"The Teller is the Feller": A Mixed-Methods Examination of Student Perceptions of Teammate Behavior, Basic Psychological Need Fulfillment, and Gender in Undergraduate Engineering Student Project Teams

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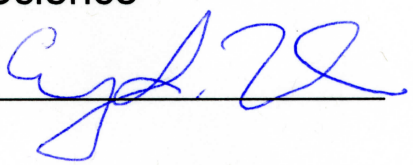
Author Signature: 

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Abstract

Undergraduate engineering project courses are frequently characterized by a large teamwork component – but these important student experiences can be diminished by teammates exhibiting undesirable behaviors such as lacking initiative or failing to advance the project. According to self-determination theory, all behavior is sparked by a spectrum of context-specific motivations: intrinsic, extrinsic, and amotivation. Intrinsic motivation refers to engaging with an activity for its own sake and is the type most associated with positive educational outcomes. To achieve intrinsic motivation, one's environment must support three basic psychological needs: autonomy, competence, and relatedness. This thesis is an investigation of the links between perceptions of undesirable teaming behaviors, gender, and these basic psychological needs.

Two surveys were used to collect data for this project. The Basic Psychological Needs Scale was adapted from its original form to measure the extent to which participants experienced autonomy, competence, and relatedness within the project team context. The Team Behaviors and Attitudes Survey was developed to measure how frequently and severely a participant perceived undesirable behaviors by teammates. Additionally, demographic information was collected from participants. 89 undergraduate students representing forty-three long-term project teams participated from a variety of engineering disciplines at the University of Virginia.

Results focus on the relative influence of the actor, target, and dyad on the perceptions of the actor ("rater") about undesirable team behaviors of the target ("ratee"). Thus, actors indicated not only the presence of certain behaviors in teammates but also the severity of these behaviors. With respect to gender, perceptions of peer behaviors in terms of severity significantly correlate with the gender of the actor in many cases. Male actors were found to rate others significantly

more severely than female actors, regardless of the gender of the target. For two behaviors, however, the gender of the target predicts severity ratings (*Failure to prioritize project* and *Lack of* initiative). The genders of the actor and target and their interaction did not significantly predict how frequently behaviors were perceived.

An actor's perceptions of their teammates were found not to relate to the fulfillment of each of their basic psychological needs separately, except for one behavior - "Failure to prioritize the project". In that case, students who felt autonomous and connected to their teammates but who lacked competence were likely to rate their teammates as exhibiting negative behaviors more frequently and severely. Similarly, associations between gender and basic psychological needs as a whole were not found. K-means clustering was used to characterize six motivational "profiles" based on participants' relative levels of autonomy, competence, and relatedness within the team context. Individuals with the highest relatedness scores also tended to have the highest autonomy and competence scores, and females and males were housed relatively proportionally in this group. Furthermore, extreme imbalance between autonomy, competence, and relatedness scores was not observed – while one construct may have been experienced to a greater extent than the others, the discrepancy was not large. High scores on one construct predicted high scores on the other constructs and low scores on one construct predicted similarly low scores on the other constructs.

Supplementary analyses were conducted to add context to this study. Qualitative sense-making was employed to develop seven larger themes that speak to the values of students underlying disapproval of peer behaviors. A Social Relations Model was estimated using multilevel modeling to compare how the variance in the overall behavior scores is distributed between the actor and target; the larger source of variance was found to be the target.

This project has implications for instructors to construct and improve team functioning in undergraduate engineering project courses by better understanding how students experience their project team environments and why. Furthermore, instructors may improve peer assessments by better understanding factors related to the identity of the actor (like gender) that impact perceptions of undesirable team behaviors. Some behaviors are more conducive to straightforward and objective observance and some to subjectivity on the part of the actor.

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Chapter 1: Introduction

Group work is an essential component of engineering classrooms. Studies have shown that working in small groups promotes greater academic achievement, more favorable attitudes toward learning, and increased persistence (Springer, Stanne, and Donovan 21-51). Group work is also thought to prepare students for the "real world" in engineering industry, where teamwork is prevalent. Graduates of engineering programs have reported that learning how to work in multidisciplinary teams was a key aspect of their post-graduate industry positions, spending 60-80% of their time working on a team with other engineers (Martin et al. 167-180). A key reason for this is that working on teams allows larger engineering challenges to be tackled than one engineer alone could have completed. Instructors may also want students to learn from one another – one student may have strengths, knowledge, or skills another does not – and thus the quality of the final product can be enhanced.

Purpose of the Study

Teams, however, are made of individuals that are imperfect – thus, the conditions of teams may not always be ideal. How students experience their teams is certainly of importance for any instructor wanting to support student persistence in engineering (C. Mcdowell et al. 602-607; Cross and Vick 820-832; Suresh 215-239). While some students perform at high levels on teams, other students may fail to contribute to the extent their instructor or teammates desire.

Understanding the subjective student experience in project teams is important in terms of helping students learn how to be better teammates in school and the workplace, designing more relevant peer assessments, and ultimately positively impacting students' motivation and

persistence in engineering. Perceptions of teammate behavior can be driven by other factors than simply observance of behavior. Social identity theory (Tajfel and Turner 276-293) posits that easily-accessible differences between people, like gender, inform social categorization of people into groups, social identification of the groups to which we ourselves belong, and social comparison, in which in-group/out-group distinctions frame our perceptions of our own group and others'. Thus, gender may be one factor that helps inform our discernment of how others behave.

The subjective student experience on teams is also important because students may interpret different behaviors as unacceptable in comparison to instructors. For example, instructors may welcome the opportunity to put high- and low-performing students on the same team to encourage learning, while students expect their teammates to assume ownership over a piece of the project and may interpret lower skills levels as holding the team back from effectively working toward the finished product. In past research, students expressed dissatisfaction with the work of peers in ways not captured by instructor expectations (Miller, Hirshfield, and Chachra). Of the eleven total undesirable team behaviors identified, some fit the idea of a "slacker", like failing to prioritize the project. Others are more unexpected behaviors such as *Restricting others' work* (a full list of eleven undesirable, or "negative" teaming behaviors is in Appendix B). Why these different types of behaviors are perceived by teammates was not identified in the prior research; however, differences in student motivation were hypothesized to be a possible driver. This hypothesis grew out of the observation that the eleven behaviors differed in terms of their activity levels: some (like *Failing to advance the project toward completion*) displayed a complete lack of activity whereas behaviors like *Restricting others' work* were perceived to be excessively active (e.g. spending time re-doing work already

done sufficiently by others). Noting that even negative behavior stems from some motivation, less active behaviors were thought to be connected with amotivation, a failure to see the connection between one's own efforts and outcomes. In contrast, other behaviors were viewed as active and controlling and were thought to be driven by mistrust or fear of failure, leading to strained team dynamics. Though different types of motivation may be present in the same person (Ratelle et al. 734-746), these behaviors were hypothesized to be consistent with extrinsic motivation, such as fear of getting a poor grade (Miller, Hirshfield, and Chachra).

The focus of this research is to explore if and how student motivation leads to the perception of undesirable behaviors on teams, if and how perceptions of behavior depend on the gender identity of the individual judging or being judged, and how gender identity may correlate with motivation on project teams.

Research Questions

The overarching question driving this entire thesis is:

What causes undesirable team behaviors to be perceived by teammates?

Three core and three supporting research questions are used to explore this overarching question. They are as follows:

Hypothesis 1: The gender identity of the actor, target, and dyad play a role in how undesirable team behaviors are perceived by teammates.

Research Question 1: Do the perceptions of undesirable team behaviors in terms of frequency or severity vary with the gender identity of the dyad, actor, or target?

Hypothesis 2: The motivation of the actor plays a role in undesirable team behaviors being perceived by teammates.

Research Question 2: Do the perceptions of undesirable team behaviors vary with the fulfillment of basic psychological needs of the actor as framed by self-determination theory?

Supporting Research Questions

Research Question 3: Are female students' fulfilment of basic psychological needs different than that of male students in the student project team environment?

Research Question 4: Is the variance in perceptions of undesirable team behaviors driven more by the actor or target?

Research Question 5: What underlying values are important to students as they navigate team behaviors and relationships?

Research questions 1-3 represent the intersection of three major constructs: basic psychological need fulfillment (autonomy, competence, and relatedness), perceptions of peer behavior in terms of each of the eleven undesirable behaviors, and gender identity of the individuals in question. These can be visualized in Figure 1. Research questions 4 and 5 focus only on the construct of perceptions of peer behavior. Overall, these five research questions seek to address the potential subjective sources of differences between how peer behavior is perceived due to the identities of the people involved apart from an objective measure of actual behavior.

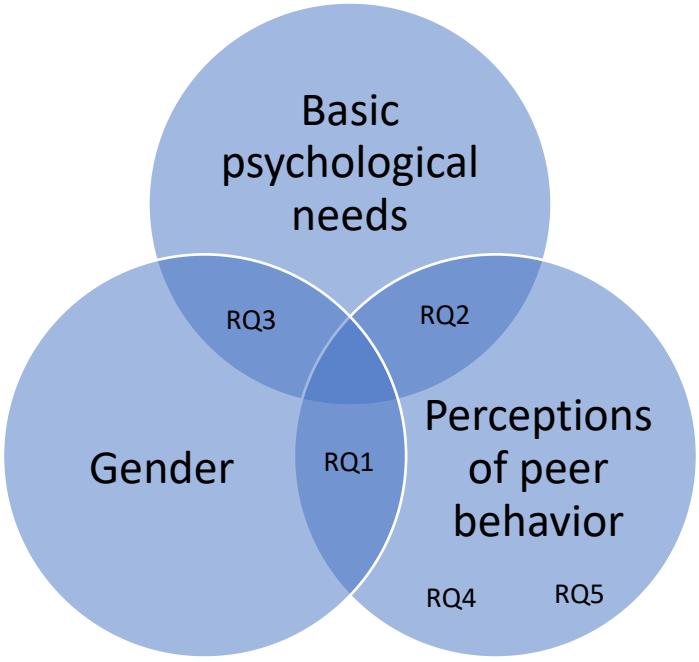


Figure 1: Construct visualization of research questions

Chapter 2: Literature Review

Three areas from the research literature form the basis of this project: peer assessments on teams, motivation as framed by self-determination theory, and drivers of peer perceptions through the lens of expertise recognition. The forum for most students to provide feedback about their teammates is through instructor-created peer assessments. However, different behaviors may be perceived as acceptable through the eyes of students than instructors. Behaviors identified by students have been shown to differ in terms of their relative "activity" levels, suggesting differences in motivation. (Miller, Hirshfield, and Chachra) Self-determination theory views motivation as a spectrum ranging from amotivation (complete lack of motivation) to intrinsic motivation (doing something for its own sake) which is the type most associated with positive educational outcomes. The presence or absence of three constructs that support intrinsic motivation may help explain these differences in peer-derived behaviors. Furthermore, perceptions of behavior are not objective and may be driven by a variety of factors apart from behavior itself. Expertise recognition literature is examined as a way of examining what factors may influence how and why peers perceive certain behaviors or qualities about one another.

In engineering classrooms, teamwork experiences are commonly employed to (1) help students thrive in the team environment they are likely to enter post-graduation, (2) support students' development of communication, innovation/creativity, and design skills (Borrego et al. 472-512) and (3) support the ABET accreditation criteria that states students must develop "an ability to function on multidisciplinary teams" (ABET)

Educators' care toward their students is exhibited not only by directly supporting a student's learning and performance, but also by optimizing their experience within the classroom. In their

seminal work, Erickson and Schultz argue for increased research efforts surrounding the student experience in this way:

> "Why would any educator need to know about student experience of the curriculum? We can test students to find out if they learned or not. If there is sufficient money and we are well organized enough we can reteach those who didn't learn the first time around and catch those who slipped through the cracks and somehow didn't get taught at all. But if we are concerned that a wide range of students learn judgment and reasoning, as well as facts, perhaps a clearer understanding by educators of students' subjectivity in school is required." (Erickson and Shultz 465-485)

Undergraduate engineering education is one particular space in which students must learn much more than specific content from the curriculum – they must learn teamwork, problem-solving, design, and furthermore develop a sense of their own identity within engineering. Thus, understanding the subjective experience of students on teams is critical.

Teams and Assessments

Team environments in educational settings are unique in that the performance of a team (and thus, of an individual) is impacted by the behavior and idiosyncrasies of different team members. These behaviors may aggregate by way of composition, in which all team contributions are weighted equally and the team outcome is a linear combination of team member inputs, or compilation, in which more complex relationships emerge (Stewart, Fulmer, and Barrick 343-365). Either way, team outcomes depend on the contributions of its members. (Sonnentag and Volmer 37-66; Stewart, Fulmer, and Barrick 343-365) For an individual participant on a team that is not functioning well, this means that one's grade, ability to attain course learning

objectives, and perspective on their own learning experience may be negatively impacted by the failure of other team members to contribute effectively.

