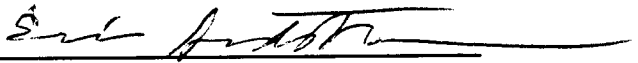


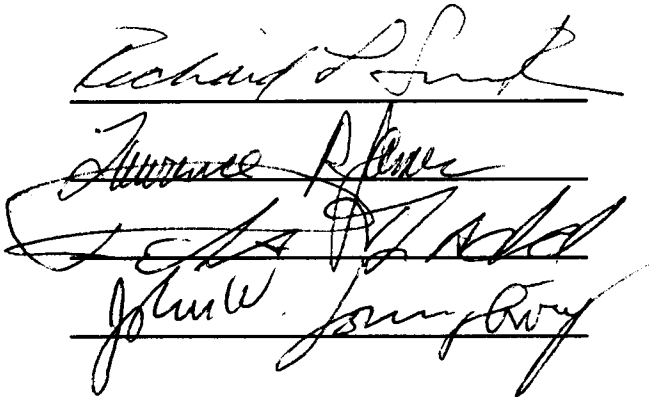
To the Graduate Council:

I am submitting herewith a dissertation written by David Alan Futrell entitled "Cognitive Ability and Myers-Briggs Type Indicator Preferences as Predictors of Group Performance: An Empirical Study." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Industrial/Organizational Psychology.

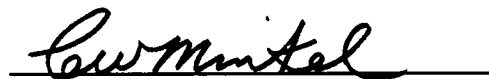


Eric Sundstrom, Major Professor

We have read this dissertation
and recommend its acceptance:



Accepted for the Council:



Associate Vice Chancellor
and Dean of The Graduate School

COGNITIVE ABILITY AND MYERS-BRIGGS TYPE INDICATOR
PREFERENCES AS PREDICTORS OF GROUP PERFORMANCE:

AN EMPIRICAL STUDY

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

David Alan Futrell
May, 1992

DEDICATION

This dissertation is dedicated to my parents, Jack Futrell and Judy Gentry, who provided the opportunity and encouragement for me to attend college and graduate school.

ACKNOWLEDGEMENTS

There are a number of people without whom my Graduate career and this dissertation would have been much less enjoyable.

First, I would like to thank my wife Libby for supporting me through the three years or so that it took to complete this project. During that time we had a baby, moved twice, purchased a home, and went through a variety of career changes. Most of all, I want to thank her for taking care of Claire on all those lonely weekends; I know she would have been happier talking to someone who could say more than 5 words.

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the excitement of psychology and research, and were my primary inspirations for attending graduate school.

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The people with whom I had the privilege of attending UT more than made up for all the hours of studying, reading, writing and crunching numbers.

ABSTRACT

This study examined the relationship between the performance of work teams and the cognitive ability and Myers-Briggs Type Indicator (MBTI) preferences of the individuals composing these teams. Specifically, the level of cognitive ability, the heterogeneity of cognitive ability, as well as the amount and heterogeneity of the scales of the MBTI were hypothesized to be predictive of the quantity and quality of production on a team work-simulation task. Additional hypotheses predicted that individual cognitive ability and MBTI scores would be related to assessment center ratings of team skills behavior. Candidates for employment (n=579) at a new manufacturing facility completed a cognitive ability test battery and the Myers-Briggs Type Indicator, and were then assigned to 4-person groups (n=118.) They completed an assessment center exercise involving production of automobile headlight assemblies. Group performance was measured by the number of units produced and the number of error-free units. Team skills ratings of individuals were also obtained. Group production was strongly correlated with the average level of cognitive ability of group members. Cognitive ability also predicted individual team skills ratings. MBTI scales were unrelated to group performance. MBTI Extraversion and Intuition predicted team skills ratings of individuals. These findings have implications for group performance theories and for selection strategies for work teams.

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CHAPTER I

INTRODUCTION

Work groups or work teams are becoming increasingly important to organizations (Sundstrom, DeMeuse & Futrell, 1990). Increasingly competitive global markets have dramatically reduced profitability for American businesses, particularly in manufacturing. In response to this decline, many companies have restructured, attempting to eliminate layers of organization (Kanter, 1983). Accordingly, many organizations have adopted structures based on autonomous or semi-autonomous work units or teams (Cummings & Molloy, 1977).

According to Pasmore, Francis, Halderman & Shani (1982), a transition from a traditional organizational structure to a structure based on self-directed work teams was the most common type of work redesign identified in a review of 134 field experiments performed during the 1970's. These changes became increasingly common during the 1980's.

In addition to the direct benefit of reducing human resources costs, the self-directed team concept is believed to have other advantages. Peters (1988) believes that today's organizations would benefit from using 10 to 30 person self-managing work teams for *every* function. Technological changes, particularly in manufacturing environments, have allowed small groups to become responsible for much larger products or processes than previously possible (Tornatzky, 1986).

Group performance has been an important topic for academicians, particularly social psychologists for decades, with published laboratory studies numbering in the thousands (Shea & Guzzo, 1987; Driskell, Hogan & Salas, 1988).

Yet despite the recent interest in groups for corporate applications, and the long-standing interest in groups by academicians, our current understanding of the antecedents of effective work team performance is quite limited. As stated by Hackman and Morris in 1975, we know very little about the causes of effective group performance and how that performance can be improved; unfortunately, this statement is still appropriate today.

Most traditional group performance theories (e.g., Hackman and Morris, 1975, Gladstein, 1984, Steiner, 1972) are based on some variation of an Input-Process-Output Model (Figure 1). While the validity of this model is questioned now even by former proponents (Sundstrom, et al., 1990; Hackman, 1987), its purpose here is to serve as a framework for understanding the research history on group performance.

A large body of research, primarily based on *ad hoc* groups in the social psychology laboratory, has focused on the *process* portion of the model, addressing how specific behaviors of the group's members are related to the quality and/or quantity of the group's output (McGrath, 1984; Sundstrom, Bobrow, Fulton, Blair & McClane, 1988). Unfortunately, the only consistent relationship found between process and performance is that process measures are generally able to predict a group's satisfaction with its own performance. In a field study of 100 sales teams of communications equipment, Gladstein (1984) found that process measures very accurately

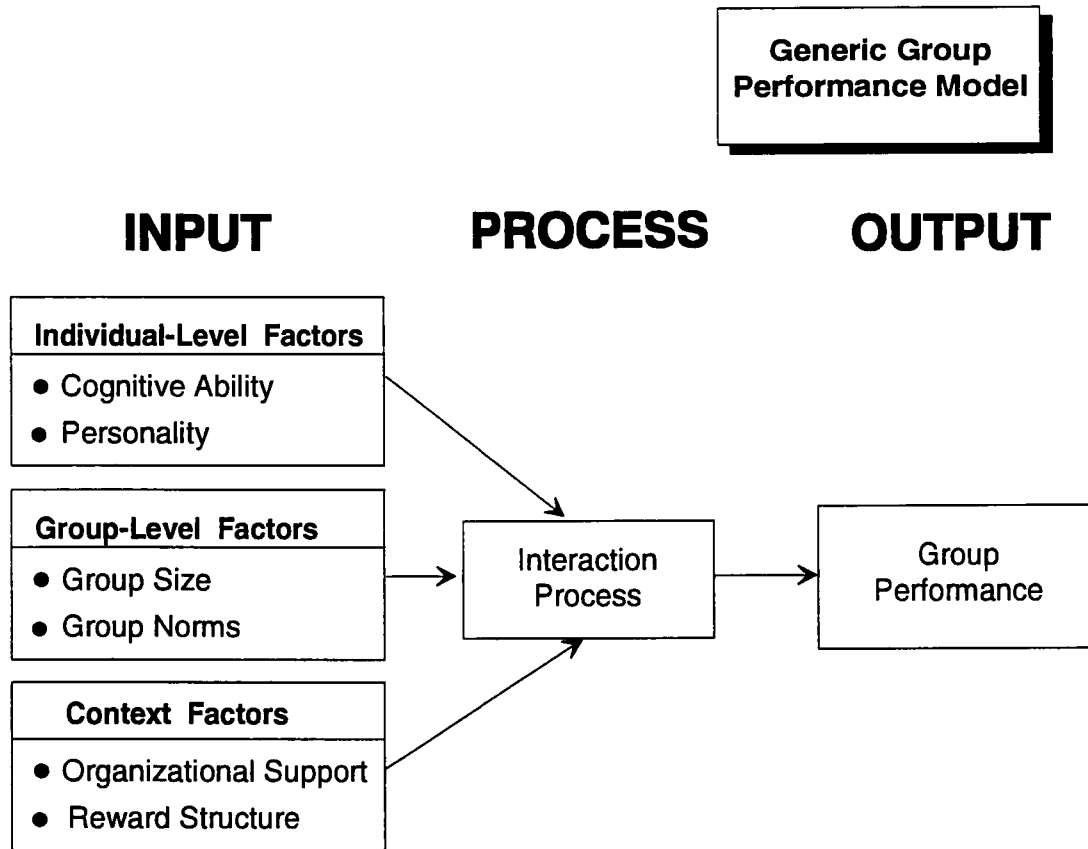


Figure 1. Generic Model of Group Performance

predicted team satisfaction, but explained no variation in actual performance as measured by sales volume.

Team development interventions almost always involve some attempt to improve a groups' interpersonal processes. These interventions consistently result in increased *viability* (member satisfaction, participation, willingness to continue working as a unit), but generally fail to improve actual performance (Sundstrom, et al., 1990).

Input factors traditionally studied are of three types: 1) Environmental, or *context-level* factors, such as the task, reward structure, and level of organizational support; 2) *Group-level* factors, such as the group size, cohesiveness, mutual affect, group structure, and norms for behavior; and 3) *Individual-level* factors such as level of member ability, level of any given personality dimension, and heterogeneity of ability, personality, sex, race, status, and age.

While context-level factors are conceptually distinct, it may be beneficial here to elaborate on the more subtle differences between group-level and individual-level input factor. While individual level factors such as level and heterogeneity of cognitive ability may be combined to yield a group-level *score*, they are not group-level *variables*. It is possible to speak of a group's level of ability or heterogeneity of age *before* the groups are actually formed. In contrast, group-level variables can only be measured after the formation of the group; for example it is impossible to measure the cohesiveness of a group solely on the basis of the properties of the individuals who compose the group; it can only be measured after to group begins to interact.

Some context-level input factors have been shown to be valid predictors of performance. Gladstein (1984) found the context factors of market growth (positive) and experience level (negative) to be predictive of performance in 100 sales teams. Cummings and Molloy (1977) reviewed 16 autonomous work group experiments and found several context factors frequently related to performance including autonomy, equipment quality, task variety, rewards, and performance feedback.

Group-level input factors consistently related to performance include keeping the group as small as possible (Nieva, Fleishman & Reick, 1978) and consistent group norms and rules for behavior (Hackman, 1987).

Seldom considered is how the characteristics of individuals composing the group impact its ability to perform. While some recent research has addressed the relationship between group demography in terms of age, organizational tenure, and education and organizational outcomes, such as turnover and promotion (Jackson, Brett, Sessa, Cooper, Julin & Peyronnin, 1991; O'Reilly, Caldwell & Barnett, 1989; Wagner, Pfeffer & O'Reilly, 1984), these studies have not focused on performance of groups. Another body of research has addressed the relationship between individual characteristics and the performance of groups (Haythorn, 1968; Nieva, Fleishman & Reick, 1978) but has yielded few clear answers.

Several attributes of individuals which might be related to group performance. These include personality factors, homo-heterogeneity of ability, and demographic variables such as sex, race and age. While each of these variables has been researched, the volume of this research is quite small in comparison to the research on group process, or the context-level

and group-level input factors. There may be several reasons for this. As these variables are all properties of individuals, most research on these variables is done at the individual level of analysis. Examining these variables at the group level becomes more complex for the researcher. A major issue is pragmatic: Obviously, it requires less time and effort to collect data for 100 individuals than for 100 groups. Once the data are collected, statistical analysis of group-level data is more difficult than for individuals. Decisions must be made by the researcher on whether and how to aggregate data, and the meaning of aggregated data is often unclear or even misleading (James, 1982). Substituting group means for individual measures without considering within-group variability may lead a researcher to the wrong conclusions, and whether the mean level of a variable (e.g. cognitive ability) can safely be considered a group *property* is unclear. These issues are serious, and need attention from methods researchers, but ignoring this area of research is probably a greater evil than proceeding with imperfect methods. Organizations generally have a considerable amount of control over whom they select for employment and how they choose to place these individuals into work units. If consistent relationships between individual composition factors and group performance can be identified, then using these measures to select individuals and structure teams may be a very efficient way for an organization to influence its performance.

The primary purpose of this research was to examine the relationship between two individual-level input factors, cognitive ability and personality preferences (as measured by the Myers-Briggs Type Indicator) and group performance. The basic model is shown in Figure 2. The dashed arrows and

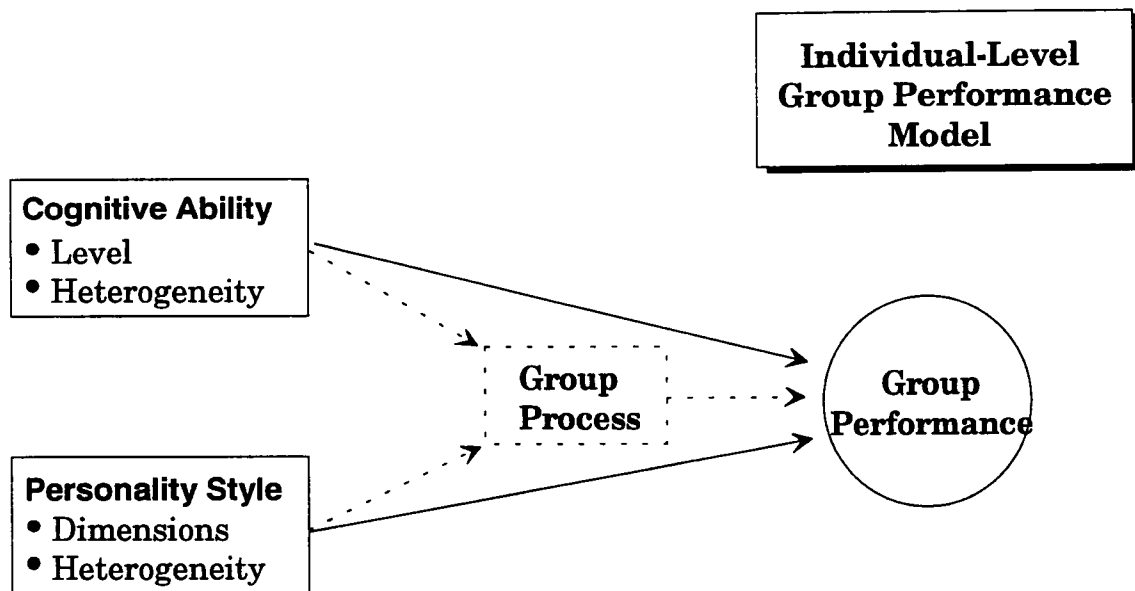


Figure 2. Individual-Level Model of Group Performance

boxes show implied indirect effects of cognitive ability and personality on performance through process. As the design of this research does not allow for explicit measure of process, the focus will be on the direct relationship between of cognitive ability, MBTI preferences, and group performance.

CHAPTER II

REVIEW OF LITERATURE

This research draws on several bodies of literature concerning a) the relationship between cognitive ability measures and performance of individuals and groups, b) personality measures and their relationship to individual and group performance; and c) research on the Myers-Briggs Type Indicator.

This chapter concludes with the development and specification of the hypotheses for this research.

Cognitive Ability

Cognitive ability tests are generally regarded as the single best predictors of job performance for individuals across a variety of selection situations (Hunter & Hunter 1984; Reilly & Chao, 1982; Ghiselli, 1973) although a meta-analysis by Schmitt, Gooding, Noe & Kirsch (1984) suggests that assessment centers, work samples and supervisor/peer evaluations may be equally valid. Little research has specifically addressed the effectiveness of cognitive ability tests as a selection tool for members of a work team. It should not be assumed that tests that accurately predict the performance of individuals working alone are equally valid predictors of the performance of individuals who must work in semi-autonomous teams; several alternative scenarios are possible. One is that when required to perform collaborative

tasks, communication, personality factors, and other people-relations skills might be more important than cognitive ability , or attenuate the relationship between cognitive ability and performance. Another possibility is that the relationship between *number* of high-ability team members and performance is not linear; the literature on conformity and minority influence suggests several reasons for this . A single high ability member in an otherwise dull group might be unable to influence the group as effectively as two high ability members (Nemeth, 1979), particularly if the single high ability member is not more vocal than the rest of the team (Thomas & Fink, 1961). From the perspective of conformity research, a minority of high ability members might be willing to "go along" with the majority of the group even if they realize that the method they are using for performing the task is less than optimal (Asch, 1956). There might be also be some type of ceiling effect on the performance criteria such that only one or two high-ability persons are required to make the group function effectively, with additional high-ability members failing to add effectiveness incrementally. A third possibility is that groups composed of members uniformly high in ability might experience a type of synergistic bonus (Hall & Watson, 1971), where the group's performance might be greater than would be predicted on the basis of individual scores.

Early reviews of the literature suggested that the abilities of group members tend to be positively related to group productivity, although observed correlations between averaged or summated group ability and the group's production have tended to be rather small (Mann, 1959). O'Brien & Owens (1969) suggested that a reason for the low magnitude of these

correlations might be the researchers' neglect to consider the organizational structure used by members to perform the group's task. Specifically, they hypothesized that for *collaborative* task organizations (where members cooperate with one another throughout the entire task, as in most types of discussion and problem solving tasks), that member ability would be less important than in *coordination* tasks, where different tasks are allocated to different positions, and sequencing is required. On coordination-heavy tasks they suggest that all members have an opportunity to contribute to their portion of the task, and are in fact *required* to contribute. Coordination tasks have been infrequently studied in group research (O'Brien & Owens, 1969), but are quite common in manufacturing situations. The results of their research study clearly supported their hypotheses: For tasks which require a high degree of collaboration, the correlation between member ability and group performance was near zero; members were apparently unable to contribute to the outcome of the task relative to their ability. The researchers suggest that this occurs because the high degree of interaction required prevents the group from organizing member's contributions in a systematic fashion. On coordination tasks, however, the summed abilities of individual comprising the teams correlated strongly ($r=.52$) with group productivity. Further, the groups which used a coordination structure to perform the task were more productive than groups which used a collaboration structure. A similar pattern of findings was obtained by Kabanoff and O'Brien (1979), where again the correlation between member ability and group production relationship was moderated by whether the task required coordination or collaboration.

