills and knowledge.
Seem to get in the way of my growth and development.
Withhold important information from me.
Show much more concern for what they want to accomplish than for what I want to accomplish
Are disturbed by my accomplishments

Independence:

My co-workers:

Are uninterested in the flow of information.
Do not know what I want to accomplish.
Work best when they work alone rather than with me.
And I work separately.
Prefer to work alone rather than with me.

Are unconcerned about whether I get ahead in the organization.
Like to get their rewards through their own individual work.
Are uninterested in the things I want to accomplish.
Are most concerned about what they accomplish when working alone.