To mitigate this risk, many educators have adopted peer assessments. These assessments typically ask students to rate one another's performance on a Likert scale (Zhang; Gueldenzoph and May 9-20). When adopted at intervals during the project, these assessments can be used formatively to help diagnose problems and correct errant behaviors. They can also be used as a motivational tool to encourage active participation by using teammate perceptions of an individual as a factor in one's project grade (Fallows and Chandramohan 229-246) Teamwork often takes place away from the eyes of the instructor; thus, these tools encourage accountability and discourage "social loafing" – a phenomenon in which individuals tend to exert less effort when working collectively than individually. (Borrego et al. 472-512) Furthermore, these peer assessments have been found to promote cooperation, higher levels of performance, and team member satisfaction. (Erez, Lepine, and Elms 929-948)

A taxonomy of behaviors typically evaluated by instructors in these assessments was developed by Baker in a meta-analysis of the literature on this subject. She identifies eight components (Baker 183-209):

1. Attended group meetings; was available and on time
2. Was dependable, kept his or her word
3. Submitted quality work
4. Exerted effort and took an active role
5. Cooperated and communicated with others
6. Managed group conflict
7. Made cognitive contributions; possessed and applied necessary knowledge and skills
8. Provided structure for goal achievement

As these evaluation tools are developed by instructors, the desired behaviors as listed are top-down rather than bottom-up. How the students themselves are perceiving their own learning

environment is vitally important to their persistence in engineering (C. Mcdowell et al. 602-607; Cross and Vick 820-832; Suresh 215-239). In prior work, eleven behaviors have been identified by peers as undesirable in group settings. (Miller, Hirshfield, and Chachra) These include expecting too much from others, failure to advance the project toward completion, failure to prioritize the project, inconsistency of contributions, inconsistency with an engineering identity, lack of communication, lack of competence/experience/skills, lack of initiative, procrastination, restricting others' work, and unreliability. Though many of these undesirable behaviors overlap with ones identified by instructors, some aspects of teammate behavior viewed as important to students are not reflected in most instructor-created peer assessments. The mapping of Baker's meta-analysis and these eleven undesirable behaviors can be found in Table 1. Definitions and example quotations for each of these behaviors can be found in Appendix B.

Table 1: Comparisons between positive behavioral components and negative emergent categories

Meta-analysis of Effective Team Behavioral Components (Top Down) (Baker 183-209; Miller, Hirshfield, and Chachra)	**Emergent Categories of Undesirable Teammate Behaviors (Bottom-up)** (Miller, Hirshfield, and Chachra)
Attended group meetings; was available and on time	Failing to prioritize project
Submitted quality work	Lack of competence, experience, or skills
Exerted effort and took an active role	Failing to advance toward project's completion; Lack of initiative
Cooperated and communicated with others	Lack of communication
Managed group conflict	N/A
Made cognitive contributions; possessed and applied necessary knowledge and skills	Lack of competence, experience, or skills
Provided structure for goal achievement	N/A
Was dependable, kept his or her word	Unreliability, Procrastination, Inconsistency of contribution
N/A	Expecting too much from others
N/A	Inconsistency with an engineering identity
N/A	Restricting the work of others

The components (in terms of undesirable behaviors) that emerged from the bottom-up, student perspectives which were not in the top-down instructor view include expecting teammates to contribute beyond their "fair share", possessing traits (personality, motivation, etc.) that seem to conflict with an engineering identity, and directly or indirectly inhibiting the group from completing its work in a timely manner (Miller, Hirshfield, and Chachra). The two components that were only in the top-down instructor view were both specific management skills related to running a successful team.

Motivation and Basic Psychological Needs

The theory of motivation underpinning this research is self-determination theory (SDT). SDT "views humans as inherently oriented toward actualizing their capabilities"(DeHaan, Hirai, and Ryan 2037). Newton's first law of motion tells us that an object at rest stays at rest unless acted upon by an outside force. Humans too will act, strive, and produce only in accordance with their motivations. Though colloquially people often express motivation as a binary state (either motivated or unmotivated), SDT describes a continuum of motivations according to the entity "determining" the activity: from complete lack of motivation (amotivation) to extrinsic motivation (determined by an external stimulus) to intrinsic motivation (determined by the self) (Figure 2). (Ryan and Deci 54-67) Intrinsic motivation occurs when a person is driven to act based on the inherent satisfaction derived from participating in the activity. It is the "inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn" (Ryan and Deci 68-78). **Intrinsic motivation** is linked with promoting creativity and improved performance on tasks, both of which relate directly to positive educational outcomes (Deci and Flaste). **Extrinsic motivation** occurs when an activity is performed to achieve some external outcome. For example, a student might take a class they find uninteresting because they believe it will improve their GPA or help them get a job. **Amotivation** describes a complete lack of motivation, typically due to an individual not seeing the connection between their actions and desired outcomes.

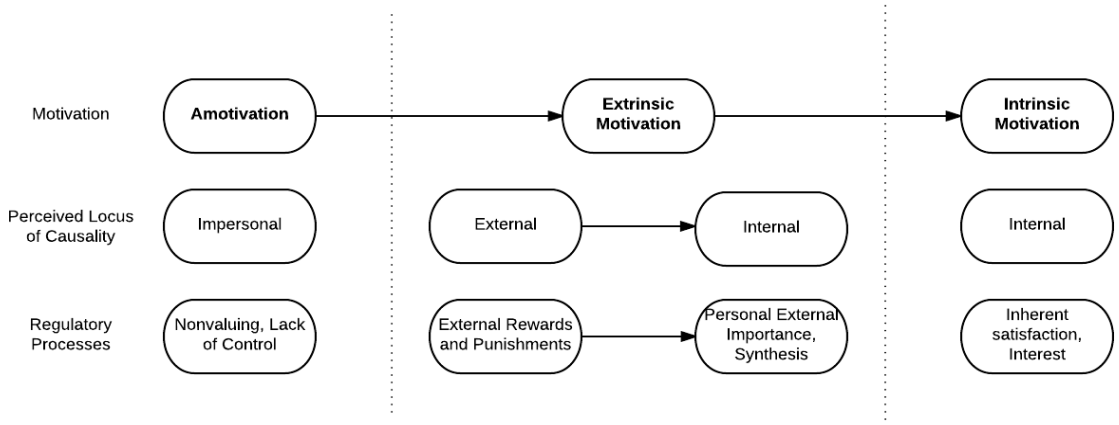


Figure 2: Simplified (Ryan and Deci 68-78) Self-Determination Continuum

Processes like intrinsic motivation support the actualization of one's capabilities, but the environment a person is situated in can help or hinder this development. The "helping" aspects include the extent to which an individual feels autonomy, competence, and relatedness within that environment. **Autonomy** refers to the extent to which a person has the freedom to choose their own goals and activities. **Competence** is the extent to which a person feels capable of doing the things he or she has set out to achieve. **Relatedness** is how much a person feels connected to and cared for by others in their immediate reality. These three aspects are known as ***basic psychological needs***, and account for variability in levels of intrinsic motivation. They have been shown to be innate and universal to all people (though in different amounts), regardless of gender, class, or whether people consciously rate these needs as being important to them (Ryan and Deci 68-78). The satisfaction of these needs is associated with positive outcomes such as adaptive psychological functioning and health behavior changes. Basic need satisfaction in all three arenas consistently predicts wellbeing and flow, a state of intrinsically-rewarding complete absorption in one's endeavors. (Schuler, Brandstatter, and Sheldon 480-495; Ryan and Deci 68-78; Nakamura and Csikszentmihalyi 89-105) Subtheories of Self-Determination Theory, including Basic Psychological Needs Theory, suggest that psychological wellbeing and optimal

functioning depend on an environment that supports each of these needs. Intrinsic motivation itself is predicated on these three factors being present in an environment. (Ryan and Deci 68-78) Basic psychological need satisfaction has been found to be a "significant mediator of the effects of subjective socioeconomic status, household income, and income inequality on health complaints even when controlling for individual differences in … sex and age." (Di Domenico and Fournier 1679-1697) Need satisfaction is shown to impact both students and teachers. For students from varying backgrounds, academic performance may be mitigated by prioritizing basic psychological need satisfaction in the classroom and on teams. Satisfaction of these three needs also allayed the effects of stress levels and emotional exhaustion for new teachers. (Aldrup, Klusmann, and Lüdtke 21-30)

While instructors may be tempted to view "slackers" as possessing an immutable characteristic that makes them a poor teammate, it has been widely found across variable domains that differences in motivation (intrinsic, extrinsic, or amotivation) have an impact on individuals' behaviors. That is, behaviors (even if undesirable) spring from some type of motivation. For example, researchers studying schizophrenic behavior suggested that "maintenance of frequent participation in physical activity over a longer period in this particular population is reflective of both the quantity (i.e., lower levels of amotivation) and quality (i.e. a shift from controlled to autonomous regulations) of motivation." (Vancampfort et al. 171-176) Furthermore, behavior of some individuals can significantly impact motivation types of others in that context. Research on athletic coaches suggests that the behavior of coaches, except social support, significantly predicted autonomy, competence, relatedness, and overall intrinsic motivation of their athletes. (Hollembeak and Amorose 20-36) Other researchers found that "autonomy supportive coaching style had an indirect and positive effect on prosocial behavior",

where prosocial behavior can be understood as any behavior intended to help another person. (CHEN et al. 1889-1900)

In the classroom setting, the perception of controlling (i.e. giving students few choices) teaching behaviors was found to correlate positively with students' frustration and negatively with autonomous motivation levels. (Bartholomew et al. 50-63) In a study in which students were randomly assigned to either autonomy-supportive teachers or controlling teachers, students in the autonomy-supportive group reported higher intrinsic motivation, perceived competence, and self-esteem. (E. L. Deci et al. 642-650) Students told to learn material either to teach it to others or to be tested themselves reported similar levels of rote memorization. However, the "teaching" group reported higher levels of intrinsic motivation, more conceptual learning, and more active engagement with the subject. (Carl and Edward 755-765) A study measuring autonomy, competence, and relatedness of teaching styles (measured through autonomy-support, structure of the classroom, and involvement, respectively) found that these three qualities influenced students' perceptions of their teachers as well as their engagement. (Skinner and Belmont 571-581) Thus, it is reasonable to hypothesize (as in this thesis) that an individual's scores for autonomy, competence, and relatedness are related to how that individual perceives teammate behaviors.

It can be expected, then, that instructors also have the opportunity to support motivation that will lead to positive educational outcomes for students. Effective potential interventions for instructors to use for teams not functioning optimally are explored in one research review of team effectiveness constructs from industrial and organization psychology and engineering education literature. Because most educational project teams are formed within one class and one major discipline, students have less opportunity to bring diverse skills to a team. In such

situations, instructors should strive to emphasize a project's complexity in order to force teams to coordinate their efforts and work harder. Some studies suggest specific teamwork training for team members, creating teams on a "trial plan" and allowing students to switch early on if personalities do not mesh, or avoiding forming teams when the work can be done by an individual. (Borrego et al. 472-512)

Perceptions of Peer Behavior

Thomas-Hunt and Phillips note that perceptions do not always match reality by saying, "the complexity of most organizational tasks makes it difficult for expert members to demonstrate the correctness of their perspective prior to the completion of the group's task and the receipt of feedback from sources external to the group. Consequently, teams often have difficulty assessing the veracity of members' claims of expertise" (Thomas and Phillips 1585-1598). Evaluations of expertise within a group may differ between individuals, and thus may be colored by the idiosyncrasies of those individuals. These evaluations also may or may not reflect the true nature of the object of evaluation. Some studies have found that among women, educational status as objectively measured by education level attained does not significantly predict expertise evaluations (Thomas and Phillips 1585-1598; Joshi 202-239)

This may be explained in part by social identity theory (Tajfel and Turner 276-293) which posits that easily-accessible differences between people, like gender, form the basis for in-group/out-group distinctions. People tend to prefer the in-group in a context-specific way. For example, a male job applicant may be preferred for a traditionally "male" position such as police chief whereas the female job applicant may be preferred for a traditionally "female" position

such as nurse. These preferences are not always explicitly known to the evaluator. One study found that male and female applicants for the same position were not found to actually possess different strengths, but rather that the evaluator redefined the criteria deemed necessary for job success to favor the specific credentials that the in-group candidate happened to possess. The evaluators in this case were not aware of their own implicit biases. In fact, perceiving one's own judgments as objective actually predicted greater bias (Eric and Cohen 474-480) As engineering is widely known to be a male-dominated field, women are often perceived to be members of the "out-group" in this context. Thus, expertise judgments made about peers may be influenced by the implicit biases associated with the in-group/out-group distinction.

The greatest variance in expertise evaluations has been shown to be exhibited not through the attributes (such as gender or education level completed) of the person being evaluated (i.e., the target) as one might expect, but rather through the attributes of the person providing the evaluation (i.e., the actor) and the relationship between the two individuals (i.e., the dyad) (Joshi 202-239). Instructors may hope that high-performing students will help weaker students on a diversely-performing project team. However, Van Der Vegt suggests that levels of interpersonal commitment to help one another felt between individuals on a team were predicted by the relationship between those two group members. High-performing students were apt to help other high-performing students, leaving students with weaker histories of performance to rely on other weak students. (Van, Bunderson, and Oosterhof 877-893).

In this thesis I argue that, in the same way, perceptions of the severity and frequency of undesirable team behaviors differ between individual evaluators and that those perceptions may be influenced by factors, such as gender, not associated with actual presence or severity of said

behaviors. In particular, I hypothesize that the discrepancies in perceptions of an individual are influenced by the gender identity of the evaluator.