A second question addresses the relationship between heterogeneity of cognitive ability and group performance: Does the variability among group members with respect to their levels of cognitive ability bear a relationship to performance?. This has also been previously researched (Goldman, 1965; Johnson and Torcivia, 1967; Laughlin and Johnson, 1966), but with questionable methodology: These studies used "groups" consisting of only two individuals who were combined based on their performance on an intelligence test. The criterion was performance on another intelligence test (or an alternate form of the same test). The studies generally found a positive relationship between heterogeneity of ability and performance, although the research design leaves doubts about the generalizability of their results. Sorenson (1973) in a laboratory study of 16 three-man groups found that groups with all three members high on measures of both social differentiation and remote associates proficiency performed as poorly in a creative writing experiment as groups where all three members were low on both of these cognitive measures. Groups composed of members which were high on only *one* of the two dimensions were superior performers. Analysis of the behaviors exhibited in these groups over time in this study revealed that the groups with members who were high on both dimensions spend much more time performing *evaluating* behaviors (comparing two or more ideas, requesting clarification, criticizing), and not as much time on *elaborating* (explaining previously offered informations, recalling and adding to previous points). These results suggest a positive relationship between heterogeneity of cognitive ability and group performance, but given the very small sample size (only 4 groups of each type), should be viewed with caution.

Tziner and Eden (1985) in a two-month study of 208 highly interdependent tank crews found that crews with members uniformly high in ability performed better than would be expected solely on the basis of the ability levels of the individuals, while performance for groups of uniformly low ability was below the expected level. This study suggests that homogeneity of ability is beneficial, but only if the *level* of cognitive ability is high.

In summary, *level* of cognitive ability appears to be positively related to group performance, at least where tasks are of the cooperative type. There is no consistent relationship between heterogeneity of cognitive ability and group performance.

Personality Style

Another factor potentially important to group performance is the composition of a group in terms of the personality of its members. Many anecdotes from athletic teams and organizational settings describe persons, who, while talented or bright, were unable to "fit in" or contribute as a "team player." Cattell (1951) stated that the mean level of any of several personality factors in a group "should enable one to predict the syntality, that is to say the performance, of the group, in any one of a number of fields." (p. 166). Mann (1959), in a comprehensive review of the literature on personality and behavior in small groups, found several personality factors to be related to behavior, although the studies reviewed focused only on behaviors exhibited by individuals in groups, and not on the performance of

the group itself. Many researchers seem to believe that personality accounts for some of the variation between individual attributes and team performance (Driskell, Hogan & Salas, 1988), although the research history to date does not suggest much support for this belief.

From a scientific perspective, personality may be defined in many different ways. Jeanneret and Silzer (1990) suggest that within psychology, 4 viewpoints may be taken in the study of personality. These are: 1) *Biological* - personality results from evolution, genetics, and early life experience; 2) *Experimental* - personality should be studied in terms of learning, perception, and higher cognitive processes; 3) *Social* - personality can be best understood in terms of social context: Models, cultural roles, and cultures themselves; and 4) *Psychometric-Trait* - personality should be studied in terms of attributes which presumably reflect underlying traits.

The Psychometric-Trait viewpoint model generally guides research in Industrial/Organizational (I/O) psychology. From the perspective of an I/O psychologist, personality assessments are performed with the intention of measuring traits which may be relevant to successful job performance. The Psychometric-Trait perspective favors objective, self-report inventories. These tests are generally paper-and-pencil tests which have limited, structured response items (agree-disagree, paired-choice, true-false, etc.), and they yield raw scores which are typically converted to some type of normal/standard score. Most tests are multi-dimensional, and thus also yield a "profile" of how the individual scored across all the dimensions.

The construction of most personality instruments is more empirical than rational. Generally, hundreds of items are constructed and evaluated

~~subjects.~~ The data are then subjected to exploratory factor
~~The researcher is then left to observe the types of items~~
~~and name the personality factor based on the nature of~~
~~tion is the Myers-Briggs Type indicator which was~~
~~to measure psychological "types."~~ These psychological
~~the theory of Jung (1921/1971).~~

~~st personality instruments was~~ Woodworth's Personal
~~as used during World War I to screen neurotic and~~
~~ners.~~ Following WWI, other personality instruments,
~~MPI,~~ were developed primarily for the purpose of
~~ally disturbed individuals, although some of these~~
~~aidated in industrial settings with inconclusive results.~~
~~ality tests have been developed which are normed on~~
~~tions.~~ Some of the more popular of these are the
~~ical Inventory, the 16PF, the Guilford-Zimmerman~~
~~ey, and the Myers-Briggs Type Indicator.~~ These
~~several common characteristics: they are~~
~~aper-and-pencil tests, and they yield "profiles" which can~~
~~inations with a large norming base.~~

~~personality assessments to predict performance of~~
~~a complex and controversial topic (Gatewood and Feild,~~
~~in resources practitioners utilize personality instruments~~
~~selection, team development, and career counseling~~
~~is little objective, published evidence to justify their use.~~
~~mployee selection literature suggest that validities of~~

personality instruments are at best, very modest and situationally specific (Guion & Gottier, 1966). Schmitt, Gooding, Noe & Kirsch (1984) performed a meta-analytic review of the selection literature, and report a corrected average correlation between personality and various performance criteria of only .149.

Personality and Group Performance

If personality is related to performance, this relationship may have its largest effect when tasks are performed by groups. If an individual works alone at a task, it may not make much difference whether he is friendly/unfriendly, dominant/submissive, or adjusted/neurotic, etc. In situations where the individual must work with others to accomplish a task, however, these factors could have a significant impact on the ability of the group's members to get along with one another, communicate, and possibly, to perform effectively.

There are three principal mechanisms by which the personality of individuals can impact the performance of a group (Mann, 1959). The first mechanism is motivational; the individual may be fulfilling some *need* by interacting with others, and this need may influence the individual's behavior in the group. The second mechanism is that the individual may serve as a *stimulus* object for the other members of the group, and the perception of the individual by others assumes primary importance; the individual might be perceived having traits of a leader, inspiring others to greatness, or as a nuisance, inspiring others to ignore him or her. The third

mechanism considers the group as a system, and focuses on the personality characteristics of the individuals composing the group and how those individual characteristics influence the processes adopted by the group's members in structuring and performing their task.

At least two properties of personality measures may be addressed in terms of their relationship to group performance. First, the level or amount of any personality factor may be correlated with outcome measures. For example, one can hypothesize that it is better for a group to have a large amount of "extraversion", and a very little "neuroticism" present in order to perform well. This aspect of personality has received very little research attention.

Variations in the *combinations* of personalities (heterogeneity) in teams may also be related to group performance, although the exact nature of this relationship is difficult to assess. One could hypothesize that groups might perform best when team members have similar personalities, because this might improve communication and minimize conflict. Equally plausible is the hypothesis that having a variety of personalities is better because several "styles" of approaching problems is present. A third possibility is that the relationship between heterogeneity of personality and performance is moderated by the type of task. If the group's task is to glue flowers on a parade float, it may be beneficial to have homogeneous personalities which might help maintain a harmonious atmosphere. However, if the group's task is to make a decision about whether or not to close a manufacturing plant in a small town during an economic recession, it might be better to have a

variety of personalities present which could ensure that all implications resulting from the decision are considered before it is made.

Previous research on the heterogeneity of personality composition of groups has yielded mixed results. Several early group researchers used the Fundamental Interpersonal Relationship Orientation-Behavior (FIRO-B) instrument, and created homogeneous or heterogeneous groups. Moos and Speisman (1962) found homogeneous groups better at solving puzzles than heterogeneous groups. In a similarly designed study, Hewett, O'Brien and Hornik (1974) found homogeneous groups to be superior at atom-model building. In a longer-term study (several weeks), Shalinsky (1969) found homogeneous groups of boys at summer camp to be superior at building kits and camp sing-outs than groups composed of heterogeneous boys.

Other research, however, has found heterogeneous groups to be superior performers. Using teams of computer systems analysts as subjects, Hill (1975) found heterogeneous groups more productive than homogeneous groups. Using the Guilford-Zimmerman Temperament Survey, Hoffman and Maier (1961) found that heterogeneous groups were better at most types of problem solving tasks than homogeneous groups.

More recently, Driskell, Hogan and Salas (1988) have reviewed the research on the relationship between personality and group performance, and suggest three reasons why little conclusive evidence exists between personality and group performance. First, most instruments emphasize a psychopathological view of personality, and that the mere absence of psychopathology is not necessarily predictive of performance. It could be argued that in populations of normal subjects, measures of psychopathology

should be low in magnitude with little variability. This range restriction would result in a significant lack of explanatory power. Second, personality research has suffered from poor and varied operational definitions of personality. Literally hundreds of instruments measuring thousands of personality traits have been used in group research, which means that either the number of personality traits is too large to be of any use, or that there is a tremendous amount of overlap in the definition of a relatively small set of traits. As an illustration of this problem, in Mann's (1959) review, he found the field of personality assessment to be "test rich and integration poor" (p. 242). More than 500 different measures of personality measure were used with labels ranging from "oral sadism" to "cyclothymia." From these 500 variables, he was able to reduce the number of factors to seven which seemed to occur in most instruments.

Finally, research on personality effects in groups have generally ignored the role of task. While this seems an obvious requirement, most previous research has failed to specify the group's task, instead seeking a very general model of group performance applicable across tasks (Morris, 1966).

This study attempted to avoid these pitfalls by using an instrument (MBTI) which is designed to measure aspects of personality for normal subjects, as opposed to detecting psychopathology. All hypotheses relative to personality were specifically formed using the concepts and terms of this instrument, thus avoiding references to "personality" in a general sense. Finally, the hypotheses made predictions relative to specific aspects of team performance on a single task.

The Myers-Briggs Type Indicator

Given the empirical nature of most personality instruments, the general lack of agreement among researchers about the both the definition and number of factors that compose personality, and the proper method by which personality should be measured, a reasonable approach is to choose a specific instrument, and adopt its terms and concepts prior to hypothesizing relationships between personality and other measures. The personality instrument chosen for this research was the Myers-Briggs Type Indicator.

The Myers-Briggs Type Indicator (MBTI) is an instrument adapted from Jung's theory of psychological types (Jung, 1921/1971). Jung's theory is based on the assumption that individuals can be identified by inborn personality types. These types are characterized by a predisposition to use certain mental functions or processes. He calls these orienting functions, and states that they represent an individual's orientation to consciousness. He defines a function as "a particular form of psychic activity that remains the same in principle under varying conditions" (Jung, 1921/1971, p. 436).

The MBTI consists of four bipolar scales of the functions Extraversion-Introversion, Sensing-Intuition, Thinking-Feeling, and Judging-Perceiving. In the descriptions below, the each dimension will be defined in its most general form as presented in the MBTI manual (Myers and McCaulley, 1985), or Hirsh and Kummerow (1989). These general descriptions are followed by a description how that dimension is related to other published scales, and brief description of other measures related to the dimension.

relationships between interviewers descriptions of persons and their types will be presented followed by any behavioral evidence relative to that dimension. This information comes from Thorne and Gough (1991), who compiled MBTI research which includes correlations between MBTI scales and three observational instruments: The *Interviewer's Check List* (ICL), the *Adjective Check List* (ACL), and the *California Q-Set* (CQ-Set). Their project is probably the most thorough and current single piece of MBTI research to date, and is particularly useful as much of their data is based on actual behavioral observation.

Attitudes: Extraversion-Introversion (E-I) -- This scale reflects whether the individual prefers to focus on the outer world of people and things (E) or the inner world of ideas and impressions (I). This function is supposedly indicative of the origin of one's stimulation. Persons with the Extraversion preference are most stimulated by the external world of activities, people, and objects. Introverts obtain their energy from within; from ideas, impressions, and emotions (Hirsh & Kummerow, 1989). The U.S. population is estimated to be composed of about 70-75% Extraverts, 25-30% Introverts (Myers & McCaulley, 1985; Hirsh and Kummerow, 1989).

Research evidence comparing performance on the MBTI E-I scale (with Introversion at the high end of the scale) with other personality, cognitive ability, and behavioral measures has yielded some consistent findings. Persons scoring high on Introversion also score high on the MMPI social introversion scale, which is indicative of feelings of social distance, uncertainty about own abilities, and lack of initiative. MBTI introversion

also correlates negatively with the CPI's Sy (Sociability) scale. Persons who score high on Sy are believed self-assured and outgoing. Introversion also appears to be negatively related to masculinity, and personal adjustment.

Results from the observational data show that Introverts were calm and deliberate, had some evidence of weak father/mother dominant background, and a rather high level of anxiety. Extraverts were observed to use hands when talking and display an high level of animation, high levels of self confidence, witty, and possessing effective interpersonal skills. Introverts generally appeared less happy than extraverts. On the ACL, Introverts were most frequently described as aloof, reserved, silent, withdrawn, inhibited, and retiring, while extraverts were described as active cheerful, energetic, jolly, sociable and warm. The CQ-Set items reveal a very similar description (Thorne & Gough, 1991).

Perception: Sensing-Intuition (S-N) -- This scale differentiates between persons who prefer to focus on immediate experience gained from their senses (S), and persons who focus on the future, relying on the use of insight and intuition (N). This scale is supposedly indicative of what people pay attention to and how they collect information. Sensors prefer to focus on facts and rely on directly experienced stimuli. Sensors prefer learning through practice and observation, like to approach things step-by-step, and value things which have immediate and practical applications. Intuitives collect information seemingly at random, frequently experiencing "flashes" of discovery. They prefer to learn by grasping general concepts, and are less concerned with memorizing facts and details. Intuitives focus on what is

possible, and tend to be less interested in information that can be observed directly. Intuitives trust their inspiration and imagination to guide them, and may be annoyed by things that are precise and well defined (Hirsh & Kummerow, 1989). Approximately 70-75% of the U.S. population prefer Sensing, 25-30% prefer Intuition (Myers & McCaulley, 1985; Hirsh & Kummerow, 1989).

Measures that correlate with the S-N dimension (higher numbers at Intuitive end of scale) include a negative correlation with the Obsessional Personality Scale of the *Lazare-Klerman-Armor Inventory* (LKA). On Allport, Vernon, and Lindzey's *Study of Values* (A-V-L) inventory, Intuitives favor esthetic principals while Sensors favor practical and functional values. Similarly, on Hogan's *Survey of Ethical Attitudes*, Sensors favor traditional, practically-evolved ethics, while Intuitives favor less traditional ethics based on personal evolution. Intuitives score higher on the *Adjective Check List's* (ACL) creativity dimension and also score higher on the CPI's flexibility scale. Intuitives also score higher on the LKA's Hysterical Personality Scale, which may indicate a proneness to emotional volatility and corresponding lack of stability (Thorne & Gough, 1991).

Common observations of during interviews showed Sensing types to be well-groomed, simple and direct in expression, and generally appear to have traditional and highly regulated backgrounds. Intuitives appeared more nervous and animated, asked more questions of the interviewers, were more awkward, but used a wider vocabulary than sensors. The CQ-Set item most strongly associated with the Intuition dimension was "Thinks and associates to ideas in unusual ways; has unconventional thought processes" (Thorne &

Gough, 1991, p. 51). Adjectives most frequently used to describe Intuitives were imaginative, ingenious, original, unconventional, and curious. Among Sensors, the modal CQ-Set item was "Favors conservative values in a variety of areas" (Thorne & Gough, 1991, p. 53). The most frequently occurring adjectives were conservative, contented, conventional, interests narrow, stable, and practical.

Judgment: Thinking-Feeling (T-F) -- This scale differentiates between persons who make decisions based on logic, facts, and objective analysis (T), and persons who make decisions bases on subjective values and person-centered concerns (F). This function is supposedly indicative of how a person makes decisions. When making decisions, the Thinker seeks truth, while the Feeler seeks agreement. When evaluating information, Thinkers are tend to be skeptical and questioning, while Feelers tend to believe what they are evaluating. Thinkers evaluate relationships in terms of their purpose, while Feelers see relationships as an end in themselves. Thinkers believe truth is more important than tact; Feelers believe the opposite. To others, Thinkers may appear cold and tough-minded, while Feelers are likely seen as warm and soft-hearted (Hirsh and Kummerow, 1989). In the U.S., 60-67% of the male population are Thinkers, 33-40% Feelers. Females show the opposite distribution; about 67% prefer Feeling, and 33% prefer Thinking (Myers & McCaulley, 1985; Hirsh & Kummerow, 1989).

This dimension (with Feeling at the high end of the scale) of the MBTI is negatively related to the A-V-L's Theoretical and Economic values scales, which supports the idea that Feelers base their decisions on something other

than analytic and pragmatic values. Feeling is also negatively related to Masculinity as measured in Bem's *Sex Role Inventory* and the F+ scale on the *Personal Attributes Questionnaire* (PAQ).

In the interview situations, Thinkers seemed to put great emphasis on achievement and used words effectively but economically. Feeling males made considerable use of hands while talking, seemed hostile to interviewer, and appeared to be dissatisfied with life. Feeling females were perceived as attractive, were happy, and had good interpersonal effectiveness. Similarly, the top QC-set item for males was "Is facially and/or gesturally expressive" (Thorne & Gough, 1991, p. 53). The adjectives most frequently used were affectionate, artistic, complicated, despondent, and weak. For females, the top QC-set item was "Behaves in a giving way toward others" (Thorne & Gough, 1991, p. 54), and the most frequently used adjectives were affectionate, appreciative, considerate, feminine, and friendly.

For Thinking males, the top QC-Set item was "Favors conservative values in a variety of areas" (Thorne & Gough, 1991, p. 54), and the most frequent adjectives were ambitious, conservative, conventional, efficient, and logical. For Thinking females, the top QC-Set item was "Is critical, skeptical, not easily impressed" (Thorne & Gough, 1991, p. 55). Top adjectives included aggressive, aloof, ambitious, and autocratic.

Style of dealing with the outside world: Judgment-Perception (J-P) --
This dimension is primarily the work of Myers and Briggs, and not Jung. Persons who score toward the "J" end of the scale are said to prefer to use a judgment process (T or F) for dealing with the world, and also tend to be

planned and organized. Persons scoring toward the "P" end prefer to use a perceptive process (S or N), and prefer a flexible, spontaneous lifestyle. This function supposedly indicates the type of lifestyle a person adopts. Judgers prefer to have their life organized and structured, whereas Perceivers arrange their lives so that they can experience whatever comes along. Judgers dislike ambiguity, do not like leaving things "in the air", get satisfaction from completing tasks, and want their lives to be purposeful. Perceivers are more tolerant of ambiguity, may dislike making decisions, prefer starting new projects to finishing current ones, are tolerant and adaptive, and may prefer having a wide variety of experiences. The U.S. population is composed of 55-60% Judgers and 40-45% Perceivers (Myers & McCaulley, 1985; Hirsh & Kummerow, 1989).

Other scales which correlate with the J-P dimension (with P at the high end of the scale) include a positive relationship with Sensation-Seeking, a negative relationship with the LKA Obsessive Personality Scale, and a positive relationship to the CPI Flexibility scale. Thus, other instruments suggest that Perceiving types indeed are likely to be rather informal, and more likely to be resistant to precise planning as compared to Judging types.

The interviews revealed Judging types to be well-groomed and well-dressed, had church-going parents, were successful in high school, and have a stable optimistic view of the future. Perceiving types were more likely to use their hands when talking, appeared unkempt or poorly groomed, and were generally unhappy at school and home during high school. The top QC-Set item for males was "Is unpredictable and changeable in behavior and attitudes" (Thorne & Gough, 1991, p. 55). The adjectives most frequently

used to describe Perceivers were artistic, careless, changeable, and cynical. The top 2 QC-set items for Judging types was "Is a genuinely dependable and responsible person", and "Is fastidious" (Thorne & Gough, 1991, p. 55). Adjectives used were conscientious, conservative, conventional, deliberate, and industrious.

The MBTI uses a rather elaborate scoring technique to arrive at the four dimensions and their associated preference scores. This scoring method is presented in Appendix A.

Use of the MBTI is widespread and rapidly growing, particularly in corporate America. It is regularly used by such companies as Apple, AT&T, Citicorp, Exxon, GE, Honeywell, and 3M (Moore & Woods, 1987; Bayne, 1990), primarily by career counselors and organizational development consultants. There are many reasons for the MBTI's appeal. First, the instrument is relatively brief. The standard Form (G) has 126 forced-choice items, and takes about 30 minutes to complete; a shorter self-scoring form is also available. Relative to other personality inventories, the MBTI is a "user friendly" test; the items are non-threatening and do not have clinical overtones. The items primarily require the user to choose between two terms or express a preference between two everyday activities. Third, the MBTI is relatively easy to score and interpret. Each of the 16 "types", and each of the types receives a verbal description which tends to emphasize the alleged strengths of that type, and mention little about its potential shortcomings. While the publisher requires that the MBTI administrator be qualified in the use of the instrument, the instrument is relatively simple to administer and understand. It requires much less effort and skill to interpret and provide

feedback on the MBTI than for other personality instruments such as 16PF, MMPI or CPI. These factors give the MBTI wide appeal to organizational development professionals.

In addition to its use in corporate settings, the MBTI has recently received much research attention spanning a wide variety of topics. For example, Rice & Lindecamp (1989) used the MBTI to predict business success of small retailers, but found no differences. Shiftlett (1989) used the MBTI to predict brain hemisphere dominance, concluding that the S-N and J-P scales were indicative of hemisphere dominance. Thorne, Fyfe, and Carskadon (1987) examined MBTI scores of coronary heart disease patients, and found that Sensing types were overrepresented in the sample. Harris and Lester (1986) found Intuiting and Perceiving types (among groups of college undergraduates) more likely to use marijuana. Franzoi (1985) examined the personality characteristics of the cross-country hitchhiker, finding N and F types more likely to exhibit this nomadic behavior. Schurr, Ruble, Nisbet, and Wallace (1984), examined "more and less successful" college football players based on the position they play, and their MBTI types. They found that the best lineman were "sensors", the best running backs were "intuitives", and that the best defensive backs were more likely to be "introverts". Marcic, Aiuppa and Watson (1989) found that persons who were more similar to other members of their work group in terms of MBTI profiles had higher self-esteem and longer tenure than persons who were less similar in type.

Despite its popularity and commercial success, the MBTI has been less appealing to academic researchers of personality. Personality psychologists

may avoid the research with the MBTI for a variety of reasons. Since the MBTI is an explicitly "typological" theory; its theoretical base does not predict relationships based on continuous scale scores as do most other instruments. Instead, it specifies that each of the 16 types is unique; for example, an ENTP is predicted to differ from an ENTJ in more ways than P differs from J. Extensive analysis of the instrument by Stricker and Ross (1964) led to criticisms of both the scales and the underlying concepts. Typological theories in general are troublesome in terms of psychometrics (Mendelsohn, Weiss, & Feimer, 1982), and more recent empirical analysis has not strongly supported the typological model, although Hicks (1984), found that the S-N scale predicted self reported bookishness in a discontinuous fashion (i.e., the regression slope was different for each of the types with a sharp discontinuity at the scale's midpoint). Myers & McCaulley (1985) admit that this midpoint discontinuity is subtle, and suggest that sample sizes of 4,000-5,000 are needed to ensure adequate statistical power.

The majority of researchers who use the MBTI report continuous scale scores in their analysis rather than of the "types" (Hicks, 1984), although this could be a matter of convenience, as analyzing the MBTI in terms of "types" requires hypothesis building around complex contingency tables. If the researcher assumes that each of the 16 types is unique, analyzing the results requires interpretation of 2, 3, and 4-way interactions. McCrae & Costa (1989) have reinterpreted the MBTI in terms of what has recently been called the "Five-Factor" personality model (Digman & Inouye, 1986), finding that the scales of the MBTI acceptably measure four of the five factors: E-I

measures "Extraversion"; S-N measures "Openness to experience"; T-F measures "Agreeableness"; and J-P measures "Conscientiousness". The fifth factor, not measured by the MBTI, is "Neuroticism".

Hypotheses and Rationale

This research treated the MBTI as four independent, continuous-score scales: Introversion, Intuition, Feeling, and Perceiving. Previous analysis has supported this approach, even though the MBTI is explicitly constructed to measure a "types". The instrument has been shown to measure four relatively independent continuous factors (McCrae & Costa, 1989).

The cognitive ability measures (which will be described in detail in the next chapter) were the Industrial Reading Test (IRT) and the Numerical Ability, Mechanical Reasoning, and Space Relations subscales from the Differential Aptitude Test (DAT).

While the principal focus of this research was to measure the relationship between individual measures and group performance, several hypotheses were generated at the individual level of analysis. These levels of hypotheses focused on different factors. The first objective (at the group level of analysis) was to examine how cognitive ability and MBTI-scale scores were related to group performance. This was done by using aggregated individual measures and testing their relationship to the quantity and quality of the *group's* output.

At the individual level, MBTI-scale scores and cognitive ability measures were examined in relation to ratings of effectiveness exhibited in the same group performance exercise.

Group-Level Hypotheses: Figure 3 shows the group level variables and their hypothesized relationships.

Hypothesis 1: Group cognitive ability level is positively related to group production.

Cognitive ability is often best predictor of performance for individuals. Previous research (Haythorn, 1968; O'Brien & Owens, 1969; Kabanoff & O'Brien, 1979) has suggested that this relationship exists, although perhaps in a weakened form, for group tasks as well. Driskell, Hogan & Salas (1988) disagree with this statement, and hypothesize that task type moderates this relationship, and state that on a mechanical/technical task, such as this, there should be no discernable relationship between "intellectance" (p. 104) and performance. As this task was more of the cooperative type (O'Brien & Owens, 1969) which allowed the group a considerable amount of flexibility in designing and sequencing their assignments, it was believed that the team's members would be able to take full advantage of their cognitive ability in performing this exercise, and that groups with high levels of ability would perform the task better than groups low in ability.

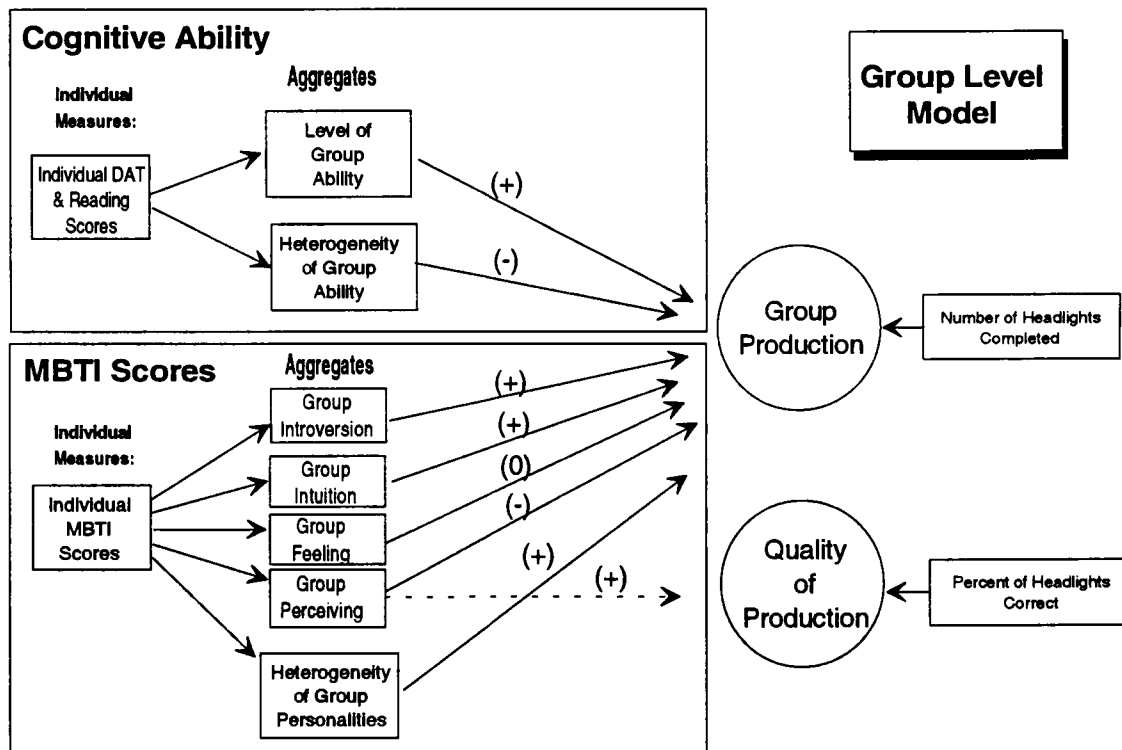


Figure 3. Summary of Hypothesized Relationships among Group-Level Variables in the Study

Hypothesis 2: Heterogeneity of cognitive ability is negatively related to group production.

While level of ability present in the group may be the most important component of performance, uniformity of ability may also be desirable (Tziner & Eden, 1985). Groups composed of members of widely varying intellectual aptitude may suffer from a variety of language problems and other communication difficulties which could result in poor or inappropriate task structuring and an increase in the amount of time spend planning the task.

Hypothesis 3: Group "Introversion" is positively correlated with group production.

Driskell, Hogan, and Salas (1988) suggest that "Sociability will be positively related to performance on imaginative/aesthetic and social tasks, but negatively related to performance on mechanical/technical and logical/precision tasks" (p. 106). Sociability, by their definition, is very similar to the extraversion/introversion scale of the MBTI. The reason for the predicted negative relationship is that group members high on Extraversion are more likely to engage in affiliative behaviors than are Introverts. While this may increase the group's satisfaction level, and also increase assessment ratings, this affiliative behavior takes time, and is

predicted to interrupt the flow of the group's task. Put simply, groups high on Introversion will spend more time assembling headlamps and less time talking.

Hypothesis 4: Group "Intuition" is positively correlated with group production.

Intuitive types are hypothesized to be more creative and systems-oriented than their Sensing counterparts. While the groups high on Sensing are likely to begin work more quickly and work more steadily than Intuitive groups, groups high on Intuition are predicted to overcome this by utilizing their creativity to develop more effective production systems which will allow them to produce more output.

Hypothesis 5a: Group "Perceiving" is negatively related to group production.

Judging persons are hypothesized to be planned, organized and efficient. As this is a fairly complex, timed task, groups high on this dimension were predicted to develop efficient processes and to waste little time. Groups high on perceiving were expected to spend much more time on the planning portion, collecting data and evaluating alternatives method before actually starting to build headlights.

Hypothesis 5b: Group "Perceiving" is positively correlated with quality of group production.

While groups high on the Judging dimension were predicted to be more productive than groups high on Perceiving, Judging groups were also expected to rush toward closure on these tasks, while Perceiving groups would be spend more time and effort in evaluating their products before pronouncing them finished. Because of the Judgers' propensity to rush toward closure, Perceiving groups were expected to be more likely to spot defects in production and produce higher quality work.

Hypothesis 6: Heterogeneity of group personalities is positively related to group production.

As stated earlier, previous research on this question has yielded mixed results. This research was been done primarily using children and college students as subjects and performance on trivial tasks as the criteria. The task in this research is complex, and combines elements of problem solving, communication and cooperation. Given the variety of demands of the task, heterogeneity of personality profiles was expected to be an asset because it would provide the group with a variety of styles with which to approach the problems encountered by the group.

Individual-Level Hypotheses: Figure 4 shows the individual-level variables and their hypothesized relationships.

Hypothesis 7: Cognitive ability is positively related to ratings of team skills behavior.

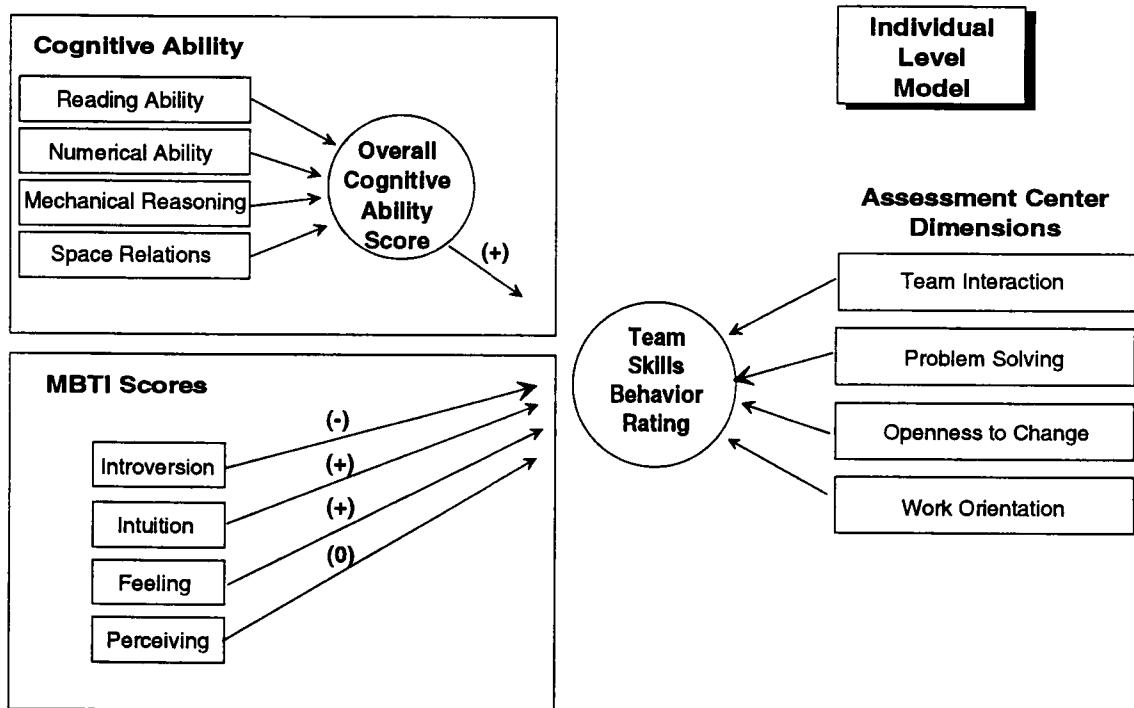


Figure 4. Summary of Hypothesized Relationships among Individual-Level Variables in the Study

This assessment center exercise requires a variety of skills, among them the ability to read and understand instructions, the ability to analyze and solve problems. Persons of higher cognitive ability are more likely to exhibit these behaviors effectively. Results of previous research has supported this hypothesis. Crawley, Pinder, & Herriot (1990), in correlating 4 different aptitude measures with 9 assessment center dimensions found significant, positive correlations in 31 of the 36 cells.

Hypothesis 8: "Introversion" preference is negatively related to ratings of team skills behavior.

Assessment center exercises reward interactive, communicative behaviors. Extraverts seen as are more likely to exhibit communicative and affiliative behaviors than introverts. This individual-level hypothesis contrasts with group-level hypothesis 3. If the data support both hypotheses 3 and 8, it means that persons receive higher scores for performing behaviors that actually serve to inhibit the group's performance.

Hypothesis 9: "Intuition" preference is positively related to ratings of team skills behavior.