Chapter 3: Methods

Participants

Participants in this study were recruited from undergraduate engineering project classes at the University of Virginia. Examples include Synthesis Design II (ENGR 1420) and Civil Design (CE 4991). With the consent of class instructors, a sign-up email was circulated including the link to the survey itself. In some cases, a short presentation was also given in the relevant class to recruit participants. Participants must have been currently working on a team for a time period of at least 4-6 weeks at the time of the survey, and they could take the set of two surveys (Basic Psychological Need Satisfaction Scale and Team Behaviors and Attitudes Survey) at their own leisure on a computer via Qualtrics. Both surveys were completed at the same time. In this way, about 350 students were recruited, yielding 89 respondents (response rate: 25.4%).

Surveys

A mixed-methods approach was adopted. Two surveys were used: the Basic Psychological Need Satisfaction Scale (BPNS) (Ryan and Deci 68-78; Gagné 199-223), which has been used and validated widely, and the Teammate Behavior and Attitude Survey (TBAS), which was developed for the specific purposes of this study.

Basic Psychological Need Satisfaction Scale

The Basic Psychological Need Satisfaction Scale is a 21-item questionnaire based in self-determination theory that assesses the extent to which an individual's need for autonomy, competence, and relatedness to others is met within a particular context. The general scale has been modified to fit a variety of different contexts including but not limited to the work and

relationship domains (Kasser, Davey, and Ryan 175-188; E. L. Deci et al. 930-942; Ilardi et al. 1789-1805). For the purposes of this study, the general scale was modified to fit the classroom team domain as shown in Appendix A. Respondents answered each item on a scale from 1 (not at all true) to 7 (very true). Seven items correspond to the autonomy construct, six items to the competence construct, and eight items to the relatedness construct. A composite score for each subscale (i.e,. autonomy, competence, relatedness) is obtained by first reverse scoring the items that are phrased negatively (Items 3, 4, 7, 11, 15, 16, 18, 19, and 20) and then averaging the items on the relevant subscales. As such, the output of this questionnaire are three scores ranging from 1 to 7 for each subscale.

Counts of missing answers to items in the BPNS can be found in Table 2. (R) indicates a question was asked in the reverse and later needed to be reverse scored.

Table 2: Missing value counts and attributes in BPNS

Question Number	Corresponding basic psychological need	Count of missing answers (of 89 total participants)
1	Autonomy	0
2	Relatedness	17
3 (R)	Competence	5
4 (R)	Autonomy	18
5	Competence	0
6	Relatedness	0
7 (R)	Relatedness	23
8	Autonomy	0
9	Relatedness	0
10	Competence	1
11 (R)	Autonomy	6
12	Relatedness	0
13	Competence	2
14	Autonomy	0
15 (R)	Competence	17
16 (R)	Relatedness	19
17	Autonomy	5
18 (R)	Relatedness	39
19 (R)	Competence	24
20 (R)	Autonomy	29
21	Relatedness	0

One main factor appeared to be driving missing values - reverse scored items had considerably higher missing rates than items scored regularly. The average number of missing values for reverse scored items was 20.0. In comparison, the average number of missing values for regularly scored items was 2.08. Closer examination revealed that this effect was a result of the format of the survey. After each item, participants used a slider to describe to what extent they identify with the given statement, ranking their response from 1 (Not at all true) to 7 (Very true). Each slider was gray in color until the student dragged it to match their chosen response, at which point it turned blue. The default of the program was to have a custom start position for the slider, which was 1 (Not at all true) for questions 1 and 4-21 and 7 (Very true) for questions 2

and 3. Sliders that were not adjusted were recorded as "missing" though some students may have meant to answer the question with the custom start position.

Seven items on the BPNS relate to autonomy, six items to competence, and eight items to relatedness. Upon review of the data, 100% of the participants answered more than half of the questions per construct (4 items for autonomy, 4 items for competence, and five questions for relatedness). Given the pattern of missing values it was reasonable to assume that questions listed as missing were due to students agreeing with the preset custom start position of the slider. Thus, all missing values were recoded with the value corresponding to that question's custom start position ("1" for questions 1 and 4-21 and "7" for questions 2 and 3). After recoding, there were assumed to be no missing values.

Team Behaviors and Attitudes Survey

In conjunction with this established survey, a second survey was constructed for the purposes of this study. The Team Behaviors and Attitudes Survey (TBAS) explores teammate perceptions of one another's behavior over the course of the class project in which they participated using a round-robin format. In particular, it examines eleven distinct types of undesirable teaming behaviors identified in previous work (Miller, Hirshfield, and Chachra), including

- expecting too much from others,
- failing to advance toward project's completion,
- failing to prioritize project,
- inconsistency of contribution,
- inconsistency with an engineering identity,
- lack of communication,
- lack of competence, experience, or skills,

- lack of initiative,
- procrastination,
- restricting others' work, and
- unreliability.

The survey also collected demographic information, such as sex, age, and year in school to analyze whether perceptions of contribution differed between groups.

Ideally, each individual on a team would complete the TBAS survey to provide a more complete picture of how each individual was widely perceived to behave. Incentive structures encouraged volunteering in conjunction with other teammates. The payment associated with participation in this study increased for each individual on a team if the entire team participated. However, not every member from each team participated.

This survey was meant to be a starting point for a mixed-methods analysis. Therefore, it was important to provide questions to be analyzed statistically as well as ones asking participants to deeply reflect and verbalize their commentary about teammate behaviors. Verifying that participants understood the concept of each vignette presented was a high priority.

The final survey was built in a branched format. First, respondents answered demographic questions about themselves such as their year in school, major, and age. They also indicated their team's size and their teammates' first names (Appendix C). They answered a series of 3 questions about their overall impression of contributions made to the project by each teammate. Then, they read a list of 11 vignettes that corresponded to the 11 identified negative team behavior types (Miller, Hirshfield, and Chachra). To reduce fatigue and order effects, all 11 behavior vignettes were presented at once. Listing previously named teammates one at a time, participants answered three quantitative questions about their overall viewpoint about each teammate's contributions. Then, respondents indicated whether each teammate exhibited each

behavior binarily (yes/no) in one long form. Participants were asked to be particularly sensitive, answering "yes" if a behavior occurred even once. Answering "no" constituted a score of "0" for that particular behavior and teammate. Answering "yes" led to a series of four quantitative and three qualitative questions about that teammate and behavior. The four quantitative scores assessed frequency, effect on personal experience, effect on team's work quality, and effect on team overall. These last three question scores were averaged, yielding a score between 1 and 7 for that teammate. A score of "4" indicated "no effect". Scores above four indicated increasingly positive evaluations of the behavior while scores below four indicated increasingly negative evaluations. In total, behaviors were scored from 1 to 7, so that each teammate had a score for each behavior (Table 3). This branched format provided multiple benefits. First, it allowed participants to compare the behavior vignettes to one another and see the differences more clearly. Second, if respondents knew that answering "yes" required more work beforehand, they might have been less honest about which behaviors did and did not occur.

Table 3: Sample collected data

	Demographics				Team Member #1					Team Member #2				
	Sex	Discipline	Age	...	Overall	Behavior 1	Behavior 2	Behavior 3	...	Overall	Behavior 1	Behavior 2	Behavior 3	...
Participant 1	F	Systems	19		3.7	0	0	0		5.1	5.21	0	6.27	
Participant 2	M	Computer	21		4.2	0	3.95	0		4.4	5.33	2.87	0	
Participant 3	M	Civil	22		2.8	4.26	5.13	0		4.3	0	0	4.33	

Cognitive interviews were conducted to test preliminary survey questions. Each interviewee was an engineering graduate student who was either currently on a team project or had recently concluded one. The significant problem identified was that the interviewees had a hard time distinguishing between the concepts presented in the 11 vignettes, so the wording was updated to more clearly differentiate between them. Quantifiers were also updated to be more concrete (e.g. "Did you enjoy working with _____?" became "How frequently did you enjoy working with _____?" 1: Never, 2: Less than half the time, 3: More than half the time, 4:

Always). Furthermore, the survey asked for class affiliations that ensured each student was uniquely identified.

Sample

The sample is examined at three levels: individuals, dyads (pairs of two), and groups. Each level has a set of characteristics specific to that level. The individual level considers age, gender, year in school, race, and major. The dyad level considers the specific class in which the pairs were enrolled and prevalence of identification of behaviors. The group level considers number of teams reported, number of full teams, average team size, and average reported length of time since the team was formed.

Individuals

In total, 89 unique respondents completed both surveys. These students had an average age of 21.07 (with five students not giving their age). 50.6% of respondents were female, and 49.4% were male. 6.7% were first-years, 0% second-years, 22.5% third-years, 67.4% fourth-years, and 3.4% greater than four years (undergraduate). 76.4% identified as White, 16.8% Asian, 3.4% Black, and 3.4% as Other. 46.1% of respondents were enrolled or planning to enroll in biomedical engineering and 31.5% in systems engineering, with other disciplines represented in small numbers (engineering science, mechanical engineering, aerospace engineering, civil engineering, and computer engineering). The breakdown of demographics by gender is found in Figure 3.

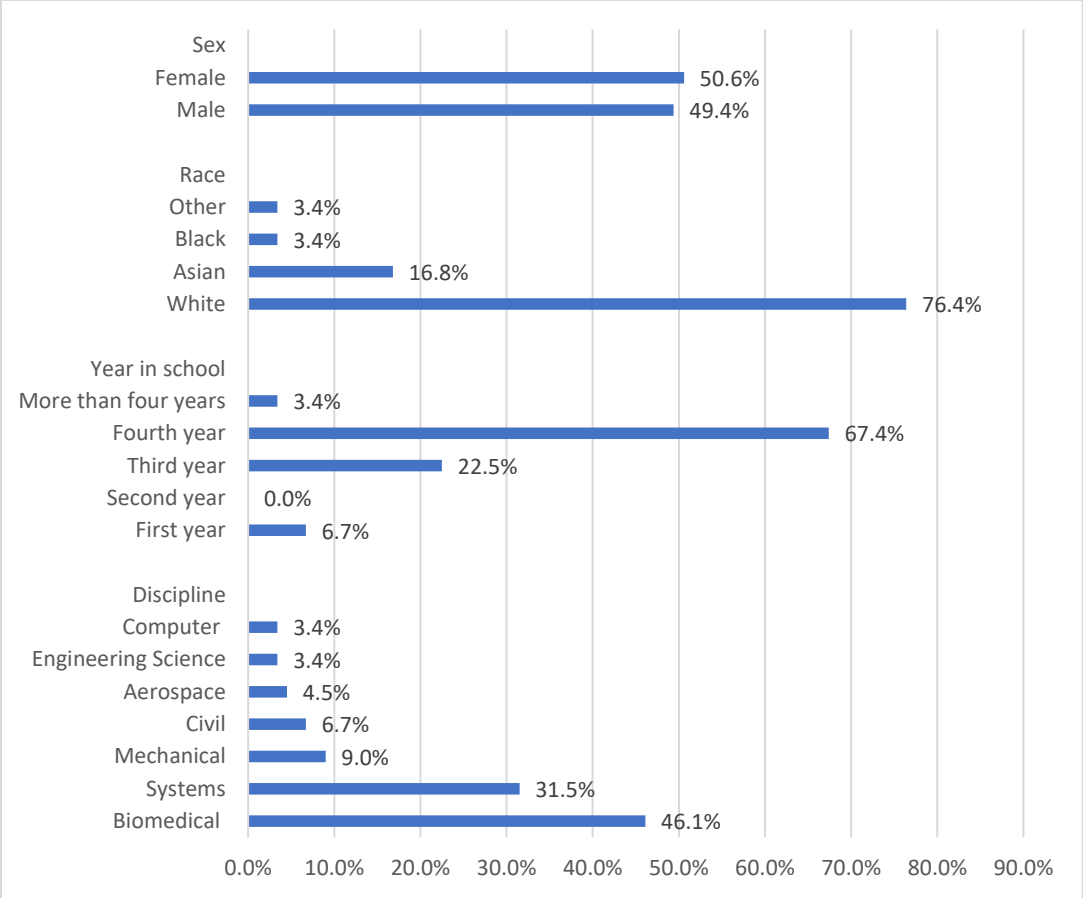


Figure 3: Participant demographic proportions

Table 4 highlights the relative proportions of male and female participants by race, year in school, and major. In groups with higher n values (white students, fourth years, and students from biomedical or systems engineering), the percentage of students who are male and female are close to 50%. This gender parity was specific to the study, as the engineering school at the University of Virginia is 34% female as a whole. (Mather) Furthermore, the classes recruited for this study were specifically project design classes. The structure of students in each school year is a result of the curriculum. Most students do not take classes with long-term project

components until their third or fourth year. ENGR 1420 is one of the few project classes offered to first years and is open only to a specific group of students from a scholar program.

Table 4: Participant demographic counts by gender

	n	Female	Male
OVERALL	89	50.6%	49.4%
RACE			
Other	3	66.7%	33.3%
Black	3	100%	0%
Asian	15	53.3%	46.7%
White	68	48.5%	51.5%
YEAR IN SCHOOL			
4+	3	100%	0%
Fourth year	60	45%	55%
Third year	20	65%	35%
Second year	0	0%	0%
First year	6	50%	50%
MAJOR			
Aerospace Engineering	4	25%	75%
Biomedical Engineering	37	48.6%	51.4%
Civil Engineering	6	100%	0%
Computer Engineering	3	33.3%	66.7%
Engineering Science	3	33.3%	66.7%
Mechanical Engineering	8	37.5%	62.5%
Systems Engineering	28	53.6%	46.4%

Dyads

This dataset provided behavior information on 178 unique “ratees”, or "targets" some of whom were also raters, or "actors." 61% of unique targets were male, reflecting team makeup more than anything else. This yielded 329 unique “pairings”, or “dyads”. Out of these 329 dyads, each behavior existed with the following frequencies (Table 5):

Table 5: Behavior frequencies by dyads

Expecting too much from others	13.4% (44 dyads)
Failure to advance project toward completion	13.7% (45)
Failure to prioritize project	16.4% (54)
Inconsistency of contribution	17.0% (56)
Inconsistency with an engineering identity	7.0% (23)
Lack of communication	13.7% (45)
Lack of competence, experience, or skills	9.4% (31)
Lack of initiative	19.1% (63)
Procrastination	9.4% (31)
Restricting others' work	6.4% (21)
Unreliability	9.4% (31)

The TBAS asks participants to provide demographic information about themselves but not about their teammates (other than first names). To reconstruct likely genders for targets, the following procedure was used. First, some targets were also actors and thus had a listed gender. Second, qualitative data provided about a target sometimes used gender-specific pronouns, which were taken to be the correct gender. Third, the 1996 census list (average respondent age was 21.07 and the survey was taken in 2017) of most popular boys and girls names was searched and the higher listing was chosen as the correct gender. Fourth, if the name was not on the census list (which were most often international names) a google-search was completed of the gender commonly associated with that name. In total, 93 (46%) were previously indicated as an actor, 32 (16%) were taken from qualitative data pronouns, 66 (33%) were taken from the 1996 census list, and 10 (5%) from a google search. The four dyads (Male rates male, Male rates female, Female rates male, and Female rates female) were thus constructed by comparing the actor's gender to the target's gender.

Table 6: Class demographic counts by dyad

	n	Male-Male	Male-Female	Female-Male	Female-Female
OVERALL	329	114	49	86	80
CLASS					
BME 3030	9	0	3	3	3
BME 3090	56	13	9	12	22
BME 4064	36	22	6	4	4
CE 4991	26	0	0	12	14
ENGR 1420	25	10	2	9	4
MAE 4620	18	12	3	3	0
MAE 4700	9	2	1	4	2
SYS 4054	150	55	25	39	31

Table 6 indicates how many of each dyad were represented for each class participating in the study. The proportions of each dyad varied between the eight classes. CE 4991 had no male participants and thus all the ratings given are "female-male" or "female-female".

Groups

At the team level, eight design classes at the University of Virginia were represented across five departments: biomedical engineering, civil engineering, general engineering, mechanical and aerospace engineering, and systems engineering (Table 7). In total, forty-three teams ranging in size from two to seven people total (including the rater) were represented – 11 of which had all members participating. Teams had been working together for nearly one or two full semesters at the time of the surveys (at the end of the Spring 2017 semester) except in BME 3030 where teams had worked together for one month. Nearly all students enrolled in these design classes were in their third, fourth, or fifth year as an undergraduate. The exception to this was the students in ENGR 1420, who were all first years selected from a particular student scholar program.

Table 7: Demographics by team

Class	Class Title	Description	Total number of teams	Number of full teams	Average Team Size	Average Reported Team Length (in weeks at time of survey)
BME 3030	Design and Innovation in Medicine	A project-based grounding in biomedical product design and topics including design fundamentals, problem/needs identification, etc.	3	1	2.67	3.2
BME 3090	BME IDEAS Laboratory II	Second half of a year-long to formulate and solve problems in biomedical systems, including experimental design, performance, and analysis.	9	3	3.78	16.4
BME 4064	Biomedical Engineering Capstone Design II	Second half of a year-long design project in biomedical engineering. Students select, formulate, and solve a biomedically relevant design problem.	7	4	3.0	31.9
CE 4991	Civil Engineering Design and Practice	Providing practical civil engineering design experience. Students participate in multi-disciplinary team design projects requiring integration of technical skills.	5	0	6.4	12.3
ENGR 1420	Synthesis Design II	N/A	5	0	6.0	14.3
MAE 4620	Machine Design II	Applies the design process to projects. Organization of design teams to work on specific semester-long design projects.	4	0	5.0	30.8
MAE 4700	Spacecraft Design II	The course will result in the detailed design of the spacecraft, the fabrication of a full scale prototype and a proposal to NASA.	1	0	5.0	26.0
SYS 4054	Systems Capstone II	A design project that involves the study of an actual open-ended situation, including problem formulation, data collection, etc.	9	3	5.56	31.7

Each class tended to have students in a particular school year. For example, capstone classes largely had students in their fourth or fifth years. BME 3030 and BME 3090 participants were in their third or fourth years. BME 4064 students were all in their fourth year. CE 4991

students were in their fourth or fifth years. ENGR 1420 students were in their first year. MAE 4620 and MAE 4700 students were all in their fourth year. SYS 4054 students were nearly all in their fourth or fifth year.

Because information other than first names about targets was largely not collected in the surveys, interdisciplinarity of teams could often not be ascertained. However, if the actors themselves reported a different major than that of the class they were enrolled in, interdisciplinarity is implied. Two teams from BME 3030 were interdisciplinary (with students in engineering science and mechanical engineering). Two teams from BME 4064 were interdisciplinary (with students in engineering science). For ENGR 1420, students are still taking introductory classes and are unlikely to have settled on a particular major. However, one team had participants intending to enter different disciplines. The one team from MAE 4700 had both mechanical and aerospace students, though MAE is a combined department housing both mechanical and aerospace engineering. Ten teams from SYS 4054 were interdisciplinary, with participants hailing from computer engineering, mechanical engineering, aerospace engineering, and civil engineering.

Chapter 4: Results and Discussion

Explanation of Datasets

Demographics as well as data from the Basic Psychological Needs Scale and the Team Behaviors and Attitudes Survey were collected for the purposes of this project. From this, three datasets were used for different purposes throughout the analysis phase of this study. Defining features of these datasets are detailed here.

1. **Participant Dataset**. This dataset includes the 89 individuals that acted as participants in this study. The data is independent and often normally distributed, making conventional statistical analyses more straightforward. It includes participant demographics and reported autonomy, competence, and relatedness scores from the Basic Psychological Needs Scale. It also includes some summarized measures of how an individual rated others on their team: average severity scores for each of the eleven behaviors, average scores for perceived overall contributions of teammates, and frequency scores (percent of number of teammates identified) for each of the eleven behaviors.

2. **Full Pairings Dataset.** This dataset includes three hundred twenty-nine unique pairings attained as each participant rated each other member of their team on a variety of metrics. Each entry in this dataset includes an entry identification number (1-329), associated actor, reported actor gender, associated target, and derived likely target gender. Within this dataset, there are 89 unique actors and one hundred seventy-eight unique targets. It also includes information that helps identify commonalities between the pairings – for example, team identification number or

total number of individuals on the team. From the Team Behaviors and Attitudes Survey, each entry contains the following:

- Whether the actor thinks the target exhibits each of the eleven behaviors (binarily) at least once
- For any behavior the target is said to exhibit, four quantitative ratings and three qualitative responses related to how and how severely the target exhibited the behavior. If a target was deemed to not exhibit a behavior, these questions were not answered.
- Three questions where the actor evaluated the target's overall impact on the team and the degree to which they enjoyed working with the target

Actors typically evaluate more than one teammate, and targets are often rated by more than one teammate. Thus, this dataset is full of interdependencies and cannot be considered independent. Furthermore, an actor may not have identified any behaviors for a particular target or may have only identified a few. Non-zero data was sparse.

3. **Reduced Pairings Dataset.** This dataset is a subset of the full pairings dataset. While the participants themselves took the Basic Psychological Needs Scale, information about the autonomy, competence, and relatedness scores of those being rated was desired. Participants were incentivized to take part in the study in conjunction with their other teammates in order to cross-reference ratings of an individual. When a participant who took the survey was also themselves rated by other teammates, information about the target's motivation and the actor's behavior (as perceived by others) is known. This dataset isolates pairings in which the actors were also a target such that information is known about how that actor was judged to

behave. Within this dataset, two hundred forty-three unique dyads exist. Of the sixty-six unique actors in the reduced pairings dataset, exactly 50% are male and 50% female. However, occurrences of each of the eleven behaviors are few (ranging from 0 in the case of *Inconsistency with an engineering identity* to 19 for *Expecting too much from others*).

Core Research Questions

Research Question #1: Do the perceptions of undesirable team behaviors in terms of frequency or severity vary with the gender identity of the dyad, actor, or target?

Frequency of ratings was examined by considering each behavior separately in the Full Pairings dataset. Each participant had different numbers of teammates and thus may have greater or fewer opportunities for rating a behavior as occurring or not. Frequencies were calculated by first constructing proportion charts for the four dyads, as seen for *Inconsistency of contributions* in Table 8. In this case, there were 114 opportunities for male participants to rate male teammates when all unique pairings are considered. Of those, 9 instances of *Inconsistency* were perceived to occur, yielding a proportion of 0.079.

Table 8: Example of frequency proportion chart for *Inconsistency of contributions*

	"Yes" count	"No" count	Total count	"Yes" proportion
Male-Male	9	105	114	0.079
Male-Female	10	39	49	0.204
Female-Male	23	63	86	0.267
Female-Female	14	66	80	0.175

Chi square tests were conducted to test for differences between frequencies of each of the four dyads (Male-male, male-female, female-male, and female-female). Significant differences

were detected in only a minority of behaviors: *Inconsistency of contributions* and *Lack of initiative.* The results for the chi-square tests are shown in Figure 4 below; "m-m" corresponds to males rating males, "m-f" to males rating females, and so on. In both cases, the proportion of females rating males with these behaviors was high. For *Inconsistency of Contribution*, the largest contributors to the chi square are the "male-male" and "female-male" dyads (i.e. whenever there was a male target). For *Lack of initiative,* the largest contributors to the chi square were the "female-male" and "female-female" dyads (i.e. whenever there was a female actor).

Rows: Dyad Columns: Behavior

	yes IC	no IC	All
m-m	9	105	114
	19.40	94.60	
	5.5786	1.1443	
m-f	10	39	49
	8.34	40.66	
	0.3302	0.0677	
f-m	23	63	86
	14.64	71.36	
	4.7764	0.9798	
f-f	14	66	80
	13.62	66.38	
	0.0108	0.0022	
All	56	273	329

Cell Contents
Count
Expected count
Contribution to Chi-square

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	12.890	3	0.005
Likelihood Ratio	13.558	3	0.004

(a)

Rows: Dyad Columns: Behavior

	yes LI	no LI	All
m-m	18	96	114
	21.83	92.17	
	0.6719	0.1591	
m-f	13	36	49
	9.38	39.62	
	1.3943	0.3302	
f-m	24	62	86
	16.47	69.53	
	3.4448	0.8159	
f-f	8	72	80
	15.32	64.68	
	3.4969	0.8282	
All	63	266	329

Cell Contents
Count
Expected count
Contribution to Chi-square

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	11.141	3	0.011
Likelihood Ratio	11.360	3	0.010

(b)

Figure 4: Chi-Square test for association results for Inconsistency of Contribution (a) and Lack of Initiative (b)

To investigate whether differences in frequency correlate with the actor's gender or target's gender, the datasets above were combined. For example, for *Inconsistency of contributions* there are 19 ratings with a male actor out of a possible total 163. The only statistical differences in terms of the proportions of frequency for male and female actors were for two behaviors: *Inconsistency of contributions* and *Failure to prioritize project.* The results for these tests of proportions are detailed in Table 9.

Table 9: 2-sample test of proportions results by behavior

	Actors				**Targets**			
Behavior	**Male actors (n=163)**	**Female actors (n=166)**	**Actors z-value**	**Actors p-value**	**Male targets (n=200)**	**Female targets (n=129)**	**Target z-value**	**Target p-value**
Expecting too much from others	13.5%	13.3%	0.06	0.95	15.0%	10.9%	1.11	0.27
Failure to advance project toward completion	14.1%	13.3%	0.23	0.82	13.5%	14.0%	-0.12	0.91
Failure to prioritize project	20.8%	12.0%	2.17	**0.03***	16.0%	17.1%	-0.25	0.80
Inconsistency of contribution	11.6%	22.3%	-2.60	**0.01***	16.0%	18.6%	-0.61	0.54
Inconsistency with an engineering identity	6.7%	7.2%	-0.17	0.864	5.5%	9.3%	-1.26	0.21
Lack of communication	11.0%	16.3%	-1.38	0.17	13.5%	14.0%	-0.12	0.91
Lack of competence, experience, or skills	8.6%	10.2%	-0.51	0.61	10.5%	7.8%	0.86	0.39
Lack of initiative	19.0%	19.3%	-0.06	0.95	21.0%	16.3%	1.09	0.28
Procrastination	11.7%	7.2%	1.38	0.17	11.0%	7.0%	1.28	0.20
Restricting others' work	6.7%	6.0%	0.27	0.79	7.0%	5.4%	0.59	0.56
Unreliability	11.0%	7.8%	1.00	0.319	12.0%	5.4%	2.16	**0.03***

Furthermore, 2-sample tests of proportions were employed to test for differences in the proportions between male and female targets. Only *Unreliability* shows a significant difference. Frequency of judgments about particular team behaviors do not depend on the gender identity of the dyad, actor, or target except in specific cases.