High ratings in this exercise, particularly on the dimension of problem solving, depends on exhibiting behaviors such as building on the ideas of others, offering ideas, and recognizing both symptoms and causes of problems. Persons with an "N" orientation utilize insight, imagination, and

creativity to a greater degree than persons with an "S" orientation, who were expected to be content to simply continue to use the original headlamp assembly system rather than analyze that system's problems and reorganize the task accordingly. The "N" approach to problem solving was expected to produce more of the rewarded behaviors than the "S" approach.

Hypothesis 10: "Feeling" preference is positively related to ratings of team skills behavior.

High ratings on team skills behavior, particularly on the "Team Interaction" dimension depended on exhibiting behaviors such as helping other members, checking for group agreement, and encouraging others to contribute their ideas and suggestions. The "F" orientation, with its warmth and affiliative nature was hypothesized to be more likely to yield these types of behaviors than persons with the "T" orientation, with its primary function being judgment according to impersonal logic. The "T" orientation was expected to yield more of the types of behaviors that receive low ratings, such as tactlessness when disagreeing with others and openly showing impatience.

Table 1 summarizes the hypotheses in the study.

Table 1. Summary of Hypotheses

- 1: Group cognitive ability level is positively related to group production.
 - 2: Heterogeneity of cognitive ability is negatively related to group production.
 - 3: Group "Introversion" is positively correlated with group production.
 - 4: Group "Intuition" is positively correlated with group production.
 - 5a: Group "Perceiving" is negatively related to group production.
 - 5b: Group "Perceiving" is positively correlated with quality of group production.
 - 6: Heterogeneity of group personalities is positively related to group production.
 - 7: Cognitive ability is positively related to ratings of team skills behavior.
 - 8: "Introversion" is negatively related to ratings of team skills behavior.
 - 9: "Intuition" is positively related to ratings of team skills behavior.
 - 10: "Feeling" is positively related to ratings of team skills behavior.
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CHAPTER III

METHOD

Design

The general design of this research was to examine relationships between selection measures and the performance of groups in the context of a pre-existing team skills exercise. The MBTI was completed on the evening the candidates arrived at the test site. The following morning, the candidates completed the cognitive ability test battery, took a break, then participated in the assessment center exercises.

Participants

The participants in this study were 579 candidates competing for positions at a new manufacturing facility in the southeastern United States as members of 10-20 member semi-autonomous work teams. All candidates were in this occupation. The majority (85%) of the positions were for specific jobs within the Operating Technician classification, which has direct responsibility for performing the production tasks. The second class of jobs was that of skilled trades. These positions were to be filled by journeyman tradesmen, such as Tool and Die Makers, Electricians, Pipefitters, Machine Repair technicians, etc. These tradesmen provide technical support and resources for the Operating Technicians; they do not actually perform direct

production tasks. Of the 579 participants, 441 (76%) were male, and 425 (73%) were Caucasian.

Of these 579 individuals, enough complete information was obtained to compose 118 4-person groups. Information for the remaining 107 individuals was excluded from the group-level analysis because either complete information was unavailable for the group or the because the group exercise was run with less than four persons. For individual-level analyses, $n=579$; for the group analyses, $n=118$.

Measures

Myers-Briggs Type Indicator - The MBTI was given to all candidates who participated in the assessment process. They were told that this instrument was for research purposes only, and would have no impact on whether or not they would be hired. They were instructed that although this information was regarded by the organization as important, that if they chose not to complete it, it would not impact their chances of being hired. Specifically, the candidates were told that the general design of the research was to predict *group* performance, and that when one person did not fill out the form, data for the entire group had to be excluded from the research. More than 95% of the candidates completed the MBTI.

The MBTI's standard scoring sheets were not used because they contained questions about the candidate's current employment status and also contained one question which asked whether or not the respondent liked their current job (this item might have lessened their belief that the MBTI

would not be used in the selection decision), and also because the standard scoring sheets contained no space for the candidates' social security number, which was needed in order to link MBTI results to the candidates' cognitive ability scores and other demographic data. The individual item responses were entered into a computer, checked for errors, and the edited responses scored by a computer program.

Continuous MBTI scores were computed according the procedure recommended in the MBTI technical manual (Myers & McCaulley, 1985). This method expresses the score as a continuous score with a midpoint arbitrarily set at 100. If the type is E, S, T, or J, the preference score is subtracted from 100. If the type is I, N, F, or P, the preference score is added to 100. This yields four continuous scale scores, with higher scores representing Introversion, Intuition, Feeling, and Perceiving.

Five group-level MBTI scores were computed for the analyses. First, the MBTI was considered as four independent, continuous scales: Introversion, Intuition, Feeling, and Perceiving. The mean dimension score across all persons on each team yielded the group's dimension score. The scoring method is explained in detail in Appendix A.

The fifth personality measure was the heterogeneity of the composition of the group. This was computed using the distance measure $\underline{D}$ (Osgood & Suci, 1952; Cronbach & Gleser, 1953). The $\underline{D}$ statistic is used to measure profile similarity. It is the generalized Pythagorean theorem measuring the distance between all possible points in euclidean space. If group was composed of four persons with identical scores on every dimension, $\underline{D}$ would be zero. The more the members differ in terms of the four MBTI dimensions,

the larger D becomes. This statistic is recommended by Nunnally (1978) for all problems which involve the analysis of profiles.

Cognitive Ability - All subjects completed a test battery composed of the Industrial Reading Test (Forms A and B, The Psychological Corporation, 1978), and the subscales Numerical Ability, Mechanical Reasoning, and Space Relations from the Differential Aptitude Test (Forms V and W, The Psychological Corporation, 1982).

The Industrial Reading Test (IRT) is a measure of reading ability which was developed for use in industrial and vocational education. Both forms of the IRT consist of 9 text passages and a total of 38 multiple-choice items. The passages of text relate to industrial settings, utilizing topics such as first aid, safety, the metric system, and blueprint reading. It is designed for subjects with the reading ability of the typical vocational high school student or adult with a high school education (The Psychological Corporation, 1978).

The Numerical Ability subtest of the Differential Aptitude Test (DAT) is designed to test understanding of numerical relationships and numerical concepts. It contains items that are computational in nature, as well as items that tap conceptual issues, although there are more of the former type. Each form of the test contains 40 multiple choice items.

The Mechanical Reasoning subtest presents pictures of mechanical situations along with a simply worded question about the function or behavior of that device. Each form of the test contains 70 multiple choice items.

The Space Relations subtest requires the respondent to visualize a constructed object from a pattern. It requires the mental manipulation of objects in three-dimensional space. This test has two forms, each containing 60 multiple choice items.

All four tests are timed, multiple choice tests, and were given under the conditions described in their respective technical manuals. This test battery was selected by the organization because it was designed for selecting adult employees for similar jobs, because the dimensions closely matched the what the organization desired to measure, and because the tests are well-established and have a large norming base.

A single group-level cognitive ability score was computed as follows. First, individual composite scores were computed by taking the first standardized principal component from a factor analysis across the four tests. This yielded a single, standardized score for each individual. The mean of these scores across the four individuals in the group yielded the group cognitive ability score.

Heterogeneity of group cognitive ability was obtained by subtracting the group's cognitive ability score from each individual score, and summing the absolute values of the differences (see Appendix A for an example).

Team Skills Ratings - Individual level assessment center ratings were used to test hypotheses 7 through 10. This assessment center exercise was jointly developed by the organization and an external consulting group. These exercises were developed specifically to measure the team skills believed

necessary for optimum performance in semi-autonomous work teams in a manufacturing environment.

This assessment center consisted of two exercises: a 55-minute leaderless group discussion ("Team Meeting") exercise. This exercise was not utilized in the present research. The second exercise was a team work-sample exercise which required the group to assemble headlamps for an automobile. This second exercise provides the setting for this research. It proceeded as follows:

Candidates were brought into the assembly room. This room contained a large table with 4 work stations. The candidates are randomly assigned to a station. The facilitator provides some general instructions (5 minutes maximum), and then tells the candidates that they have 16 minutes to learn the exercise. They are instructed to read a "process sheet" at each station which describes that station's task, and contains a piece of work-in-process. The candidates have four minutes to learn the work of each station, rotating through each station until the 16 minutes are up. During this phase of the exercise, the candidates are allowed to freely discuss the exercise and help each other out, and the facilitator will also provide help by demonstrating the task or answering questions.

When the 16 minute "learning period" ends, the candidates are told that they are to spend the next 15 minutes disassembling any headlights they completed, and that they are free to discuss any changes they would like to make to the process. After this 15 minute period, they had 8 minutes to build headlight assemblies. The number of headlights completed and

number correct are recorded. The candidates then have 20 minutes to tear down the headlights and further discuss the process and its inefficiencies. Following this period the candidates are given 15 minutes to produce headlights. When the time is up, the facilitator stops the group and records the number of headlights complete and the number correct. The candidates are then told to tear down the headlights and return the room to exactly the same condition it was in when they arrived.

Throughout the exercise, two trained assessors are in the room making observations of the behavior of the individuals for the purpose of evaluating the candidates' ability to function as a team member. Each assessor rates each candidate individually on a 1-9 scale using four dimensions: Team Interaction, Problem Solving, Openness to Change, and Work Orientation. Appendix B contains a detailed description of these dimensions, the specific behaviors rated, and the rationale for assigning the 1-9 scores..

The measures used in the analysis were the mean of the two raters on each dimension. Since these four dimensions were highly intercorrelated ($r=.73$ to $.79$), the four dimensions were summed to yield an aggregate measure of the team's skill ratings.

Criteria for group performance - The group's task was to build headlight assemblies for an automobile in the context of the assessment center exercise described in the previous section. The specific criteria were: 1) Group production = Total number of headlights assembled; and 2) Production quality = Percentage of headlights assembled which are free from errors (headlights correct / headlights complete * 100).

Data Analysis

SAS (1985) PROC CLUSTER was used to compute the $\underline{D}$ statistic (Osgood & Suci, 1952; Cronbach & Gleser, 1953) used as a measure of MBTI heterogeneity.

Tests of internal consistency (Coefficient Alpha) were computed to estimate the internal consistency of the cognitive ability measures and the Myers-Briggs Type Indicator. Internal consistency for the MBTI was computed using SAS (Version 6.06) PROC CORR (1990). Internal consistency statistics for the cognitive ability measures were computed using SPSS/PC+ (1988). This software was also used to compute descriptive statistics, correlations and multiple regressions.

Interrater reliability for the assessment center dimension was computed using the intraclass correlation (Ebel, 1951). As available statistical packages were unable to estimate this statistic directly, this was computed using Microsoft Excel (Version 3.0, 1990)

All other analyses (aggregation of individual to group scores, ANOVA's, principal component analyses, and other regression analyses) were performed using JMP (Version 2.0) software for the Apple Macintosh (SAS Institute, 1991).

Descriptive statistics (means, standard deviations, and ranges), correlations among all measures, and the results of multiple regressions are reported.

CHAPTER IV

RESULTS

Results of all data analyses are presented in this chapter. First presented are psychometric properties of the instruments used, followed by descriptive statistics of the measures in the study. Next, the group-level hypotheses are tested, followed by the individual level hypotheses. Finally, the results of several post-hoc analyses are presented.

Estimates of Reliability

Coefficient Alphas were computed for the four cognitive ability tests used. The obtained estimates (presented in Table 2) were well above the generally accepted minimum threshold of .70 (Nunnally, 1978).

Table 2. Coefficient Alpha Scores for Cognitive Ability Tests

Test	Form A	Form B
Industrial Reading Test	.89	.89
Numerical Ability Subtest	.91	.92
Mechanical Reasoning Subtest	.92	.93
Space Relations Subtest	.94	.92

Internal consistency measures for each of the four scales of the MBTI were computed. Items which endorsed a scale were coded 3, items which rejected an item were coded 1, and omitted or unscored items were coded 2. This is consistent with the method utilized in an item analysis of the MBTI by Tzeng, Outcalt, Boyer, Ware, & Landis (1984). The results are presented in Table 3. The coefficients ranged from .71 to .81. The estimates obtained in this sample are consistent with the reliabilities published in the MBTI guide (Myers & McCaulley, 1985), and previous research (Tzeng, et al, 1984).

Previous research has confirmed that the MBTI measures four relatively independent factors (McCrae & Costa, 1989; Johnson & Saunders, 1990). Using the present sample, several exploratory-type factor analyses were performed using Maximum Likelihood and Principal Components extractions, and various rotations including Varimax, Quartimax, and Harris-Kaiser Ortho-Oblique methods with the solution constrained to four factors. The observed factor pattern was exactly what would be expected: In each case, four clear, relatively independent factors emerged, with items loading on the correct scales almost exactly as specified by the instrument with the exception of a few items from the Perceiving scale which preferred to load on the Intuition scale.

Interrater reliability estimates for the assessment center dimensions are presented in Table 4. The first set of estimates is computed using an intraclass correlation coefficient (Ebel, 1951). The intraclass r is an estimate of the reliability of the *average* rating between the raters. This statistic is most appropriate for this application because it allows the removal of

Table 3. Coefficient Alpha Scores for MBTI scales

Scale	Alpha
Extraversion - Introversion	.78
Sensing - Intuition	.81
Thinking - Feeling	.71
Judging - Perceiving	.77

Table 4. Interrater Reliability Estimates for Assessment Center Dimensions

Dimension	Reliability of Average Ratings (Intraclass <i>r</i>)	Reliability of Individual Ratings (Pearson's <i>r</i>)
Team Interaction	.68	.51
Problem Solving	.69	.52
Openness to Change	.64	.48
Work Orientation	.64	.47
Composite Team Skills Rating	.76	.62

"between raters" variance from the estimate. Since differences *between* raters are not utilized in the selection process, this variation has no meaning for this situation and should be removed. The second set of estimates shows the reliability of the *individual* ratings. This estimate includes the between-raters variation and is computationally identical to a Pearson's r between the first and second raters. The intraclass r 's for the individual dimensions ranged from .64 -.69, which are slightly below the traditionally accepted lower bound for reliability of .70. The reliability of the composite score, however, was acceptable at .76. All hypotheses in the study were based on the composite team skills rating.

Descriptive Statistics

Descriptive statistics for group-level variables in the study are presented in Table 5. Individual-level statistics are presented in Table 6. Not surprisingly, the means for the measures at the individual and group level are virtually identical. The variation between groups for the aggregated measures is less than at the individual level; for most of the measures the standard deviation for the group level data is approximately half that of the same measure at the individual level.

Table 7 shows the frequencies and percentages of the participants for each of the 16 MBTI types. The distribution of all two-letter type combinations is also shown. The most prevalent single type was Extraverted - Sensing - Thinking - Judging (ESTJ), 43% of the sample. Second-most

Table 5. Descriptive Statistics for Group Level Measures in the Study

Variable	n	Mean	SD	Min.	Max.
Cognitive Ability					
Industrial Reading Test	118	28.2	3.8	14.8	35.3
Numerical Ability	118	19.2	4.6	6.5	30.5
Mechanical Reasoning	118	48.9	6.3	26.5	62.5
Space Relations	118	31.3	6.0	18.3	46.5
Composite Ability	118	0.0	0.9	-2.9	1.8
Heterogeneity of Ability	118	4.8	1.8	1.5	10.8
MBTI Scales					
Introversion	118	86.0	10.7	61.5	118.5
Intuition	118	86.1	11.9	50.5	114.0
Feeling	118	82.7	9.4	61.0	107.0
Perceiving	118	76.9	9.4	60.5	99.0
Heterogeneity of MBTI (D)	118	57.4	13.5	29.1	93.7
Team Skills Ratings					
Team Interaction	118	4.8	0.6	2.9	6.1
Problem Solving	118	4.7	0.7	2.6	6.0
Openness to Change	118	4.9	0.5	3.1	6.1
Work Orientation	118	5.0	0.6	3.1	6.5
Composite Team Skills Rating	118	19.4	2.2	11.9	23.8
Performance					
Headlights Completed	118	10.6	3.08	3.0	19.0
Percent Correct	118	79.3	21.5	0.0	100.0

Table 6. Descriptive Statistics for Individual Level Measures in the Study

Variable	n	Mean	SD	Min.	Max.
Cognitive Ability					
Industrial Reading Test	579	28.3	6.8	0.0	38.0
Numerical Ability	579	19.3	9.4	2.0	40.0
Mechanical Reasoning	579	48.7	12.3	10.0	69.0
Space Relations	579	31.1	11.9	7.0	60.0
Composite Ability Score	579	0.0	1.7	-4.3	3.5
MBTI Scales					
Introversion	579	86.1	21.8	49.0	151.0
Intuition	579	86.8	23.5	37.0	149.0
Feeling	579	83.0	19.0	37.0	137.0
Perceiving	579	77.2	19.8	45.0	151.0
Team Skills Ratings					
Team Interaction	579	4.8	0.9	1.0	9.0
Problem Solving	579	4.6	1.0	1.0	8.5
Openness to Change	579	4.9	0.8	1.0	7.5
Work Orientation	579	5.0	0.9	1.5	9.0
Composite Team Skills Rating	579	19.3	3.2	5.0	33.5

Table 7. MBTI Type Table

ISTJ	ISFJ	INFJ	INTJ
n=76	n=17	n=8	n=13
13.1%	2.9%	1.4%	2.2%
ISTP	ISFP	INFP	INTP
n=11	n=2	n=6	n=8
1.9%	0.3%	1.0%	1.4%
ESTP	ESFP	ENFP	ENTP
n=21	n=6	n=10	n=18
3.6%	1.0%	1.7%	3.1%
ESTJ	ESFJ	ENFJ	ENTJ
n=251	n=42	n=19	n=71
43.4%	7.3%	3.3%	12.3%

E	n=438	76%
I	n=141	24%
S	n=426	74%
N	n=153	26%
T	n=469	81%
F	n=110	19%
J	n=497	86%
P	n=82	14%
EN	n=118	20%
ES	n=320	56%
IN	n=35	6%
IS	n=106	18%
EF	n=77	13%
ET	n=361	62%
IF	n=33	6%
IT	n=108	19%
EJ	n=383	66%
EP	n=55	9%
IJ	n=114	20%
IP	n=27	5%
NF	n=43	43%
NT	n=110	19%
SF	n=67	12%
ST	n=359	62%
NJ	n=111	19%
NP	n=42	7%
SJ	n=386	67%
SP	n=40	7%
FJ	n=86	15%
FP	n=24	4%
TJ	n=411	71%
TP	n=58	10%

prevalent type was ISTJ, accounting for 13%, followed by ENTJ with 12%. These three types combine to account for more than two-thirds of the sample. All share the Thinking-Judging" combination which captures 71% of the sample. The least prevalent types are ISFP (0.3%), ESFP (1.0%) and INFP (1.0%). This population is far more homogeneous than would be expected by chance (Table 8). Figures 5 through 8 show histograms of the samples' distributions on the 4 MBTI dimension. This sample is extremely heavy on Thinking and Judging.

Zero-order Pearson correlations among all group-level continuous variables in the study are shown in Table 9. Individual-Level correlations are presented in Table 10. The magnitude and direction of correlations are very similar at both levels of analysis.

Cognitive Ability Results

Hypothesis 1. Results supported the prediction that group cognitive ability level would be positively related to group production. As shown in Table 9, the zero-order correlation between the composite cognitive ability score and the number of headlights produced was significant ($r = .44, p < .001$).

Hypothesis 2 . Results failed to support the prediction that heterogeneity of cognitive ability in a group would be negatively related to group production. As shown in Table 11, the incremental R^2 for heterogeneity of ability with cognitive ability level in the model was not significant (R^2 change=.01, F change=.27, $p = .60$).

Table 8. Comparison of Obtained MBTI Type Distribution to Expected Distribution

		S T	S F	N F	N T	
I	J	O = 76 E = 131	O = 17 E = 44	O = 8 E = 7	O = 13 E = 13	O = 114 E = 195
I	P	O = 11 E = 36	O = 2 E = 12	O = 6 E = 5	O = 8 E = 16	O = 27 E = 70
E	P	O = 21 E = 32	O = 6 E = 11	O = 10 E = 9	O = 18 E = 16	O = 55 E = 68
E	J	O = 251 E = 178	O = 42 E = 36	O = 19 E = 8	O = 71 E = 25	O = 383 E = 246
		O = 359 E = 376	O = 67 E = 60	O = 43 E = 28	O = 110 E = 71	O = 579 E = 579

O= Observed

E= Expected

χ^2 (9 d.f.) = 211.05, $p < .001$

Expected values bases on high school graduate sample (N=606) reported in Myers & McCaulley, 1985, p. 46.

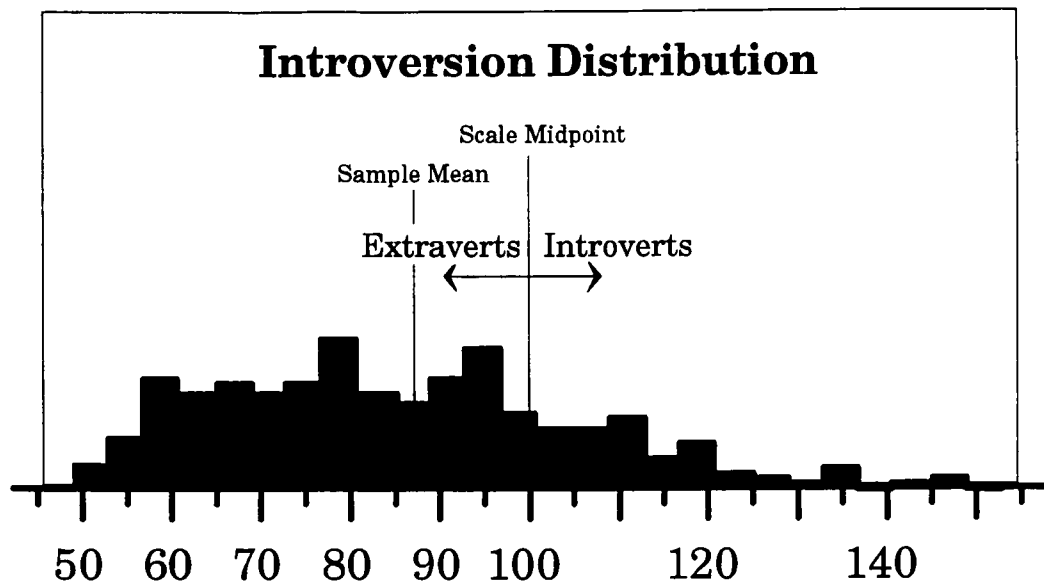


Figure 5. Distribution of MBTI Introversion Dimension

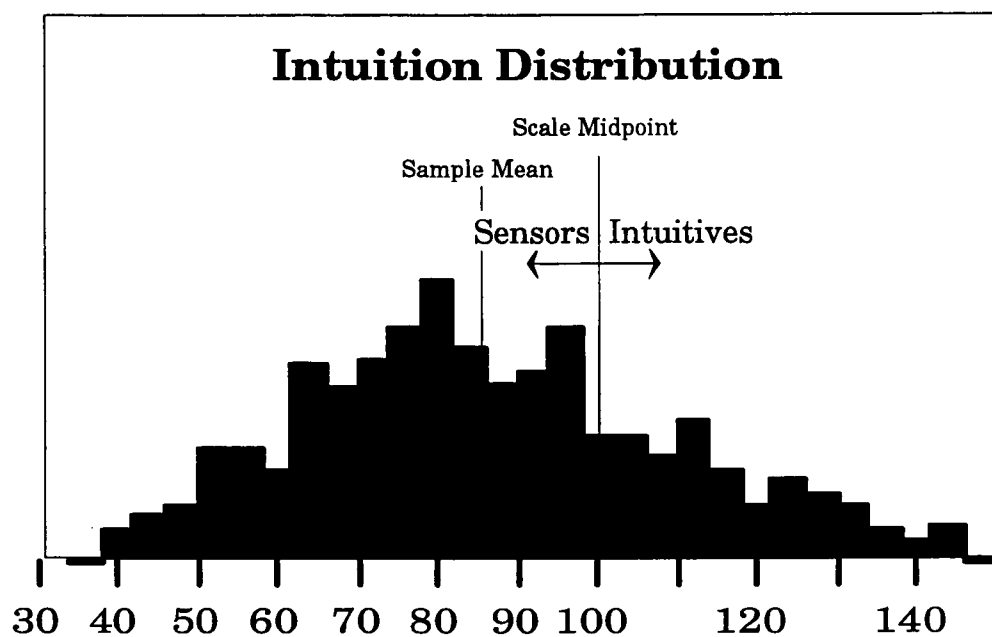


Figure 6. Distribution of MBTI Intuition Dimension

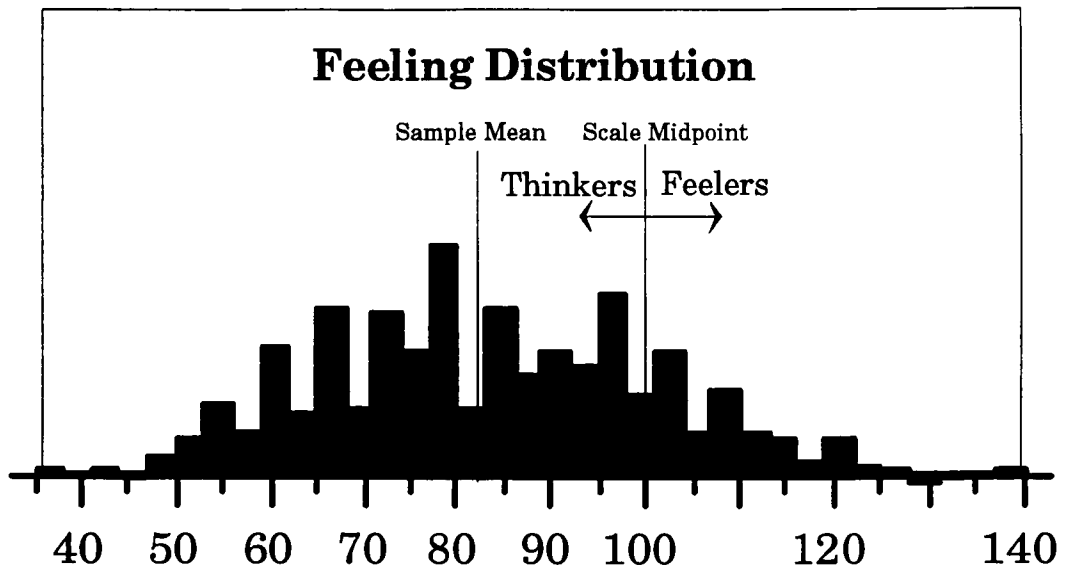


Figure 7. Distribution of MBTI Feeling Dimension

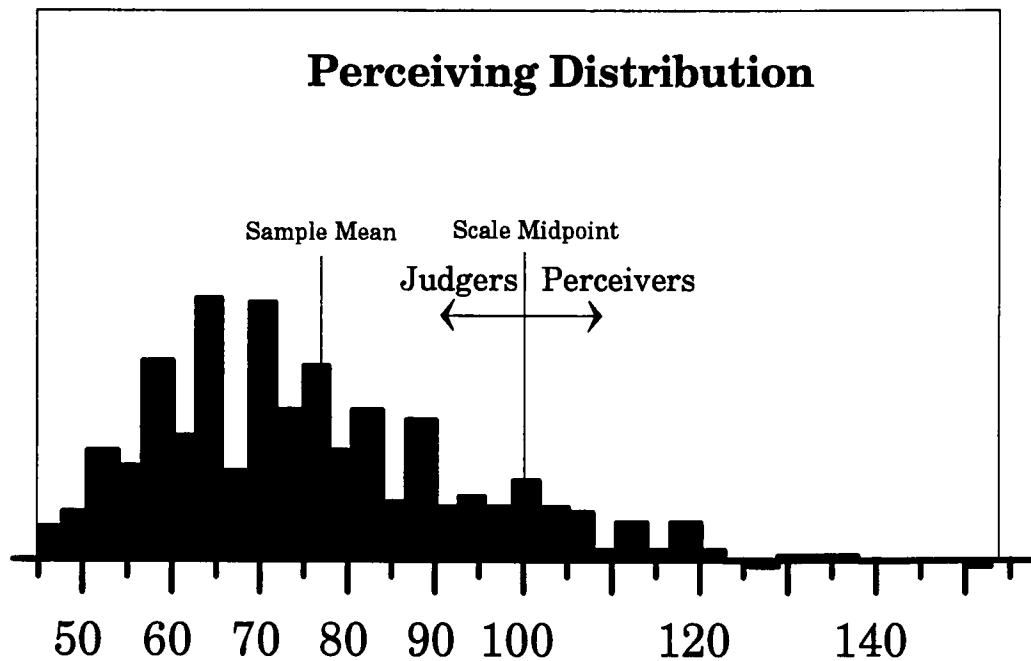


Figure 8. Distribution of MBTI Perceiving Dimension

Table 9. Zero-Order Pearson Correlations among Measures in the Study Group Level of Analysis (n=118)

Variable	1.	2.	3.	4.	5.	6.
1. Reading	-	68 ^c	66 ^c	48 ^c	86 ^c	-33 ^c
2. Numerical		-	57 ^c	47 ^c	82 ^c	-01
3. Mechanical			-	62 ^c	86 ^c	-32 ^c
4. Spatial				-	77 ^c	-15
5. Composite Ability					-	-25 ^b
6. Hetero. Ability						-

Variable	7.	8.	9.	10.	11.	12.
1. Reading	-10	24 ^b	-12	-06	23 ^b	35 ^c
2. Numerical	-02	29 ^c	-03	01	18 ^a	35 ^c
3. Mechanical	-04	09	-16 ^a	-01	16 ^a	34 ^c
4. Spatial	-06	30 ^c	-12	18 ^a	09	34 ^c
5. Composite Ability	-05	28 ^c	-13	03	20 ^b	86 ^c
6. Hetero. Ability	07	09	06	06	00	-16 ^c

Variable	13.	14.	15.	16.	17.	18.
1. Reading	35 ^c	34 ^c	34 ^c	38 ^c	33 ^c	12
2. Numerical	19 ^b	20 ^b	23 ^b	23 ^b	38 ^c	17 ^a
3. Mechanical	38 ^c	27 ^b	31 ^c	35 ^c	38 ^c	21 ^b
4. Spatial	36 ^c	32 ^c	36 ^c	37 ^c	36 ^c	29 ^c
5. Composite Ability	38 ^c	34 ^c	38 ^c	40 ^c	44 ^c	24 ^b
6. Hetero. Ability	-25 ^b	-25 ^b	-17 ^b	-23 ^b	-07	-05

Table 9 (continued)

	7.	8.	9.	10.	11.	12.
7. Introversion	-	22 ^b	-.03	.06	19 ^a	-.03
8. Intuition		-	.04	41 ^c	25 ^b	.14
9. Feeling			-	.09	-.04	-.04
10. Perceiving				-	41 ^c	.01
11. Hetero. MBTI					-	.12
12. Team Interaction						-
	13.	14.	15.	16.	17.	18.
7. Introversion	-.05	-.12	.07	-.03	-.11	.04
8. Intuition	.08	17 ^b	.03	.11	.09	.12
9. Feeling	-.08	-.04	-.07	-.07	-.01	-.03
10. Perceiving	-.01	.11	.01	.03	.08	.06
11. Hetero. MBTI	.06	.14	.15	.13	.02	.09
12. Team Interaction	85 ^c	77 ^c	75	92 ^c	27 ^b	26 ^b
	13.	14.	15.	16.	17.	18.
13. Problem Solving	-	76 ^c	79 ^c	94 ^c	26 ^b	34 ^c
14. Openness to Change		-	72 ^c	88 ^c	20 ^b	21 ^b
15. Work Orientation			-	88 ^c	32 ^c	36 ^c
16. Composite Rating				-	29 ^c	33 ^c
17. Headlights Complete					-	21 ^b
18. Percent Correct						-

Decimal points omitted

^a*p* < .05, ^b*p* < .01, ^c*p* < .001; all probabilities one-tailed

Table 10. Zero-Order Pearson Correlations among Measures in the Study
Individual Level of Analysis (n=579)

Variable	1.	2.	3.	4.	5.	6.	7.
1. Reading	-	67 ^c	64 ^c	53 ^c	84 ^c	06	26 ^c
2. Numerical		-	62 ^c	59 ^c	85 ^c	03	30 ^c
3. Mechanical			-	69 ^c	87 ^c	04	23 ^c
4. Spatial				-	83 ^c	-05	35 ^c
5. Composite Ability					-	02	33 ^c
6. Introversion						-	-20 ^c

	8.	9.	10.	11.	12.	13.	14.
1. Reading	-01	10 ^b	30 ^c	36 ^c	30 ^c	30 ^c	35 ^c
2. Numerical	-02	13 ^a	28 ^c	32 ^c	27 ^c	29 ^c	32 ^c
3. Mechanical	-12 ^b	11 ^b	32 ^c	41 ^c	31 ^c	33 ^c	38 ^c
4. Spatial	-03	22 ^c	30 ^c	40 ^c	31 ^c	35 ^c	38 ^c
5. Composite Ability	-06	16 ^c	36 ^c	44 ^c	35 ^c	38 ^c	42 ^c
6. Introversion	03	08	-11 ^b	-07 ^a	-08 ^a	00	-07 ^a

Table 10 (continued)

	8.	9.	10.	11.	12.	13.	14.
7. Intuition	12 ^b	37 ^c	15 ^c	13 ^c	14 ^c	10 ^b	14 ^c
8. Feeling	-	22 ^c	-06	-05	-04	-06	-06
9. Perceiving		-	06	06	10 ^b	08	08
10. Team Interaction			-	83 ^c	78 ^c	73 ^c	92 ^c
11. Problem Solving				-	78 ^c	79 ^c	94 ^c
12. Openness to Change					-	74 ^c	90 ^c
13. Work Orientation						-	89 ^c
14. Composite Ratings							-

Decimal points omitted

^a $p < .05$, ^b $p < .01$, ^c $p < .001$; all probabilities one-tailed

Table 11. Regression Analysis of Heterogeneity of Cognitive Ability and Cognitive Ability Level on Group Production

Variable	Beta	R ² Change	F Change	Sig. F Change
Cognitive Ability	1.60	.19	27.28	p < .00001
Heterogeneity of Cognitive Ability	.08	.01	.27	.60

An Alternate Approach: Number of High Ability Members and Production. Data analyses suggested an alternate method for examining the relationship between group performance and level and heterogeneity of ability. Ability and performance may be related such that some critical proportion of the group must be of high ability for the group to function efficiently.