Multifactor ANOVAs with behavior severity as the response and both actor gender and target gender as independent variables were run using the Full Pairings dataset to examine this question. Each of the eleven behaviors was examined separately for normal distribution, homoscedasticity, and independence (see Table 10). In each case, only pairings in which a particular behavior was said to exist were considered, thereby eliminating all of the severity scores of zero associated with the behavior not being present. Equal variances are reported using multiple comparisons.

Table 10: Severity assumption checks

Behavior	N	% Female / % Male Actors	Equal variance test (actor gender)	Equal variance test (target gender)	Anderson-Darling p-value
Expecting too much from others	41	50% / 50%	Equal	Equal	Non-normal, p=0.03
Failure to advance project toward completion	42	48.9% / 51.1%	Equal	Equal	Normal, p=0.48
Failure to prioritize project	53	37% / 63%	Equal	Equal	Normal, p=0.54
Inconsistency of contribution	49	66.1% / 33.9%	Equal	Equal	Normal, p=0.52
Inconsistency with an engineering identity	22	52.2% / 47.8%	Equal	Equal	Normal, p=0.06
Lack of communication	41	60% / 40%	Equal	Equal	Normal, p=0.76
Lack of competence, experience, or skills	29	54.8% / 45.2%	Equal	Equal	Normal, p=0.65
Lack of initiative	62	50.8% / 48.2%	Equal	Equal	Normal, p=0.24
Procrastination	30	38.7% / 61.3%	Not equal, p=0.02	Equal	Normal, p=0.54
Restricting others' work	21	47.6% / 52.4%	Equal	Equal	Normal, p=0.25
Unreliability	31	41.9% / 58.1%	Equal	Equal	Normal, p=0.72

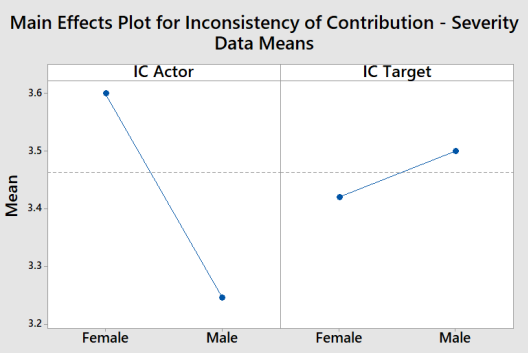
Eleven multifactor ANOVA tests were conducted using a model with actor gender, target gender, and actor gender*target gender as predictors and the specified behavior severity scores as the response. The interaction term is a measure of the impact of the four dyads: Male rates male, male rates female, female rates male, and female rates female. For instance, if males rate males differently than they rate females, that would show up in the interaction term. Results are detailed in Table 11.

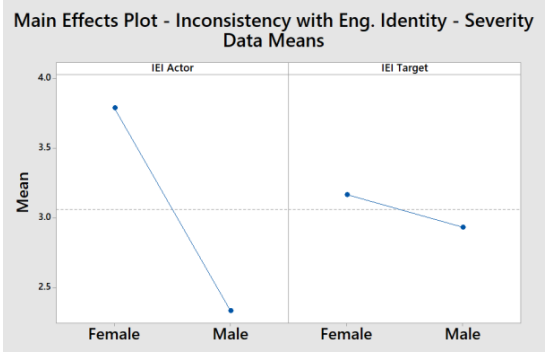
Table 11: Multifactor ANOVA significance results

Behavior	Actor gender p-value	Target gender p-value	Actor*Target p-value	Difference in actor means (Female - Male)	Difference in target means (Female - Male)
Expecting too much from others	0.56	0.59	0.56	+0.216	+0.164
Failure to advance project toward completion	0.03(*)	0.53	0.28	**+0.616**	+0.167
Failure to prioritize project	0.40	0.05(*)	0.74	+0.222	**+0.481**
Inconsistency of contribution	0.05(*)	0.65	0.39	**+0.354**	-0.08
Inconsistency with an engineering identity	<0.01(*)	0.59	0.76	**+1.455**	+0.234
Lack of communication	0.02(*)	0.20	0.94	**+0.755**	-0.237
Lack of competence, experience, or skills	0.38	0.95	0.71	+0.378	+0.007
Lack of initiative	0.83	0.03(*)	0.54	+0.145	**-0.417**
Procrastination	0.03(*)	0.68	0.66	**+0.759**	+0.201
Restricting others' work	0.65	0.43	0.90	+0.300	+0.428
Unreliability	0.18	0.72	0.89	+0.427	+0.117

(*) indicates significance, α=0.05

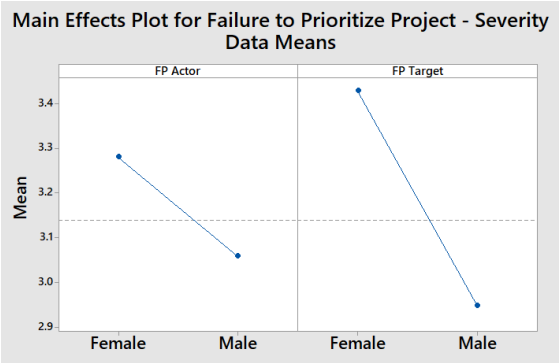
Positive values in difference column mean that males are more severe in their ratings



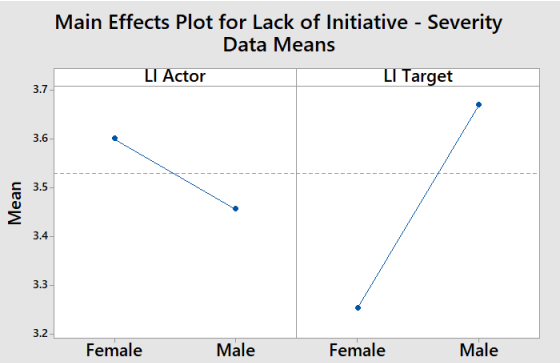


(a) (b)

Figure 5: Main effects plots for *Inconsistency of contribution* (a) and *Inconsistency with an engineering identity* (b)



(a)



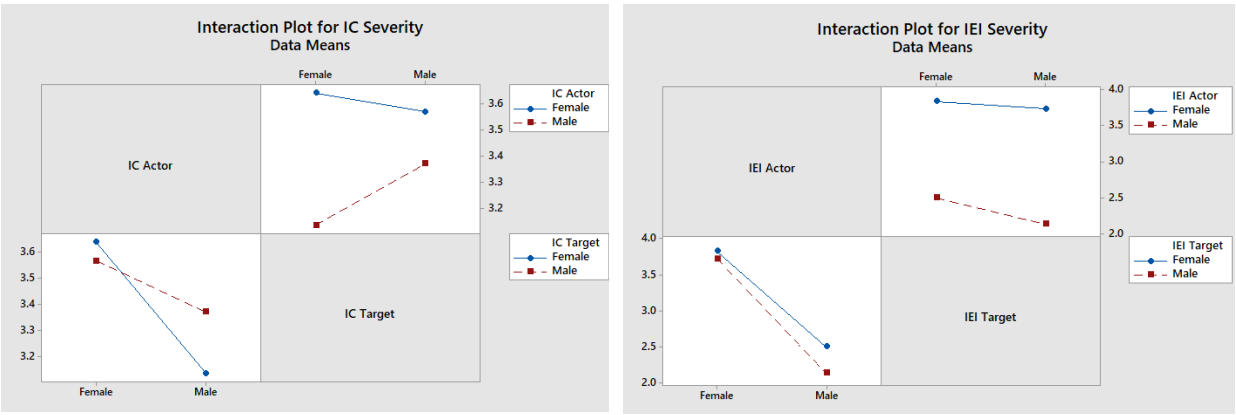
(b)

Figure 6: Main effects plots for *Failure to prioritize project* (a) and *Lack of initiative* (b)

For behaviors, scores range from 1 to 7. A score of "4" indicates "no effect". Lower scores indicate a more negative or severe appraisal of a target's behavior while higher scores indicate progressively positive appraisals of identified behaviors. But which group rates others more severely? For every one of the eleven behaviors, women rated others less severely than men regardless of the target's gender, albeit to different extents. This effect was significant at α=0.05 for *Failure to advance project toward completion* (Female M=3.40, Male M=2.79), *Inconsistency of contribution* (Female M=3.60, Male M=3.25), *Inconsistency with an engineering identity* (Female M=3.79, Male M=2.33), *Lack of communication* (Female M=3.40, Male M=2.65), and *Procrastination* (Female M=3.30, Male M=2.54). Figure 5 shows this effect

for two of these behaviors: *Inconsistency of contribution* and *Inconsistency with an engineering identity*.

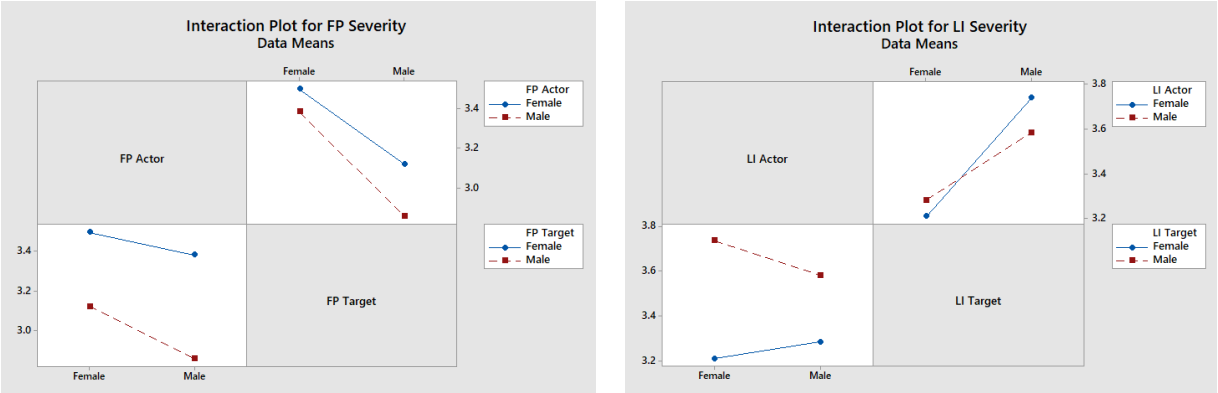
The target's gender rather than the actor's gender is significant for two behaviors: *Failure to prioritize project* and *Lack of initiative.* Women are rated less severely for *Failure to prioritize the project*, while being rated more severely for demonstrating *Lack of initiative* (Figure 6).



(a) (b)

Figure 7: Interaction plots for Inconsistency of contribution (a) and Inconsistency with an engineering identity (b)

As examples, Figure 7 gives two examples of the trend that female actors rate targets similarly regardless of the target's gender. Females also rate others less severely as a whole than do men. Furthermore, in these two cases females are rated less severely than males by their teammates.

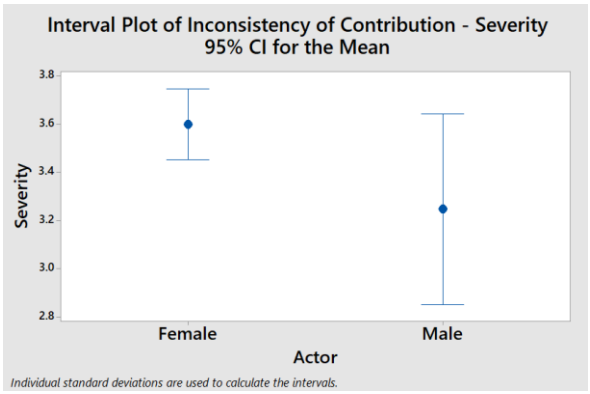


(a) (b)

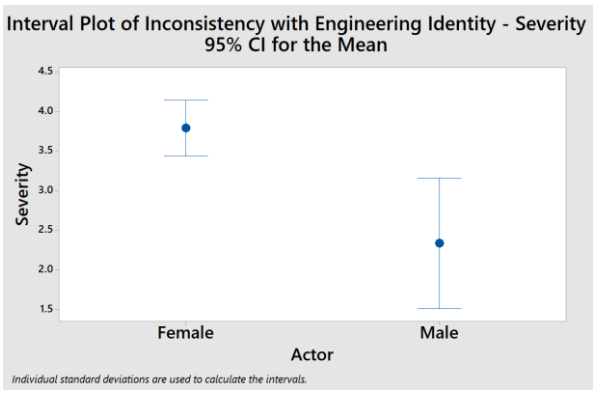
Figure 8: Interaction plots for *Failure to prioritize project* (a) and *Lack of initiative* (b)

Figure 8 shows interaction plots for the two behaviors for which target gender was significant. Each reveals different trends – albeit neither showing an interaction. For *Failure to prioritize project,* females are rated less severely than males regardless of the gender of the actor. For *Lack of initiative,* females are rated more severely than their male counterparts regardless of the gender of the actor.

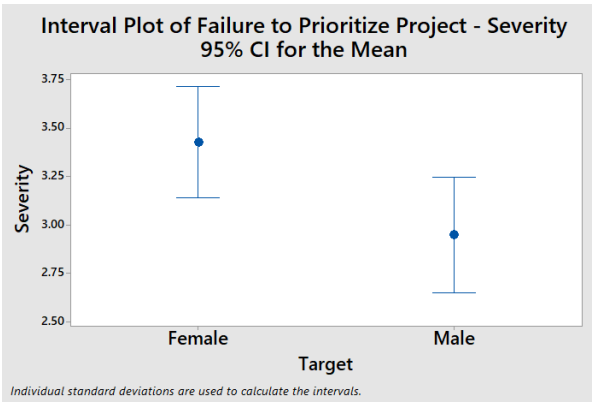
Multifactor ANOVAs indicate that the actor gender often has a more significant impact on how severely a target is rated than the target gender or gender identity of the dyad. For no behavior is the interaction between actor and target genders significant. The differences for some of these behaviors can be visualized using the boxplots in Figure 9.



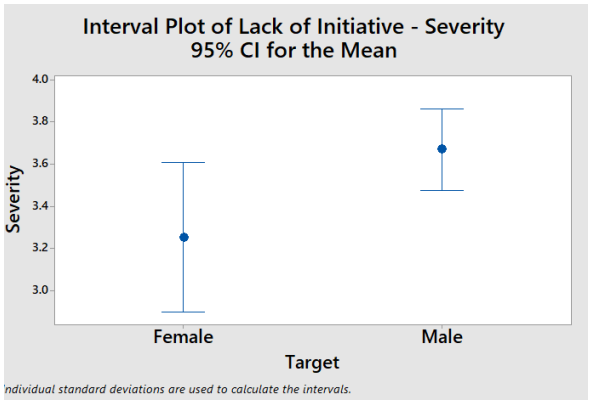
(a)



(b)



(c)



(d)

Figure 9: Interval plots by actor gender for *Inconsistency of contribution* (a) and *Inconsistency with an engineering identity* (b) *Failure to prioritize project* (c) and *Lack of initiative* (d)

Because gender is not evenly or randomly distributed between age, major, or class, a second model was constructed. Again, eleven multifactor ANOVA tests were conducted using a model with actor gender, target gender, and actor gender*target gender as predictors and the specified behavior severity scores as the response. Class was identified as the nuisance factor because it also largely encompasses age and major (students within one class tend to be the same age and taking the same curriculum for their chosen discipline). Students in the same class may have similarities that cause differences in the perceptions of behavior that occur that are

unassociated with their gender. For example, a more well-defined project may require less student leadership resulting in less severe reporting of *Lack of Initiative.* Thus, in a second round of multifactor ANOVAs, class was used to block. If a block did not contain both levels (male and female) for both actor and target, it was eliminated. Results are in Table 12; classes represented after removing blocks without both levels for actor and target for each behavior are found in Table 13.

Table 12: Multifactor ANOVA with blocking significance results

Behavior	**Number of blocks**	**Actor gender p-value**	**Target gender p-value**	**Actor*Target p-value**	**Model p-value**
Expecting too much from others	3	0.32	0.74	0.48	0.69
Failure to advance project toward completion	4	0.22	0.74	0.85	0.32
Failure to prioritize project	3	0.59	0.21	0.34	0.40
Inconsistency of contribution	3	0.12	0.72	0.63	0.57
Inconsistency with an engineering identity	1	(**)	(**)	(**)	(**)
Lack of communication	4	**0.03(*)**	0.80	0.84	0.12
Lack of competence, experience, or skills	2	0.31	0.26	0.45	0.18
Lack of initiative	3	0.84	0.11	0.75	0.40
Procrastination	3	0.17	0.75	0.91	0.28
Restricting others' work	1	(**)	(**)	(**)	(**)
Unreliability	2	0.54	0.80	0.91	0.87

(*) indicates significance, $\alpha=0.05$, (**) see results from Table 11

Table 13: Classes represented in blocked multifactor ANOVA models

Behavior	BME 3090	BME 4064	CE 4991	ENGR 1420	MAE 4620	SYS 4054
Expecting too much from others	X			X		X
Failure to advance project toward completion	X			X	X	X
Failure to prioritize project	X			X		X
Inconsistency of contribution	X	X				X
Inconsistency with an engineering identity						X
Lack of communication	X		X	X		X
Lack of competence, experience, or skills	X					X
Lack of initiative	X				X	X
Procrastination	X			X		X
Restricting others' work						X
Unreliability	X					X

In some cases, blocks were very small and contained only a handful of individuals from a particular class. An unbalanced block design is a weakness of this model. Furthermore, because each model contains only severity measures from participants who said "yes" that a particular behavior existed, selection bias is an issue. Blocking was used in this case to control for the effects of a secondary variable because randomly assigning participants to different classes before the survey took place was not possible. If the results are taken at face value, blocking by class mitigates the significance of the actor's gender from the previous models. This would indicate that the actor gender effect observed previously was to some extent a result of random variation in gender across the class/project/year/major of participants. However, the actor gender

is the only term found to be significant in any of the eleven behaviors when blocking for class. This result does align with previous models for *Lack of communication*, for which the actor gender was found to be significant, but not target gender or the interaction.

In general, perceptions of behaviors are influenced by factors that relate to the gender identity of the actor or target. Different behavior perceptions may be more or less likely to be influenced by the actor or by the target. Behavior perceptions more likely to be influenced by the actor's identity may be more subjective and depend on how the actor defines his or her values. Other behaviors whose perceptions are influenced by the target's identity may be easier to observe "objectively". Table 14 shows a summary of the results outlined in the previous section.

For behaviors in which the actor's gender was significant, males always were the party rating others more severely. Male actors rated others as failing to prioritize the project more frequently than female actors did, and female actors rated others as inconsistently contributing more frequently than men did. Furthermore, men were more frequently rated as being unreliable than were women. Males were rated more severely than women for failing to prioritize the project. As this behavior can be understood as failing to "show up" physically, this could be a result of expectations. Perhaps when women do not prioritize the project, teammates are more understanding. If this is the case, it would be a reflection of workplace culture, in which men are expected to commit more time to the office and sometimes report feeling penalized for taking time off to take care of their family, for example. Females, on the other hand, are penalized more by peers for showing a lack of initiative. This may be because men are often implicitly thought to show leadership skills, while women must be more explicit in demonstrating their leadership and competence in order for that quality to be recognized. Thus, while some females may interpret helping on various parts of the project as sufficient while others interpret that as a failure to take

ownership over a particular part of the project. Another interpretation may be that females simply did show less initiative, for example, than their male counterparts. However, this study does not investigate whether behaviors "actually happened" and instead focuses only on perceptions.

Table 14: Summary of significant results for frequency and severity of undesirable behaviors

	Actor	Frequency – Test of Proportions	Severity – Multifactor ANOVAs	**Target**	Frequency – Test of Proportions	Severity – Multifactor ANOVAs
Expecting too much from others						
Failure to advance project toward completion			X (Male actors more severe)			
Failure to prioritize project		X (Male actors rated others more frequently)				X (Male targets rated more severely)
Inconsistency of contribution		X (Female actors rated others more frequently)	X (Male actors more severe)			
Inconsistency with an engineering identity			X (Male actors more severe)			
Lack of communication			X (Male actors more severe)			
Lack of competence, experience, or skills						
Lack of initiative						X (Female targets rated more severely)
Procrastination			X (Male actors more severe)			
Restricting others' work						
Unreliability					X (Male targets rated more frequently)	

Table 14 shows that significant differences between male and female actors and targets showed up inconsistently across the eleven behaviors. To probe potential reasons for these findings, the qualitative data was examined. For example, one explanation for the behaviors for which the actor's gender was found to be significant may be that these behaviors are more dependent to the way the actor interprets them. One salient example of this is *Inconsistency with an engineering identity*, for which the actor's definition of what constitutes an engineering identity frames how they interpret the behavior of their teammates. In this case male actors were found to rate others more severely than female actors. Each time a behavior was identified, participants were asked to defend why they believed their teammate's behavior matched a particular vignette in a short-answer format. These responses were analyzed by comparing short answers for men and women who indicated that a teammate did exhibit *Inconsistency with an engineering identity* to determine whether the two groups conceptualized and experienced the behavior differently. One interesting finding was that males seemed to have a greater sense that *Inconsistency with an engineering identity* ultimately impacted the ability to move the project forward. Four of ten males had responses that emphasized the failure to contribute in a way similar to this response: "For a year long project, _____ did virtually nothing outside of meeting times." Only one female participant focused on this same effect. However, most responses (10 of 17) by men and women had the same overarching theme: a sense of discrepancy between who the target *ought* to be in terms of motivation, attitudes, identity, or beliefs according to the actor and who they actually are. An example of this attitude is, "____ was mostly concerned about the way in which things looked. Would build elaborate powerpoint decks that didn't convey any information to make it look like the team had accomplished something that week." That target

may have believed that their contribution to the PowerPoint slides was essential to the group's success, but the actor believed they were focused on the *wrong* things.

In each case that a significant difference between male and female actors was found, males were the group to rate others more severely – why? Of the 366 qualitative excerpts taken from the survey (students sometimes opted not to complete qualitative assessments), 44 contained examples of language that tried to downplay the importance of a behavior or offer an excuse for it. In total, exactly 22 of these were from male actors and 22 were from female actors. However, this proportion was different for individual behaviors. For example, when considering *Lack of communication,* for which males were found to rate others more severely, 2 of 18 males offered an excuse whereas 6 of 12 females did so. Typical language used in these cases are as follows:

> "I think everyone needs to become a better communicator and be clearer in what they are contributing to the team. _____ was late to class and meetings."
>
> "___ was in ___ own bubble. Did good work but not entirely relevant."

Participants who offered excuses for this behavior either emphasized that not just this one individual but everyone on the team had trouble communicating or that the quality of their work was otherwise satisfactory.

On the other hand, for *Procrastination* it was males who offered excuses for teammate behaviors. Of 16 males who offered qualitative responses, 5 used language to downplay the impact of the behavior. Two strategies were employed to do so: emphasizing that everyone procrastinates and explaining how some people prefer to work under different conditions than others. These two strategies can be summed up by these responses:

"_____ just has a very different work schedule than I do. ___ prefers working late at night, whereas I do not."

"___ was excellent at what ___ did but often put it off till closer to the deadline than I would have liked. We always finished on time and the work was largely above average but the times it did occur were very stressful."

"We all procrastinated hard on this project."

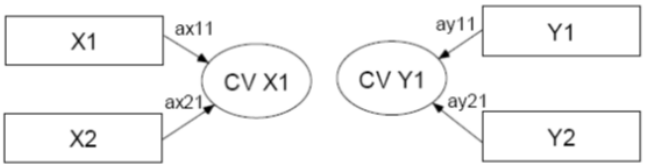
It should be noted that no females offered such excuses for this behavior. Still, male actors were found to judge *Procrastination* more harshly. Perhaps this discrepancy between which behaviors males and females choose to excuse have to do with expectations. Females are typically considered to be better communicators than males (regardless of whether this stereotype is warranted). Thus, females considering themselves excellent communicators may have been inclined to forgive other engineers (a group stereotypically associated with poor communication skills) for lacking this ability, for example.

Research Question #2: Do the perceptions of undesirable team behaviors vary with the fulfillment of basic psychological needs of the actor as framed by self-determination theory?

Canonical correlations are multivariate statistical tests used to test for correlations between multiple predictors and multiple responses. The predictors used are autonomy, competence, and relatedness scores for the 89 participants, and the responses are the average severity scores (behavior severity) and the proportion of their teammates the actor rated as exhibiting a particular trait (behavior frequency) as calculated from the Full Pairings dataset. The

univariate analog to this is multiple regressions, but multiple regressions were not used in this case because they ignore the intercorrelations between the multiple response variables.

The set of predictors and set of responses each has a canonical covariate associate with them (CV X1 and CV Y1 in Figure 10). At least one solution set will be generated, which produces values for the correlations between CVX1 and CVY1, X1 and CV X1, X2 and CV X1, the group X1, X2 and CVX1, the group X1, X2 and CVY1, Y1 and CVY1, Y2 and CVY1, the group Y1, Y2 and CVY1, and the group Y1, Y2 and CVX1. Multiple sets of statistically significant canonical correlations may be found and would be necessarily orthogonal to one another.



$$\mathrm{CV}_{\mathrm{X1}} = a_{\mathrm{X11}}\mathrm{X}_1 + a_{\mathrm{X21}}\mathrm{X}_2$$

$$\mathrm{CV}_{\mathrm{Y1}} = a_{\mathrm{Y11}}\mathrm{Y}_1 + a_{\mathrm{Y21}}\mathrm{Y}_2$$

Figure 10: Diagram of canonical correlation

Canonical correlation assumptions include independence of subjects, normality, outliers, and sample size. Average severity scores and frequency scores are not normally distributed, as for any given behavior many participants did not acknowledge that any teammate exhibited it. However, canonical correlation is largely robust to violations of the normality assumption. Otherwise, the 89 independent participants meet the other assumptions.