To test this, the median level of cognitive ability was computed for the 472 individuals comprising the 118 groups in the study. Each individual was then assigned a dichotomous rating of High or Low, depending upon whether they were above or below the median. The data were then aggregated, with a new group level classification variable: the *number* of high ability team members. It was desired to have five levels of this new variable, one for each possible number of high ability member in the group (0, 1, 2, 3, 4). The pattern of means obtained is shown graphically in Figure 9. The pattern appears to be non-linear, with no difference between 0 and 1 high ability person, a rather large jump between 1 and 2, and smaller steps as additional

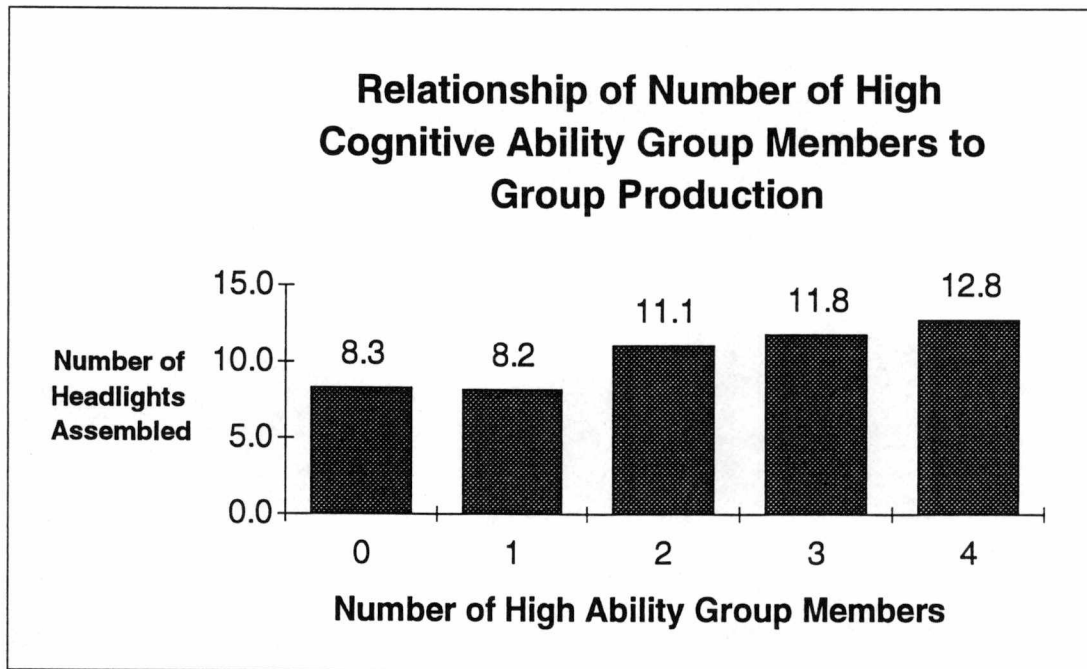


Figure 9. Relationship of Number of High Cognitive Ability Group Members and Group Production (5-Level)

high ability members are added to the group. Unfortunately, when the data were aggregated, it was discovered that only 6 groups had 0 high ability members, and only 4 groups had 4 high ability members. These small cell sizes had such large standard error values that statistically significant differences could not be shown between 0 and 2 or between 2 and 4. A three-level classification variable was created instead, the first level contained groups with 0 or 1 high ability member ($n=30$), the second class was comprised of groups with 2 high ability members ($n=56$), and the third class was groups with 3 or 4 high ability members. A one-way ANOVA treated number of high ability members as a nominal variable predicting group production. The omnibus F obtained was significant ($F(2,115) = 15.42, p < .001$). Using Tukey-HSD multiple comparisons to test pairwise means ($\alpha = .05$), results showed a significant difference in productivity between having 0-1 vs. 2 high ability members, (8.23 vs. 11.05 headlights complete), but a non-significant difference between having 2 vs. 3-4 high ability members (11.05 vs. 11.91 headlights complete). The results from this analysis are presented in Table 12. An illustration follows in Figure 10.

Another test for the presence of a non-linear trend is to use polynomial regression. The appearance of the trend in this data suggests the possibility of a second-order, or quadratic, response function. The regression model $Y = \beta_0 + \beta_1x_i + \beta_{11}x_i^2 + \varepsilon_i$ was tested. The quadratic term (with the linear term in the model) increased the R^2 by .026, and approached statistical significance ($F=3.8, p=.055$), providing limited support for the presence of a nonlinear trend in this data.

Table 12. Relationship of Number of High Cognitive Ability Members to Group Production

Classification Variable	n	Headlights Built	Tukey-HSD Comparisons (* indicates difference at $\alpha=.05$)		
			1.	2.	3.
1. 0 or 1 High Ability Member	30	8.23			
2. 2 High Ability Members	56	11.05	*		
3. 3 or 4 High Ability Members	32	11.91	*		

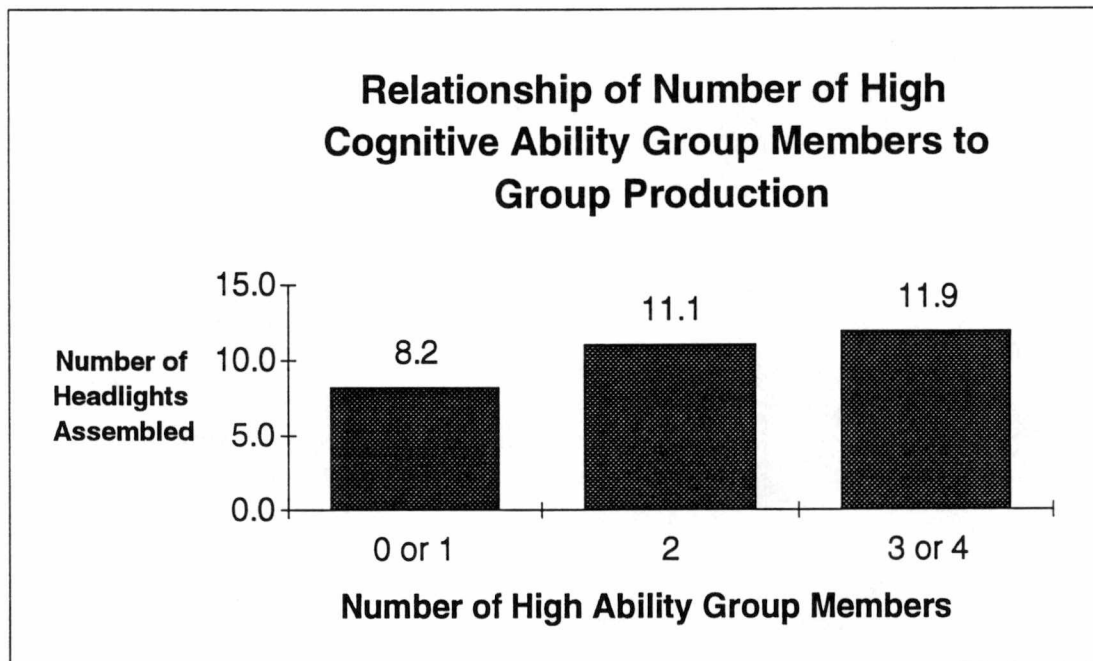


Figure 10. Relationship of Number of High Cognitive Ability Group Members and Group Production (3-Level)

This finding raises another question related to heterogeneity of ability: Groups uniformly low in ability are homogenous, as are groups which are uniformly high. Maximum heterogeneity may only be obtained if the group has equal numbers of high and low ability members, in groups of 4, groups with 2 high ability members will have maximum heterogeneity of ability. The relationship between the number of high ability members and the continuous measure of heterogeneity is shown in Figure 11.

It is possible that the reason for the large improvement in performance between 1 vs. 2 high ability members is because increasing from 1 to 2 increases both ability and heterogeneity whereas increasing from 2 to 3 high ability members *increases* level of ability but *decreases* heterogeneity of ability.

To test this, a model was run using the three-level number of high ability member classification variable to predict group production with the continuous measure of heterogeneity in the model as a covariate. The results indicate that the heterogeneity measure is not significant ($F_{1,118} = 2.17$, n.s.) in the model, but the trichotomous measure of ability remained a significant predictor ($F_{2,118} = 245.44$, $p < .0001$).

Hypothesis 7. Results supported the prediction that cognitive ability would be related to ratings of team skills behavior. As shown in Table 10, the zero-order correlation between these variables was significant ($r = .42$, $p < .001$).

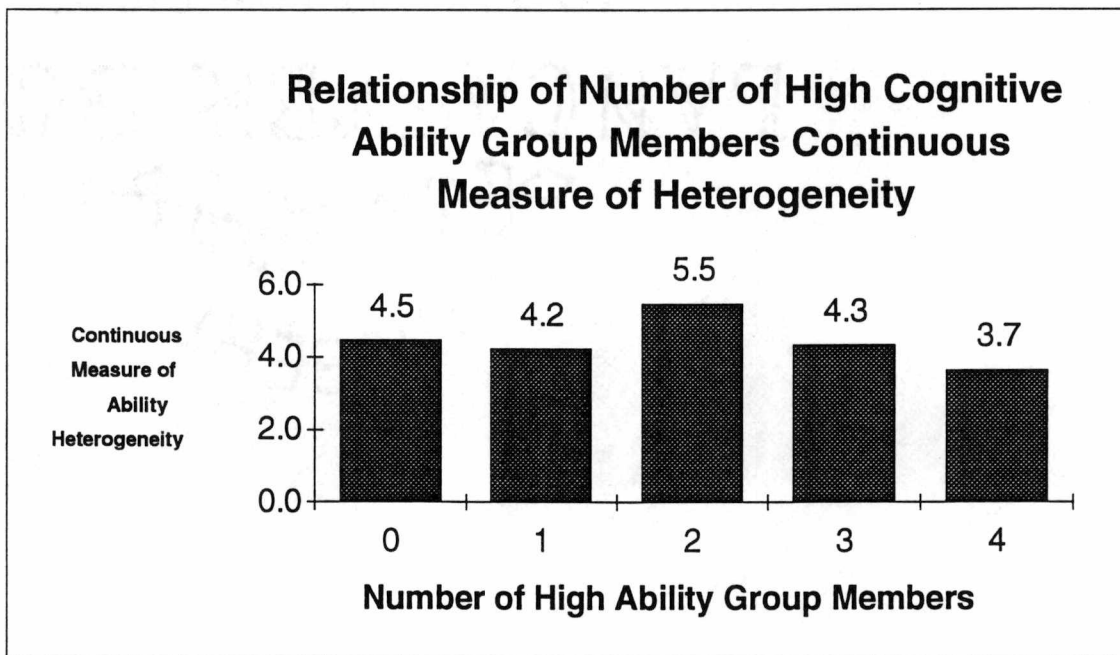


Figure 11. Relationship of Continuous Measure of Heterogeneity of Ability to Number of High Ability Members

MBTI Preference Scales and Group Performance

Hypothesis 3. Results did not support the prediction that group "Introversion" would be positively related to group production. As shown in Table 9, the zero-order correlation between these variables was not significant ($r = -.11$, n.s.).

Hypothesis 4. Results did not support the prediction that level of group "Intuition" would be positively related to group production. As shown in Table 9, the zero-order correlation between these variables was not significant ($r = .10$, n.s.).

Hypothesis 5a . The data did not support the prediction that group "Perceiving" would be negatively related to group production. As shown in Table 9, the zero-order correlation between these variables was not significant ($r = .08$, n.s.).

Hypothesis 5b. Results failed to support the prediction that group "Perceiving" would be positively correlated with quality of group production. As shown in Table 9, the zero-order correlation between these variables was not significant ($r = .06$, n.s.).

Hypothesis 6. The data failed to support the prediction that heterogeneity of group personality profiles would be positively related to production. As

shown in Table 9, the zero-order correlation between heterogeneity of group profiles as measured by the $\underline{D}$ statistic and group production was not significant ($r = .01$, n.s.).

Hypothesis 8. The prediction that "Introversion" would be negatively related to ratings of team skills behavior was supported. The zero-order correlation between these variables, although weak in magnitude, was significant, ($r = -.07$, $p = .048$).

Hypothesis 9. Results supported the prediction predicted that "Intuition" would be positively related to ratings of team skills behavior. The zero-order correlation between these variables was significant ($r = .14$, $p < .001$).

Hypothesis 10. The data failed to support the prediction that "Feeling" would be positively related to ratings of team skills behavior. The zero-order correlation between these variables was not significant ($r = -.06$, $p = .09$).

Relative Predictive Ability of Cognitive Ability and Team Skills Ratings

While examining the zero-order correlations among the variables, it was observed that the correlation between cognitive ability and group production was of greater magnitude than the correlation between the composite team skills rating and group production. In fact, the cognitive

ability measure accounted for more than twice the variance in production than did the skills ratings ($R^2=.19$ vs. $R^2=.08$).

A regression analysis was then performed using a model to predict group production by first entering cognitive ability into the model, followed the team skills ratings. Results are shown in Table 13. With cognitive ability in the model, the aggregated team skills ratings failed to significantly explain any variance in group production. The implications of this finding will be discussed in detail in the next chapter.

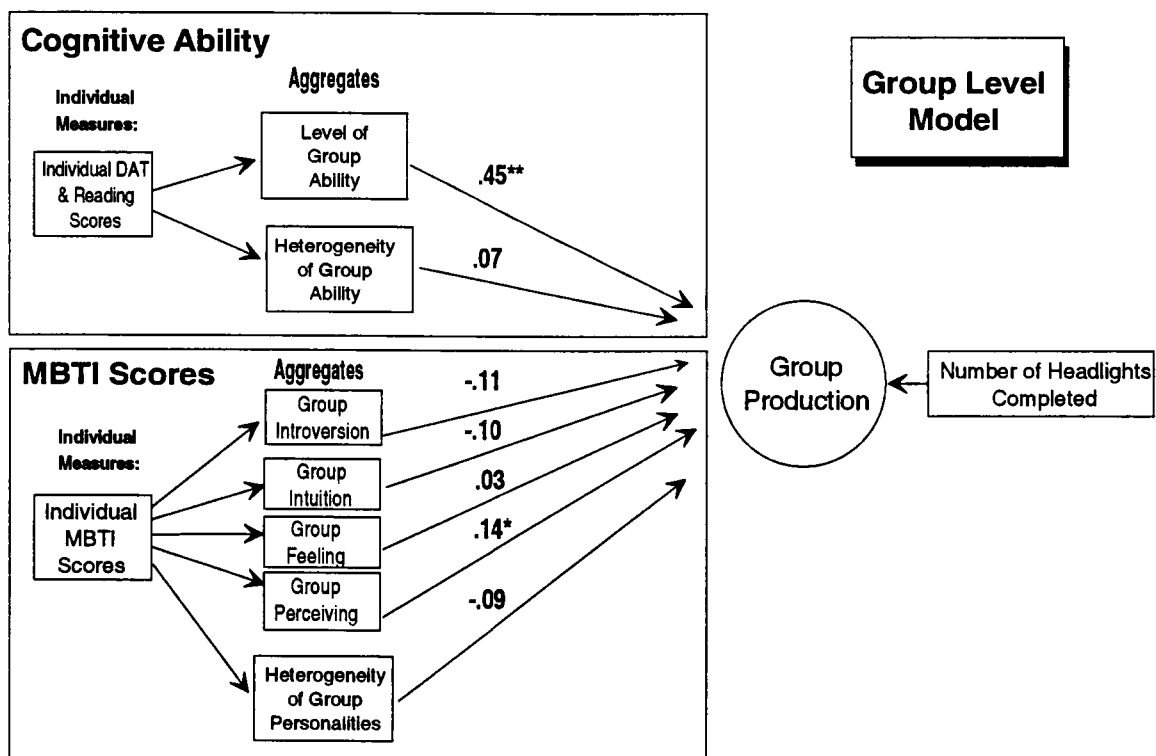
Simultaneous Relationships Among Variables in the Study

While all of the hypotheses in this study were specified between single pairs of variables, it is often enlightening to observe the pattern of results obtained when all variables are in the model simultaneously. Figure 12 shows the relationships between all group-level variables in the study and group production. The coefficients shown are partial correlations, which represent the relationship between each individual variable and group production, when all other variables are in the model (Cohen & Cohen, 1983). No surprising relationships were discovered in this way, although the MBTI Perceiving scale did emerge as a statistically significant, albeit weak, predictor of group production ($r=.14$, n.s.) when all other variables were in the model.

Partial correlations among variables at the individual level of analysis are shown in Figure 13. While the general pattern of findings remained intact, the partial correlation between MBTI Intuition and the team skills

Table 13. Regression Analysis of Cognitive Ability Level
and Team Skills Ratings on Group Production

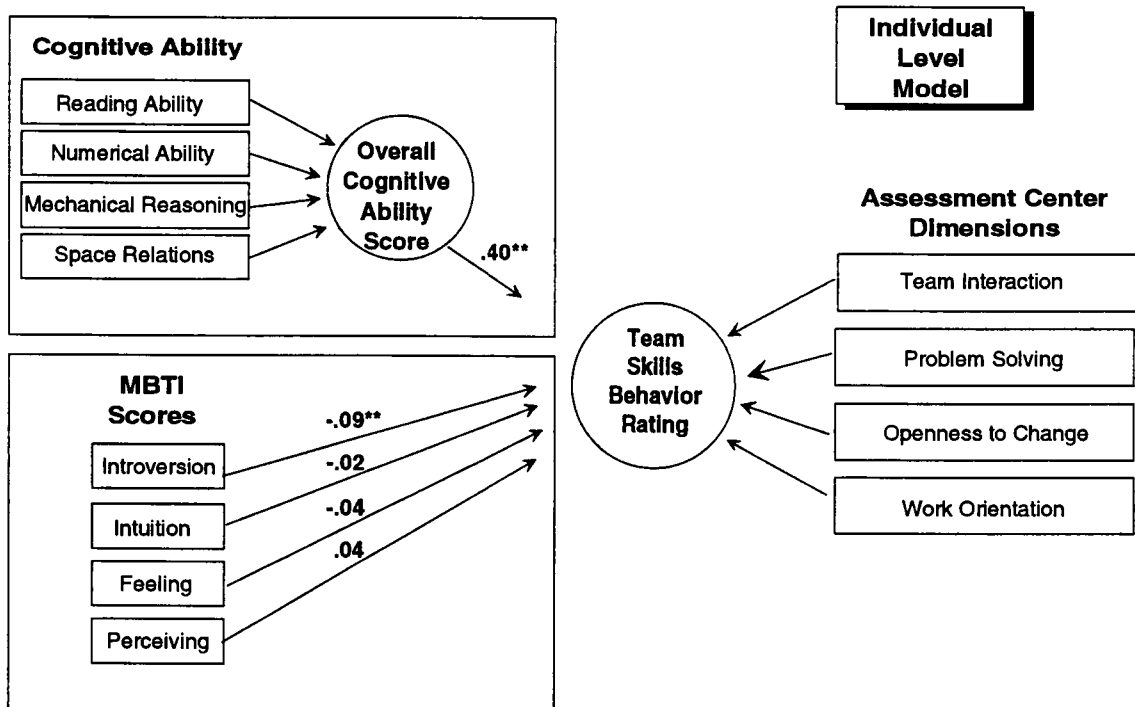
Variable	Beta	R ² Change	F Change	Sig. F Change	Partial r
Cognitive Ability	1.56	.19	27.28	p < .01	.36
Team Skills Ratings	.19	.02	2.24	.14	.14



* $p < .05$; ** $p < .01$

All coefficients shown are partial correlations.

Figure 12. Simultaneous Relationships Between Group-Level Variables and Production.



* $p < .05$; ** $p < .01$

All coefficients shown are partial correlations.

Figure 13. Simultaneous Relationships between Individual Measures in the Study and Team Skills Ratings.

rating was nearly zero ($r = -.02$) with all variables in the model, where its zero-order relationship had been significant ($r=.14$). This is probably because the MBTI Intuition measure is correlated with cognitive ability ($r = .33$), and is unable to explain any additional variation with cognitive ability in the model.

CHAPTER V

DISCUSSION

The primary purposes of this study were 1) to investigate the relationship of cognitive ability and Myers-Briggs Type Indicator preferences of individuals with group performance and 2) to examine the relationship of cognitive ability and MBTI preferences with team skills ratings. Hypotheses were tested relative to three scales of the MBTI, heterogeneity of MBTI preference scores, cognitive ability and heterogeneity of cognitive ability, and group performance. Additional hypothesis tests were performed testing the relationship of cognitive ability and MBTI scores to group skills ratings at the individual level. Several post-hoc analyses of the data were then performed.

This chapter addresses the major findings of this study. Strengths and limitations of the study are then discussed as well as opportunities for future research in this area. Finally, the practical and theoretical implications of the study are discussed. The results of the hypothesis tests are summarized in Table 14.

Cognitive Ability and Group Production

Cognitive ability was expected to be positively related to group production, and the data support this. A strong correlation was obtained between the group's mean composite cognitive ability measure and the

Table 14. Summary of Results of Hypothesis Tests

Hypothesis	Finding
1: Group cognitive ability level is positively related to group production.	Supported
2: Heterogeneity of cognitive ability is negatively related to group production.	Not Supported
3: Group "Introversion" is positively correlated with group production.	Not Supported
4: Group "Intuition" is positively correlated with group production.	Not Supported
5a: Group "Perceiving" is negatively related to group production.	Not Supported
5b: Group "Perceiving" is positively correlated with quality of group production.	Not Supported
6: Heterogeneity of group personalities is positively related to group production.	Not Supported
7: Cognitive ability is positively related to ratings of team skills behavior.	Supported
8: "Introversion" is negatively related to ratings of team skills behavior.	Supported
9: "Intuition" is positively related to ratings of team skills behavior.	Supported
10: "Feeling" is positively related to ratings of team skills behavior.	Not Supported

number of headlights assembled. Even with all other variables in the model at the same time, the partial correlation between ability and production remained strong and positive. This finding has important implications, as it shows that even when individuals are required to work in teams and perform as a unit, cognitive ability remains an important ingredient for success; in this study it was by far the most important ingredient. The task in this study was much like the cooperative tasks described by O'Brien and Owens (1969) in that it allowed the team members to develop social and technical structures for their work. For these task types, level of ability has previously been shown to predict performance (Kabanoff and O'Brien, 1979).

Heterogeneity of cognitive ability was expected to have a negative relationship with production (Hypothesis 2). The data did not support this. Heterogeneity of ability was unrelated to production when level of ability was previously entered in the regression model. There appeared to be a negative relationship between the skills ratings and heterogeneity of ability, but with level of ability in the model, the partial correlation between heterogeneity and production was not significant. It makes no sense to examine heterogeneity of ability present in a group without examining level of ability at the same time; it is impossible for a group to be high on both level of ability and heterogeneity of ability. Groups uniformly high or uniformly low in ability will necessarily be homogeneous.

Number of High Ability Members and Group Production

Another potentially important finding is the relationship between the number of high ability members and group performance. In contrast to Tziner and Eden (1985) who found that uniformly high ability groups performed better than would be predicted on the basis of their scores alone, this study showed that adding high ability members did not increase performance incrementally after there were two persons of high ability on the team. Why do these data show a trend in direct contrast to that of the Tziner & Eden study?

A potential answer to this question has to do with the task. In the Tziner and (1985) Eden study, the teams were composed of a mover, a loader, and an operator. These tasks were highly specialized and interdependent; the teams had little or no flexibility relative to which team member performed which task. In this type of situation, no matter how talented the mover and loader were, if the operator was a poor performer, the team suffers. High performance in this situation requires all three members to be skilled.

In the present study, however, a large part of the task had to do with structuring the work; there were no specialists, and although the work was interdependent, high performing groups were ones that could identify process bottlenecks and make adjustments to balance the work equally among the four-team members. It is also possible the present task may not have been optimally designed for four persons to maximally perform. The observed non-linear trend may have been due purely to the mechanics of the task.

Another important difference is that the teams in the Tziner and Eden (1985) study were experienced at their tasks having worked together for several hours a day for weeks. If any synergetic effects are to be obtained from homogeneous high ability groups, they probably occur as a result of well-developed group processes, which may take much longer to manifest themselves time than was available in the present study. This idea can be expanded to explain the obtained relationship between number of high ability members and performance in the present study. Figure 14 shows a possible relationship between number of high ability team members and group performance as a function of group development. The first (foreground) data series shows the data obtained in the present study. The two data series behind show how this relationship might change with increased time for group development. In all three situations, if the group does not have at least two members with high-ability performance is poor. As development time increases, groups with at least two high ability members improve their performance. The more high ability members the group possesses, the more advantage that group can make of its process development.

Another possibility is the social influence process of the group. While early research on influence process suggested a linear relationship between the number of minorities in a group and their influence (Latané, 1981), more recent reviews of minority influence (Tanford & Penrod, 1984; Maas & Clark, 1984) has suggested that in small groups ($n < 6$), a minority of two can have a much greater influence on a group than a single minority. If we consider the situation where high ability members are considered a minority, the

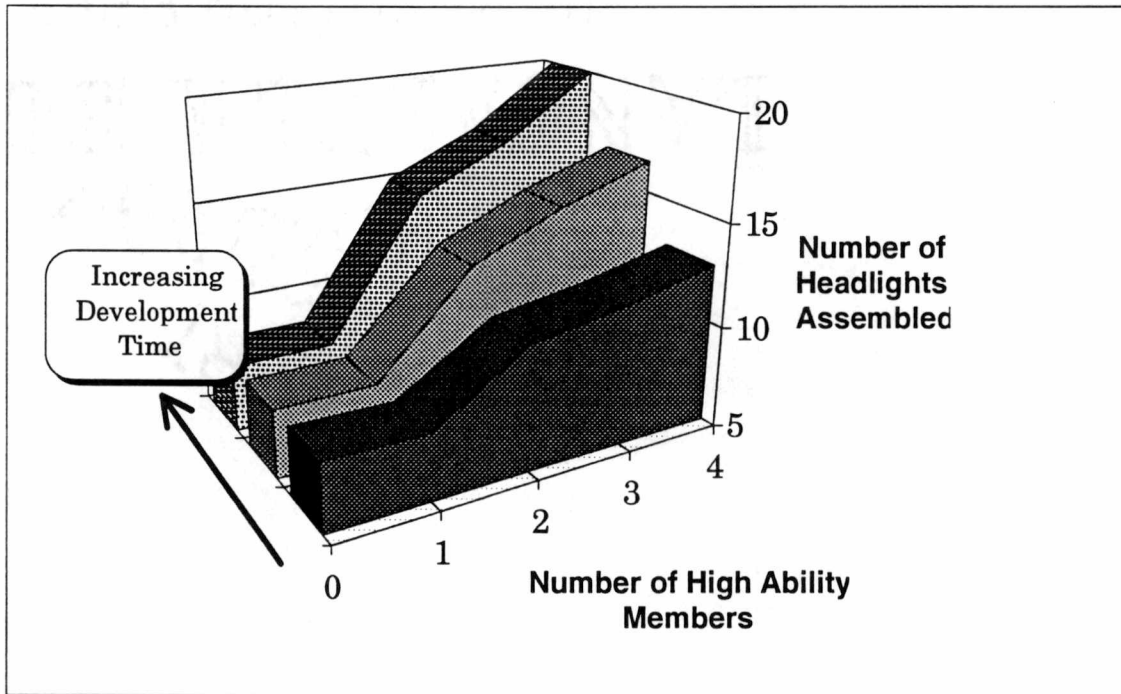


Figure 14. Theoretical Relationship Between Number of High Ability Team Members and Team Performance as a Function of Group Development Time

observed trend is consistent with the minority influence literature: The group may require two high ability members to influence the process of the group.

Cognitive Ability vs. Aggregate Team Skills Ratings as Predictors of Group Performance

The relative ability of cognitive ability and team skills ratings to explain group production is the most potentially important finding in this study. From a practical standpoint, it is generally much less expensive to obtain cognitive ability information than to obtain assessment center ratings. Also, consider the criteria and predictors in this study: The cognitive ability composite is a rather ordinary battery of paper and pencil tests; the team skills composite is the sum of the skills ratings received by team members *while building the headlights that yield the criteria for performance*.

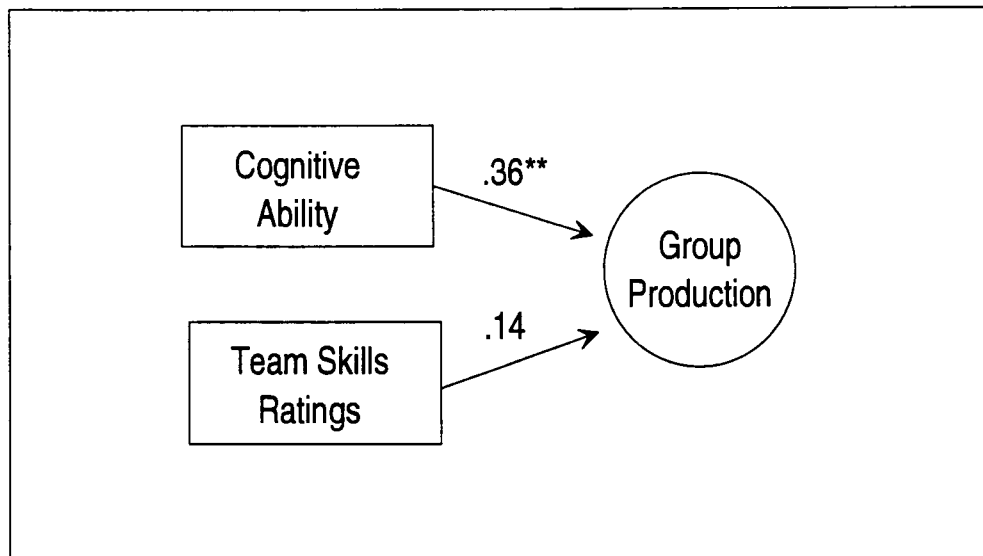
A third reason for the potential importance of this finding is that the aggregated team skills ratings are very similar to a group *process* measure. While the assessment ratings were designed to measure *individual* team skills, the ratings are based explicitly on behaviors exhibited which are thought to be either aid or hinder the *group's* production. Most process-oriented group research based on direct observation and coding of behaviors (Hackman & Morris, 1975, Sundstrom et al., 1988), is performed similarly, except that behaviors are not attributed to the individual, only to the group (i.e., group researchers only care that a behavior occurred, not which

individual performed the behavior). With few exceptions, aggregating individual behavioral effectiveness ratings should yield a measure quite similar to a group's process measure.

Since cognitive ability and the skills ratings were correlated ($r=.40$), and because it was desirable to know the *relative* contribution of cognitive ability and team skills ratings in predicting group performance, a regression analysis was performed using cognitive ability and the team skills composite in a model predicting group production.

As most group performance theory is based on some INPUT-PROCESS-OUTPUT model, it was possible that although the team skills ratings (process) had a smaller direct correlation with performance than cognitive ability (an input factor), the skills ratings might explain performance variation directly, while the cognitive ability measure was having its effect indirectly through its impact on the team skills ratings.

Team skill ratings failed to add significantly to the predictive ability of the model. Further, in the complete model, the partial correlation between the team skills ratings and production was only .14, while the partial r for cognitive ability was .36. This relationship is depicted in Figure 15. It appears that cognitive ability is indeed a better predictor of production on this exercise than team skills ratings. More significantly, it appears that cognitive ability has its effect *directly* on production, and not through its presumed relationship to team skills ratings (process). The low partial r between the skills ratings and production suggests that most of the skills ratings' ability to predict production is weak and overlaps with cognitive ability. In other words, the skills ratings may predict performance only by



**** $p < .001$ Coefficients shown are partial correlations.**

Figure 15. Relative Contribution of Cognitive Ability and Team Skills Ratings in Predicting Group Production.

acting as an inefficient measure of cognitive ability; they contribute no significant unique explanatory power.

MBTI Scales and Group Performance

The MBTI had several strikes against its ability to predict performance in this study. First and most importantly, this sample was highly homogeneous; there was an extreme shortage of Perceivers and Feelers in the sample, as the distributions in figures 5 through 8 illustrate. While this range restriction did not bode well for the likelihood of finding the predicted relationships, it is not surprising in retrospect. The most frequently occurring type in the sample was ESTJ. Typical ESTJ's have been described as a persons who enjoy working at tasks where they can actively participate, and quickly see the results. They make decisions based on logic and analysis, thrive on planning and structure, and will take steps to prevent problems and get things done. They enjoy working with other people, value stability and efficiency. They do not like surprises and changes in their work setting (Hirsh & Kummerow, 1989). Research shows that ESTJ's are frequently employed as trade and technical teachers, police officers, military personnel, craft workers, and laborers.

The least frequently occurring type in this sample was ISFP. ISFP's are typically described as persons who are compassionate, open and flexible. They enjoy working in quiet settings with persons whom they like. They are said to be more oriented toward people than toward tasks, and enjoy aesthetically pleasing work environments(Hirsh & Kummerow, 1989). Past

research has shown that ISFP's are frequently employed as bookkeepers, carpenters, nurses, and X-Ray technicians (Myers & McCaulley, 1985).

While the proportion of STJ's in this population is quite high, the stability coefficients for the Myers-Briggs are quite high, ranging from .70 to .80 over intervals as long as 5 years (Myers & McCaulley, 1985). The safest reasoning for the obtained distribution is that STJ's self-select into this occupation at a high rate, and other types who get into this occupation probably have higher attrition rates. Given that all participants in the study had been in this occupation for a long period of time, the homogeneity of the obtained distribution is not surprising.

None of the scales of the MBTI, were significantly related to group production or quality of group production (Hypotheses 3, 4, 5a, and 5b). Heterogeneity of the MBTI scales was also unrelated to group production or quality. While these findings were rather disappointing, they do not necessarily pronounce the MBTI a useless tool for predicting group performance. In addition to the restriction of range issue, there are several other reasons why the MBTI might not be predictive of performance in this study. First, although the duration of this task is longer than most laboratory studies, it is still a relatively short period of time to expect personality variables to have much impact. According to Buss (1989), in relatively brief studies, the role of personality traits is minimized, and the role of the situation or experimental manipulation is maximized. While it is possible for persons to behave atypically (i.e., not in accordance with their Myers-Briggs "Type") for brief periods, they would probably be unable to maintain this behavior over time. Second, the situation (assessment center)

is very powerful. The subjects were job candidates competing for employment, and could be assumed to be uniformly high in motivation to perform well. . A third reason is that personality might have its effect on group performance through its influence on the group's *process*. Since this was a rather short term, contrived situation, it is very unlikely that any group dynamics issues had the time or opportunity to manifest themselves.

Another issue is that the criteria measures for this task were purely performance or output of the group. Many group effectiveness models (e.g., Sundstrom, et al., 1990) include the additional component of viability, or the members' satisfaction and willingness to continue working together. It is possible that the MBTI might be better suited to predict long term success of interpersonal relations within a work unit, which is more indicative of viability than performance.

MBTI Scales and Team Skills Ratings

If the reasoning behind the lack of relationship between MBTI and group performance was correct, then personality factors were having little or no effect on the behaviors exhibited in this task. Given this, it would be surprising to find that the MBTI scales were predictive of ratings of team skills behaviors. However, two of the MBTI scales did have a significant relationship with the team skills ratings. It was expected that MBTI Introversion would be negatively related to team skills behavior ratings (Hypothesis 8); that is, Introverts would be less likely to exhibit the social behaviors that are rewarded with higher ratings. The data supported this

relationship, although the actual magnitude of the correlations were about the same as the correlations at the group level; there was much more statistical power available to detect this small effect size at the individual level of analysis.

Hypothesis 9 predicted that MBTI Intuition would be positively related to team skills ratings. The data supported this finding, although when all 4 MBTI scales and cognitive ability were in the model, the partial correlation between Intuition and team skills ratings, was non-significant. This is because Intuition is correlated with cognitive ability and apparently adds no unique explanation once cognitive ability is in the model. The relationship between the behavioral ratings and the MBTI dimension scores are consistent with the findings of Thorne and Gough (1991).

Hypothesis 10 predicted that MBTI Feeling would have a positive relationship with the team skills ratings. This assertion was not supported by the data.

Given the restriction of range on the MBTI scales and the relatively brief time allotted for the exercise, it is surprising that significant relationships between the MBTI and Team Skills ratings were found, especially in the absence of any relationship between MBTI scales and group performance. It seems likely that any impact that personality could have on team performance occur via *process* and not *directly* on performance, and in this brief time of this study process had little opportunity to impact performance.

Contributions of the Study

This study has some important strengths. First, the sample size was relatively large. Most group research published has had a sample of fewer than 50 groups. This study used 118 groups, which provides enough statistical power to detect some fairly subtle relationships.