The first canonical variate pair found in ten of the eleven canonical correlation models that were run (corresponding to the eleven teaming behaviors) was not statistically significant (α=0.1). This suggests there is no evidence of a relationship between the two sets of variables: basic psychological need fulfillment of an actor and how that actor perceives others to behave. However, a significant relationship was found in the case of one behavior: *Failure to prioritize the project* with a p-value of 0.06.

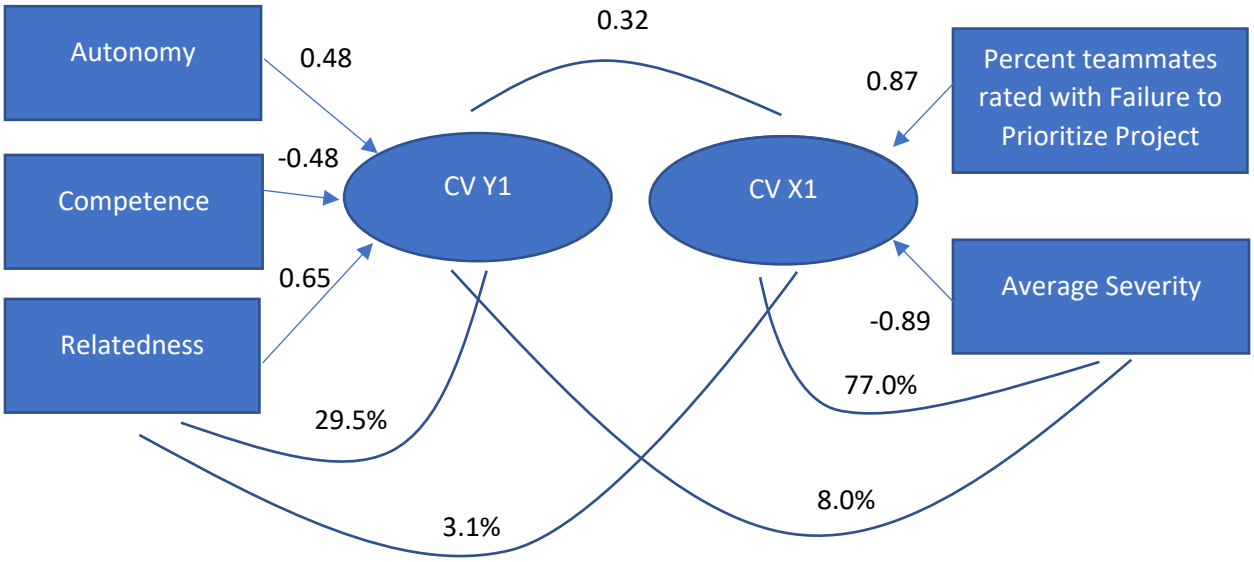


Figure 11: Canonical correlation for *Failure to prioritize project*

The canonical correlation of this model is 0.32, as shown in Figure 11. 29.5% of variance in the dependent variables (autonomy, competence, and relatedness) was explained by their canonical variable. 3.1% of variance was explained by the covariate of the dependent variables. On the other hand, 77% of variance of the frequency and severity measures was explained by their canonical variable while 8% was explained by the dependent variables. In general, this model shows that individuals who rate a high percentage of their teammates with *Failure to prioritize project* and give more severe ratings of others correlate with high autonomy and relatedness scores and low competence scores.

Supporting Research Questions

Research Question #3 - Are female students' fulfilment of basic psychological needs different than that of male students in the student project team environment?

To answer this question, genders and BPNS subscores indicating contextual levels of autonomy, competence, and relatedness in the team environment were used from the 89-person Participant Dataset (45 female and 44 male). BPNS subscores can range from 1 to 7, with higher scores indicating greater need fulfillment for that construct.

For each of the Basic Psychological Need Scale's three subscores, 2-sample t-tests examine differences between scores for males and females. The assumption of independent data is met. Using Levene's test and multiple comparisons, equal variances between men and women were ascertained for all three constructs. Anderson-Darling tests reveal a normal distribution for autonomy (AD=0.26, p=0.71) and competence (AD=0.49, p=0.22) and a non-normal distribution for relatedness (AD=1.3, p<0.01). However, the shape of the histograms and skew and kurtosis

values (<1.0) still suggest normality, and as this test is robust to minor departures from normality, the assumptions were considered met.

Autonomy scores for females had a mean of 4.91 and standard deviation of 0.81, while males had a mean of 4.94 and standard deviation of 0.79. 2-sample t-tests conducted using autonomy as the response and gender as the factor showed no statistically significant difference between the levels of autonomy experienced within the team context for males and females ($p=0.84$). Competence scores for females had a mean of 4.23 and standard deviation of 0.76, while males had a mean of 4.19 and standard deviation of 0.73. At a significance level of $\alpha=0.05$, t-tests did not show a statistically significant difference between levels of competence experienced within the team context for males and females ($p=0.80$). Relatedness scores for females had a mean of 5.17 and standard deviation of 0.84 while males reported a mean of 5.20 and standard deviation of 0.83. Similarly, no statistically significant difference between levels of relatedness to others on the team emerged for males and females ($p=0.88$). Differences in means are visualized in Figure 12.

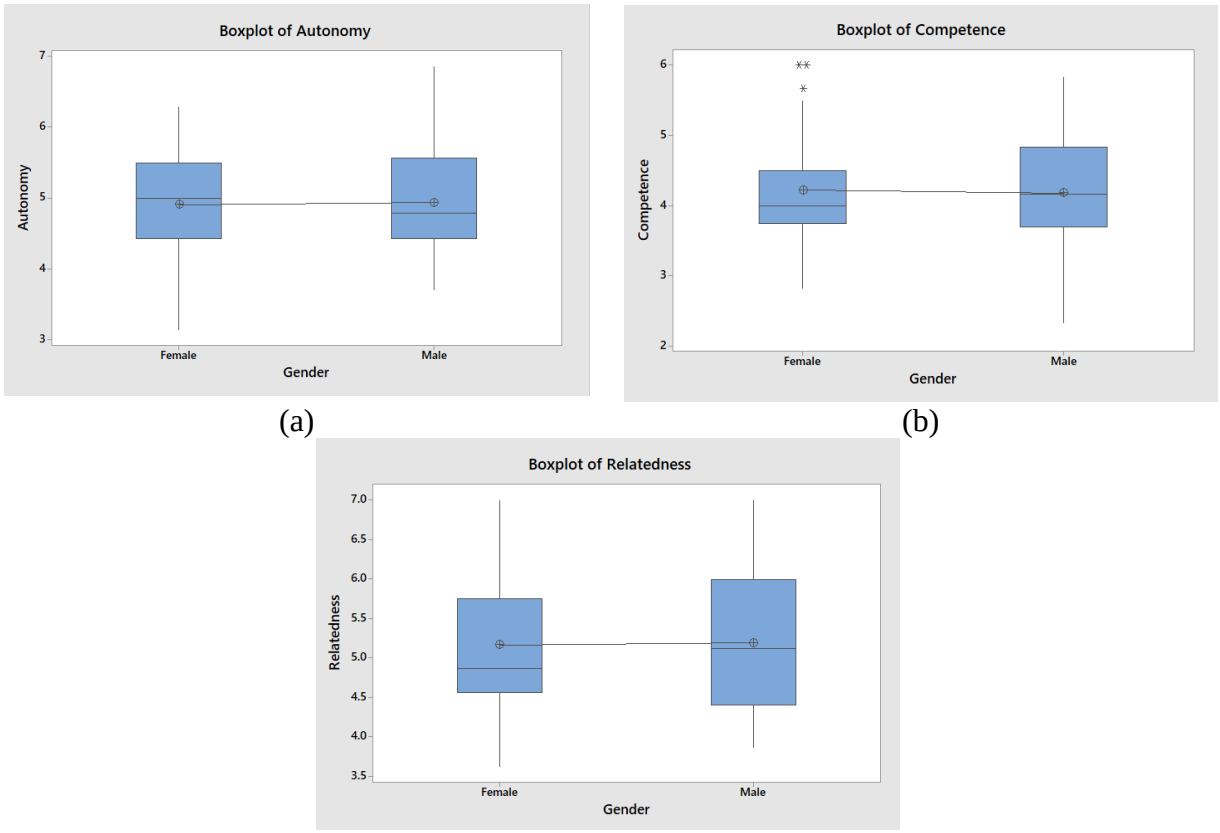


Figure 12: Boxplots for (a) Autonomy, (b) Competence, and (c) Relatedness by Gender

Autonomy, competence, and relatedness scores are interrelated, however. To examine how these three measures might correspond to one another for the participants, k-means clustering was employed. While hierarchical clustering is a method of clustering that aims to achieve the optimal step at each cluster fusion, k-means seeks a global goal: optimization of the variance of the clusters. It was preferred to other hierarchical clustering methods because (1) greedy algorithms may result in a non-optimal solution by attaining a local versus global optimum, (2) hierarchical methods take comparatively more computing time, (3) k-means centroids are more easily interpretable than some hierarchical linkage methods like Ward's because it is space-conserving (4) because data were continuous and numerical without need for further flexibility. (Lance and Williams 271-277)

After considering different numbers of clusters by examining the matrix scatterplots (Figure 13), six proved to most appropriately balance interpretability of the model with representative complexity of the associated basic psychological need profiles.

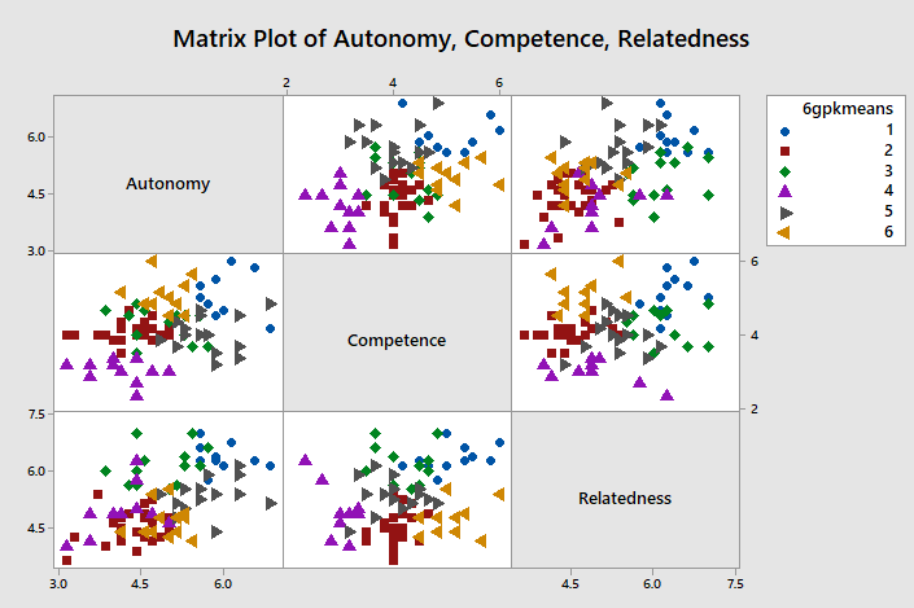


Figure 13: Matrix Plot of Six Clusters of Autonomy, Competence, and Relatedness

As can be seen in Figure 14, the six classes emerging from cluster analysis differ in terms of their relative levels of autonomy, competence, and relatedness to others. Qualitatively, these classes (Figure 14) can be defined as follows:

1. **Balanced, High** – High autonomy, High competence, High relatedness
2. **Balanced, Average** – Medium-low autonomy, Medium competence, Medium-low relatedness
3. **High Relatedness** – Medium autonomy, Medium competence, Medium-high relatedness

4. **Balanced, Low** – Medium-low autonomy, Low competence, Medium-low relatedness
5. **High Autonomy** – Medium-high autonomy, Medium competence, Medium relatedness
6. **High Competence –** Medium autonomy, Medium-high competence, Medium-low relatedness