Another advantage is that these participants were adults rather than college students. Since much of the research literature seeks to generalize to adults in a work environment, this is an important contribution. Also, these data were collected in a selection situation. Since the participants were competing for employment, the candidates were believed to have been sufficiently motivated to perform as well as they could -- something that cannot be confidently stated about most studies which use college sophomores as subjects. It is suggested that the results obtained in this study are more generalizable to workplace situations than the results of most group research currently published.

Another advantage is that the task used for the study was clear and job relevant. The participants in the study were experienced at assembly tasks, and the primary component of most of the jobs for which they were candidates is assembly. The task also allowed the candidates a large amount of latitude in determining how to structure their work. There were an almost infinite number of variations the group could adopt to assemble the headlamps; they could make the task highly interdependent, or, if they chose to, they could arrange the task so that each person built headlights entire

headlamp assemblies. This flexibility in structuring work is an important component of the teams' actual job in the manufacturing facility as well.

The performance criteria used were also meaningful, and easily measured. As expected there was a substantial amount of variability between groups in their performance at this task; restriction of range in the criteria was not a serious issue. A limitation, however, is that this was a pure *performance* task. Most current definitions of group effectiveness also include a component of *viability* (Sundstrom, et al, 1990) which is related to the group's satisfaction with their task, their teammates, the support of the organization.

Limitations of the Study

This study has limitations as well. While one of the initial goals of the research was to show a relationship between personality and group performance, it now appears that this was yet another study where personality effects were very unlikely to manifest themselves. There are a variety of reasons for this. Buss (1989) addresses the problems that plague personality researchers, and this study suffered from several of them. First, traits are more likely to have their strongest effects in informal or private situations. The stronger the behavioral demands of the situation, the less influence traits have on behavior. This is a very powerful situation, which may have dramatically reduced any potential impact of personality. As stated earlier, the period of time here may not have been sufficient to observe personality effects. It is entirely possible that the MBTI could have strong

predictive abilities relative to group performance, but that this study, based on this powerful, brief situation, was unable to detect them. It should be noted as well that two small MBTI relationships to the team skills ratings were detected even in this powerful situation.

A related limitation is the mechanism by which cognitive ability may influence performance. Much of what cognitive ability tests measure may be related to mental *speed* (Berger, 1982; Eysenck, 1982), and groups with high cognitive ability in this rather brief task may simply gain the skills necessary to perform the task more *quickly* than those with lower ability. It is possible that the lower ability groups could equal the performance of the high ability groups if given more time on the task.

Another limitation is that this study included only a very limited portion of the factors that may impact group performance. While this is a desirable property when trying to isolate and understand an effect, it puts serious limitations on the generalizability of results. Previous research has shown, for example, that context-level variables are related to performance (e.g., Gladstein, 1984). Whether these individual-level factors have the same direction and magnitude of effects in varying contextual effects is unclear. In the context of an organization which emphasizes training and designing work to make it as simple as possible might be able to eliminate any advantage a person of high cognitive ability might have. Conversely, an organization which has a reward system based on successful performance of complex tasks might be an environment which puts high ability employees at an extreme advantage. At best, this study is a vast oversimplification of the group performance process.

Another issue of concern is the level of inference. The model uses an aggregated *individual* level cognitive ability test as a surrogate for a *group* variable, and we had no criterion measure of individual performance available. The study could also have benefitted from an alternative measure of group problem-solving ability, such as performance on another group task. The presence of these measures would have allowed the assessment of the relative contribution of individual vs. group cognitive ability in predicting production.

Finally, this study includes only one task and can therefore not address any issues of task-dependence. Given the findings of Tziner and Eden (1985), O'Brien and Owens (1969), and Kabanoff and Owens (1979), the type of task appears to be a very important factor in determining whether or not cognitive ability can predict performance.

On pure collaborative tasks (all members working simultaneously on a single product) it may be impossible for members of high cognitive ability to contribute relative to their ability (O'Brien and Owens, 1969). On pure interdependent cooperation tasks, as in the Tziner and Eden (1985) tank crews, it may be possible to obtain high performance only when all members are of high ability. And on tasks such as in the present study, where the members get to make decisions about how to structure the work, cognitive ability may be the best predictor of performance. Clearly, research is needed using predictors of group performance across a variety of task types.

Suggestions for Future Research

The present study was at best a flawed test of the relationship between MBTI preferences and performance. A much better model for testing the relationship between MBTI scales and group performance would be to obtain group performance measures and MBTI measures for intact work groups who have been working together for several months. In this way the problems of this study are eliminated. Actual work performance is measured, and is representative of behavior of the team members over a long period of time where the situation does not prescribe behaviors in the overpowering manner of an assessment center. This type of study needs to be done before personality is pronounced dead as a predictor of group performance. Cognitive ability should be examined at the same time to determine if it can predict long-term team performance, or if other factors (such as context) have more predictive power than individual ability over a long period of time.

The MBTI needs to be examined in terms of its relationship to both performance and *viability* of work teams, and not just to group performance. The nature of personality may be such that its real impact is less on the ability of the team to achieve maximum performance for a short period of time, than on the ability of a group's members to get along with one another and sustain a long-term effective working relationship.

A limitation here is there are many other potentially important personality traits which the MBTI does not purport to measure, including

dominance, needs for achievement, affiliation, and power (McClelland, 1961), psychological adjustment.

Another potentially fruitful area for future research is to follow-up on the relationship between the number of high cognitive ability team members and group performance. This needs to be done with more than one task type, with varying group sizes, and varying periods of group development time. As this is a rather unusual finding, it is important that it be replicated. If replicable, several other questions remain: Is this effect related in any predictable way to the size of the team, or is it only important to have more than one high ability person? It is also important to understand the nature of this relationship. At this point, it is unclear whether there is a ceiling effect relative to this particular task which may prevent high ability members from contributing incrementally once a certain number (in this case, two) of members are obtained, or whether this is a social effect of a single minority with good ideas being unable to influence the other three members (e.g., Nemeth, 1979). Alternatively, it could be social effect of conformity by the high-ability member to the opinions of the three low-ability members (e.g. Asch, 1956). Clearly, this may have important implications for selection and placement into teams: Why should an organization expend the effort and resources to obtain uniformly high-ability employees, if they can achieve the same level of performance by judicious placement of the high-ability employees they have? A clearer understanding of this relationship might allow the development of cost/benefit utility models for optimizing team performance.

Another area in need of further research is the relationship between input factors, process factors and group performance. Organizations spend a tremendous amount of time and expense in obtaining team building and organizational development training in an effort to improve their performance. Research to date has shown little evidence that process-oriented interventions alone can improve performance (Sundstrom, et al., 1990), although they generally have an positive impact on group viability. If process improvements fail to translate into performance gains, then perhaps it is time we begin to examine methods for making changes to contextual and structural variables in the organization which may have a more direct impact on the performance of its work teams.

There is also a need to understand the moderating and mediating variables between cognitive ability and group performance. Clearly, the type of task that the group performs is important to this relationship. Other variables of interest might be cohesiveness, group size, race, sex, and age composition, and length of time the team has been together.

Theoretical Implications

Three issues were raised here which have implications for group performance theory.

First, the strong observed relationship between cognitive ability and group performance is important in that it verifies that cognitive ability is important in a group work situation (at least for this task type), as well as individual work situations. The fact that heterogeneity of ability had no

effect beyond that of ability level is also important. The hypothesis in this study was that heterogeneity of ability would be negatively related to group performance because of its presumed negative impact on communication. Pearce and Ravlin (1987) hypothesized that heterogeneity would be an asset for newly formed groups. The results of the present study support neither hypothesis.

A second theoretical issue is the relationship between the number of high cognitive ability members in the group and its performance. It is important to understand the mechanism of this effect. Is there a type of ceiling effect for the number of high ability members performance? The results of Tziner and Eden (1985) suggest the opposite to be true; their groups performed even better when all members were of high ability. We need to develop a better understanding of the task structures which may allow us to design work to take advantage of the cognitive ability of teams if they have high levels, and also to design work which allows the impact of low ability members to be minimized.

The third theoretically important issue is the relative contribution of cognitive ability and team skills ratings in predicting performance. While it may be taking considerable liberty to call these teams skills ratings a process measure, they are nonetheless summated ratings of behaviors that are supposed to be indicative of effective team performance. The fact that these ratings are less predictive than cognitive ability measures even though the raters are actually observing the performance used for the criteria makes this issue even more interesting. These findings are consistent with that of Gladstein (1984), who found that what individuals believe predicts team

performance and what actually predicts it may be quite different from what actually predicts performance. She suggests that teams (or in this case, raters) may exhibit an attributional process similar to that described by Calder (1977) regarding leadership. Specifically, individuals may have implicit theories regarding the team behaviors appropriate for high performance. When they see these behaviors, they infer that the group is performing well. In this situation, even though the raters observed all of the performance of the candidates, their ratings of the behaviors did not predict performance nearly as well as the summated cognitive ability of the team.

Practical Implications

As more organizations adopt teams as their basic unit of organization, our understanding of the factors which influence team performance becomes increasingly important. This study has several practical implications.

First, organizations may benefit from utilizing cognitive ability tests as a first stage in a selection process for those persons who must work in teams. The finding that cognitive ability was positively related to team skills rating has an important application: It suggests that persons high in cognitive ability are likely to perform better in an assessment center. If the findings of this study generalize, they suggest that if an employee selection program is being conducted with limited resources (as is generally the case), pre-screening applicants with a relatively inexpensive cognitive ability test will provide a better pool of candidates for the more expensive assessment center.

It also appears from this study that an assessment center is not a substitute for a good test of general cognitive ability.

The second implication is that organizations should examine the impact of input and contextual factors on the performance of their work teams as opposed to providing only process-based interventions. While process-based team development often improve team member satisfaction and viability, its relationship to actual performance is a tenuous one.

A third implication is that organizations could benefit by considering cognitive ability measures when they structure work teams. Whether the task is purely interdependent, or requires team members to design and structure their own work, low levels of cognitive ability are likely to result in a very poorly performing team which no amount of process intervention can improve. A related implication, should the results of this study prove replicable, is that it may be inefficient to compose a uniformly high cognitive ability group to obtain high performance. For some task types, it may only be necessary to strategically place a few high ability members in each team to serve as a catalyst for the team to perform well.

In conclusion, this study showed a strong positive relationship between group cognitive ability level and work group performance. Cognitive ability also predicted individual team skills ratings. None of the four MBTI scales predicted performance of newly formed groups, although two MBTI scales, Extraversion and Intuition predicted individual team skills ratings. An important post-hoc finding was a non-linear relationship between number of high cognitive ability team members and team performance. Also, the level of cognitive ability present in the teams was a much stronger predictor

of the team's performance than the was the aggregated team skills ratings, which is very similar to most behaviorally-based group process measures. Further research is needed to increase our understanding of the factors that promote team effectiveness in organizations.

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APPENDICES

APPENDIX A

Scoring the MBTI

The MBTI (Form G) consists of 126 items, 94 (1-93, 95) of which are actually scored. The items are of two types: The first type asks the respondent to choose express a preference between two statements; The second item type asks the respondent to choose between word pairs, choosing the one which most appeals to them.

Each of the 94 scored items counts toward one of the eight "poles". Items are assigned a weight of 1 or 2, based on its presumed importance in measuring the type. For each dimension, the smaller raw score is subtracted from the larger, the difference doubled, and then one point is added. This scoring convention makes all MBTI preference scores odd numbers, and prevents anyone from receiving a zero; scores at the midpoint are arbitrarily assigned a one point preference score for I, N, T and P for males, and I, N, F and P for females.

Most items load on both of sides of the bipolar scale. For example, item 27 above is counted toward the J dimension if the response is "A", and toward the P dimension if the response is "B". This prevents the possibility of anyone of simultaneously being high on both bi-polar dimensions.

For the coefficient alpha calculations and the factor analysis, the items were assigned a score of 3 if the respondent endorsed the item, a score of 1 if the item was rejected, and a 2 if the response was neutral.

APPENDIX B

Assessment Center Dimensions

1. Team Interaction

This is defined as the overall willingness and ability of the candidate to operate as a member of a team. Key to this dimension is whether the candidate listens to others, and actively seeks out and shows respect for their ideas. Also important is whether the candidate can communicate effectively with others, presenting ideas in a clear, understandable manner. Key assessment areas include:

Respect for Others: Does the candidate listen to others, and appear to seek out and use their ideas? Does the candidate appear to believe that other can be trusted to operate "in good faith" and honor their commitments?

"Team" Orientation: Does the candidate receive satisfaction from operating as a member of a team, and accomplishing group (in addition to personal) objectives?

Interaction Skills: Can the candidate create and maintain cooperative and friendly working relationships?

Communication Skills: Can the candidate present ideas clearly and understandably?

Specific behaviors rated positively:

1. Actively participated in exercise
2. Helped out other group members
3. Asked for others' input
4. Checked for group agreement
5. Acknowledged others' input

6. Offered ways for group members to work together rather than individually (e.g., repeatedly encouraged all members to participate in suggestions/ changes and in discussions)
7. Actively sought to include a quiet or difficult group member
8. Performed actions or made comments that helped keep the group motivated

Specific behaviors rated negatively:

9. Spoke unclearly and was hard to understand
10. Was inconsiderate and not tactful with others.
11. Was impatient with others (e.g., interrupted in disruptive manner)

2. Problem Solving

The ability to identify needed actions to correct problems or improve methods and operations. Important to this is the ability to identify the key characteristics of a problem (e.g., the nature of a breakdown) and the subsequent actions necessary. Also important is the ability to assign priorities to the steps needed to complete a job. Key assessment areas include:

Prioritizing Tasks: Can the candidate identify the necessary order of activities to allow a job to be completed efficiently and effectively?

Concrete Reasoning: Is the candidate able to reason through the causes of equipment or machine malfunctions, and identify

needed repairs? Does the candidate go beyond "surface" reasons to attempt to identify underlying causes of problems?

Creativity: can the candidate generate new or different ways to solve a problem or to perform an operation? Can the candidate identify ways to improve methods or operations?

Specific behaviors rated positively:

1. Offered ideas and suggestions
2. Recognized symptoms and looked for underlying causes
3. Built on others' ideas
4. Asked for clarification
5. Laid out a series of steps; offered approaches to help reach solutions
6. Prioritized the group's activities
7. Maintained the group's focus on tasks and goals (e.g., considered time constraints).
8. Clarified others' ideas

Specific behaviors rated negatively:

9. Engaged in irrelevant or prolonged discussion
10. Jumped from one topic to another during group discussion
11. Presented thoughts as unquestioned facts.

3. Openness to Change

The willingness and ability to accept that there are different ways of doing things, and to operate in an environment that demands continuous improvement in operations and methods. Important to this is an openness to new technologies and ways of doing things, coupled with an orientation toward actively anticipating and preparing for needed changes. Also important is the willingness to take action when needed changes or improvements are identified. Key assessment areas include:

Openness to Technology: Is the candidate willing to accept and use new technologies? does the candidate actively attempt to learn about new technologies when offered the opportunity?

Flexibility: Is the candidate willing to view problems or issues from different points of view, thoughtfully considering each while still not being "wishy-washy?" Can the candidate see ways to improve past actions?

Initiation of Improvements: Is the candidate willing to "take action" to improve the way things operate or to anticipate needed changes? Has the candidate acted to improve personal skills?

Specific behaviors rated positively:

1. Appeared willing to accept others' ideas to change things
2. Discussed and considered alternative action/points of view
3. Assisted in implementing changes/new ideas

4. Viewed problems from more than one perspective
5. Actively sought out and/or implemented ideas for change
6. Asked for and accepted feedback on own ideas

Specific behaviors rated negatively.

7. Reacted negatively to feedback
8. Appeared reluctant to accept others' ideas

4. Work Orientation

The willingness to work independently and ensure that the work being done conforms completely to quality standards. Important to this is that the candidate takes "ownership" of work products, and takes pride in the fact that the products are of high quality. Also important is a "service" orientation. The candidate should recognize the needs of the recipients of work products, and be oriented toward ensuring that the products will fully satisfy the needs. Candidates who are especially high on this dimension will go beyond looking to satisfy customers, instead being oriented toward creating enthusiasm for the product. Key assessment areas include:

Customer Orientation: Is the candidate able to define the key needs of recipients of work products? Can the candidate identify what is/was necessary to satisfy those needs? Is the candidate oriented toward going beyond satisfying the needs?

Working Independently: Will the candidate take personal responsibility for ensuring that a work product meets standards? Is the candidate oriented toward ensuring that all details are satisfied, even if that requires special effort or repetitively performing the same sets of tasks?

Personal Integrity: Will the candidate honor commitments, ensuring that promised actions are completed on time and with the intended results? Will the candidate ensure that company property and finances are not used for personal gain?

Specific behaviors rated positively:

1. Worked steadily to achieve group goals
2. Reviewed own products/suggestions to ensure their quality
3. Volunteered for or took on additional responsibilities to ensure the group's goals were achieved
4. Followed instructions accurately
5. Showed concern for the needs of the person receiving his or her product or work
6. Made certain that the group's results were high quality
7. Showed concern for the productiveness of others and the efficiency of the process

Specific behaviors rated negatively:

8. Wanted to "get it done" rather than "get it done right"
9. Complained or made nonconstructive comments.

VITA

David Alan Futrell was born in Hopkinsville, Kentucky on July 16, 1962. He moved to Hammond, Indiana (a Chicago suburb) in 1966 where he attended Porter Elementary, Morton Middle, and Morton High Schools. In 1978, he moved back to Hopkinsville and graduated from Hopkinsville High School in May, 1980. After spending a year employed as a Mazda technician, he entered Murray State University, graduating in 1986 obtaining a Bachelor's degree with a Psychology major and Business Administration minor. Following graduation, he entered the Industrial/Organizational Psychology program at the University of Tennessee, Knoxville. After completing coursework, he began work at Saturn Corporation in Spring Hill, Tennessee helping establish and validate employee selection procedures. He received his Ph.D. in May 1992.

He is presently employed as the Team Leader for Product Data Analysis in Service Engineering at Saturn Corporation in Spring Hill, Tennessee.