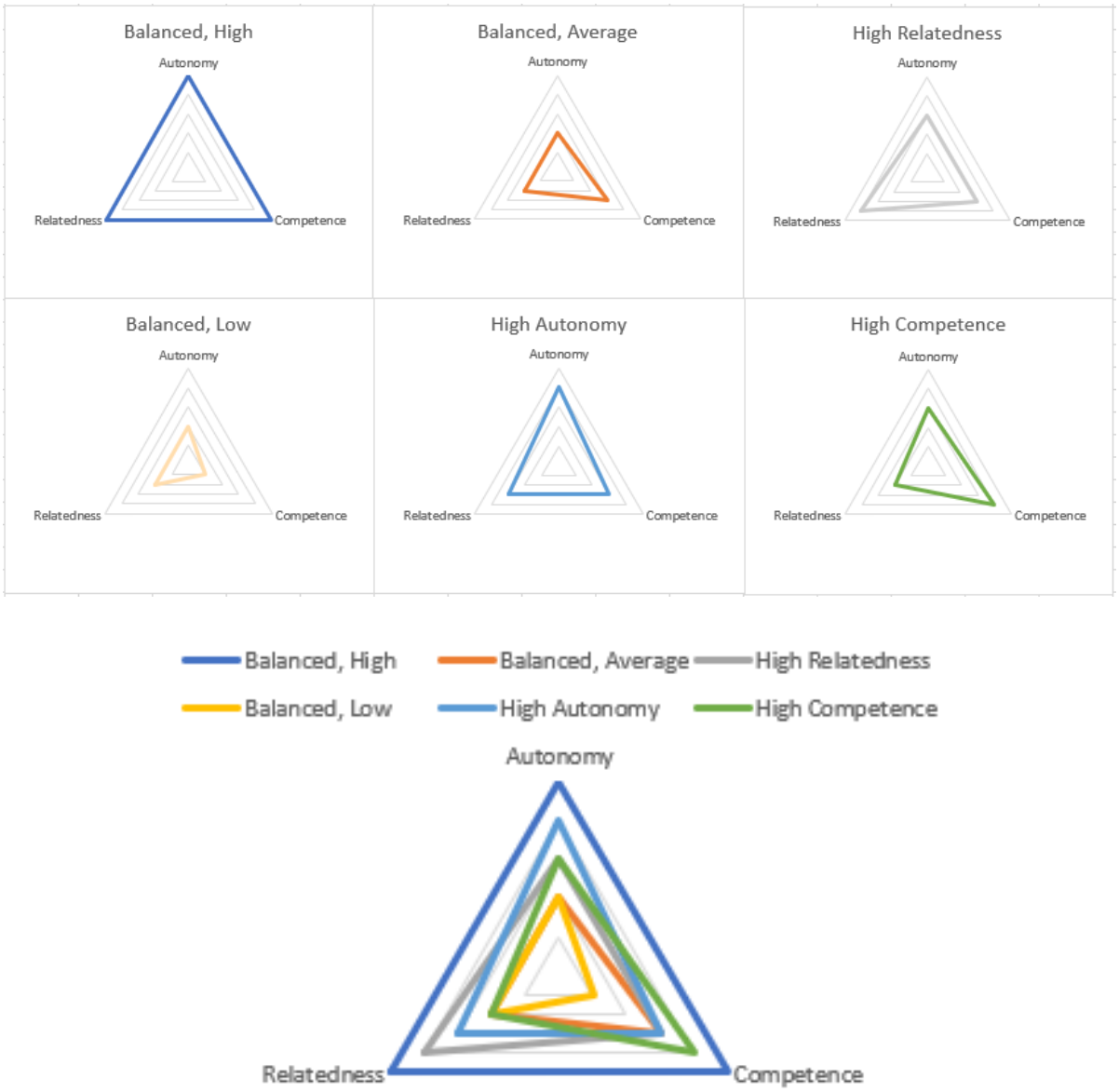


Figure 14: Classes of basic psychological need profiles

Figure 14 is based on relative autonomy, competence, and relatedness scores among those surveyed. Overall, autonomy scores range [3.14,6.86], competence scores range [2.33,6.00], and relatedness scores range [3.63,7.00]. The largest class of students assessed belong to the *Balanced, Average* class: 29.2% of students (n=26). Of this group, 61.5% are male

and 38.5% female. The centroid of this class is (Autonomy, Competence, Relatedness) = (4.39,4.05,4.50). The closest centroid to it was the *High Competence* class. As can be seen in Table 15, the main differentiator between these two classes was their disproportionate competence scores – autonomy and relatedness scores were largely similar. This was also the second tightest cluster, with an average distance from the centroid of just 0.63.

The *Balanced, Low* class is characterized by consistently low psychological need fulfillment scores for all three constructs, relative to other study participants. This class houses 12.4% of participants (36.4% male and 63.6% female, n=11). The centroid of this class is (Autonomy, Competence, Relatedness) = (4.13,3.00,4.92). The average distance from the centroid is 0.73. The class with the closest centroid to this cluster is *Balanced, Average*. Similar autonomy and relatedness scores arise between these two groups, while lower competence scores set this class apart. This class has the lowest centroid values for autonomy and competence, but relatedness scores are the third lowest.

The *Balanced, High* class encompasses 12.4% of participants (54.5% male and 45.5% female, n=19). However, this group shows apparent equity between men and women. This suggests that, when all three psychological constructs are considered in conjunction with one another, men and women are equally likely to experience high levels of autonomy, competence, and relatedness. Furthermore, the highest centroid values for all three constructs are in this class, suggesting that when high levels of one construct is present it is likely that the other constructs will be similarly high. The centroid of this group is (Autonomy, Competence, Relatedness) = (5.94,5.11,6.33). The class with the closest centroid to this one spatially is *High Relatedness*, and unsurprisingly the furthest class is *Balanced, Low.* The average distance from the centroid is 0.70.

The unbalanced classes are smaller than the balanced classes and are characterized by one construct measure that outweighs the other two. *High Autonomy* encompasses 18% of participants (37.5% male and 62.5% female, n=16). The centroid is (Autonomy, Competence, Relatedness) = (5.67,3.99,5.29). The class with the closest centroid to this cluster was *Balanced, Average* and the average distance from the centroid is 0.76.

The *High Competence* class has twelve participants who are 50% male and 50% female. The centroid of this group is (Autonomy, Competence, Relatedness) = (4.94,5.06,4.66). The class with the centroid closest to this cluster's centroid is *Balanced, Average.* The defining feature of this class is having near average autonomy and relatedness scores alongside disproportionately high competence scores (though not reaching those in the *Balanced, High* class). The *High Relatedness* class has thirteen participants, 46.2% of whom are male and 53.8% female. The centroid of this group is (Autonomy, Competence, Relatedness) = (4.88,4.26,6.14). The class with the centroid closest to this class's centroid is *High Autonomy,* apparently due to their similar competence scores.

Table 15: Cluster characteristics

Class	N	N female (% female)	Autonomy centroid	Competence centroid	Relatedness centroid
1 - Balanced, High	11	5 (45.5%)	5.94	5.11	6.33
2 – Balanced, Average	26	10 (38.5%)	4.39	4.05	4.50
3 – High Relatedness	13	7 (53.8%)	4.88	4.26	6.14
4 – Balanced, Low	11	7 (63.6%)	4.13	3.00	4.92
5 – High Autonomy	16	10 (62.5%)	5.67	3.99	5.29
6 – High Competence	12	6 (50.0%)	4.94	5.06	4.66

Though t-tests showed that on average males and females do not experience different levels of autonomy, competence, or relatedness in the project team context when each is considered individually, here these three constructs may be considered as a whole. Still, males and females do appear to belong to these classes in similar proportions (chi-square test confirms relative proportions of females in each category is not different, p=0.65). Of the "Balanced" classes (1,2, and 4), 54.2% of individuals belonging to one of these classes are men. The three unbalanced classes (3, 5, and 6) have a higher proportion of females than males (44% of participants belonging to these groups are male). When "Autonomy" is considered, *Balanced, Low* and *Balanced, Average* are the groups with the lowest centroid values and *Balanced, High* and *High Autonomy* have the highest centroid values. These groups are 54.1% and 44.4% male, respectively. When "Competence" is considered, *Balanced, Low* and *High Autonomy* are the groups with the lowest centroid values and *Balanced, High* and *High Competence* have the highest centroid values. These groups are 37.0% and 52.2% male, respectively. A test of proportions fails to reject the null hypothesis that the two proportions are the same with a p-value of 0.28. When "Relatedness" is considered, *Balanced, Average* and *High Competence* are the groups with the lowest centroid values and *Balanced, High* and *High Relatedness* have the highest centroid values. These groups are 57.9% male and 50% male, respectively.

It is also important to note what is *not* seen in this dataset: extreme imbalance. Individuals do not simultaneously have high autonomy scores relative to others surveyed while also having very low relatedness scores, for example. Having a very high score on one construct indicates at least average experience of the other constructs. By the same token, having a very low score on one construct indicates no more than average experience of the other constructs.

Research Question #4: Is the variance in perceptions of undesirable team behaviors driven more by the actor or target?

The Social Relations Model (SRM) is most often used with round-robin data in which individuals rate one another within groups in order to examine sources of variance in the data. Snijders and Kenny first developed the SRM model when dealing with relationships between family members. These relationships are certainly not independent of one another – the relationship between two individuals within a family may depend on person #1, person #2, the dynamics between the pair, and the dynamics of the family as a whole (Snijders and Kenny 471-486). Similarly, on a project team, one's perceptions of a teammate's exhibited behavior may depend on the individual making a judgment, the individual being judged, the relationship between the pair, and the dynamics of the group as a whole. For the purposes of this study, these individuals will be referred to as the actor, target, dyad, and group, respectively.

The social relations model for multiple groups is based on the following equation:

$$Y_{ijk} = \mu + F_k + A_{ik} + B_{jk} + R_{(ij)k} + E_{ijk}$$

in which the response Y_{ijk} is the sum of an overall mean μ, F_k is the random effect of family k, A_{ik} is the effect of actor i on group k, B_{jk} is the effect of target j on group k, $R_{(ij)k}$ is the dyad effect, and E_{ijk} and E_{jik} are assumed to be uncorrelated. (Snijders and Kenny 471-486) Unlike more traditional multilevel models, the levels of analysis are crossed rather than nested, meaning that each unit of the lower level is not contained in exactly one unit of the higher level. (Snijders and Bosker) In this case, level one includes the actor and target, level two is the dyad, and level three is the group. The SRM model takes account of these complex and interrelated levels of analysis by using random effects to allow for a complicated correlational structure within a

group, and the fixed effects allow the effects of covariates within each level. (Snijders and Kenny 471-486)

In this study, SAS software was used to estimate the SRM using conventional multilevel modeling (PROC MIXED COVTEST) as opposed to the method initially proposed by Snijders and Kenny that uses dummy variables and an obscure software package. Seven parameters exist in an SRM model: the mean, actor variance, target variance, group variance, error variance, actor-target covariance, and error covariance. The weakness of using conventional multilevel modeling is that the actor-target covariance is assumed to be zero. Because the group variance depends on the actor-target covariance, the method also does not give a group covariance estimate. However, the method has been shown to estimate actor variance, target variance, and error covariance accurately in comparison to the original method. Error covariance refers to the two members' correlated relationship effects, while the actor-target covariance refers to the correlated actor effect and target effect. (Kenny)

The Full Pairings Dataset was reduced for this round-robin model to contain only groups in which every member participated in the study. This smaller dataset includes only 132 unique pairings from the 11 full teams represented and does include all ratings whether a behavior was identified or not. Overall scores were calculated using an average of the three questions asked about each of a participant's teammates as a whole. These teams ranged in size from two to seven people, which was accounted for by the model.

The actor variance estimate for this model is 0.126 ($p=0.003$), while the target variance estimate is 0.180 ($p=0.001$). The error co-variance is -0.009 and the standard error of the model is 0.093. Contrary to what is suggested in expertise recognition literature, the results suggest that the target's attributes contribute more to the variance of the overall scores than the actor's

attributes. The error covariance estimate, which speaks to the effect of the relationship between the dyads, was close to zero. Furthermore, it is still currently unclear to what extent the group may contribute to the variance.

Research Question #5: What underlying values are important to students as they navigate team behaviors and relationships?

Sense-making is a term borrowed from interpretivist qualitative research, which rests on a number of assumptions ontologically, epistemologically, and methodologically. (Erickson 119-161) Interpretive inquiry differs from more positivist approaches in a number of key ways. Ontologically, Erickson asserts first that multiple realities exist and second that those realities are complicated and dependent on context. One situation may be experienced differently by each person involved – so one cannot separate reality itself from the person experiencing it. Methodologically, Erickson assumes that, because reality cannot be separated from the person experiencing it, the same is true for the researcher. The researcher is also an instrument, so methods cannot be separated from the individual researcher. Research methods are imperfect therefore, as imperfect human researchers cannot be separated from the research (and because no one method can fully capture the multiple realities present). This is why using multiple methods is advisable. Epistemologically, interpretivism assumes that actors' meaning-making is more important than the researcher's judgment about observable behaviors themselves. Furthermore, interpretivists assume that similarities in behavior are not an indication of some universal uniformity to discover, but rather an illusion. Based on our meaning-making, we often take our subjective interpretations as "real". For example, we understand "intelligence" to be a real, existing attribute that a student can either possess or not. Interpretivism, however, asserts that people may share similar meaning-making based on culture, but that similarity is actually masking the fact that individuals may interpret one behavior to have different meanings. People make meaning in real time from their surroundings – both local and nonlocal – and behave

intentionally in accordance. Understanding meaning making from one's actions requires looking at both the local and nonlocal sequences of actions (or context).

This exercise is not exactly interpretivist in nature. In part because it relies heavily on the researcher's judgment about what behaviors were present, it assumes one underlying reality, and is limited to considering only the local sequences of actions. The important aspect in common with interpretivism in this work, however, is trying to determine how students understand and make meaning of their team environments. To do this, a bigger question was asked: "What underlying values are important to students as they navigate team behaviors and relationships?"

To examine how the eleven behaviors might be connected and driven by fewer, more general themes, a qualitative approach was taken. For each participant indicating that a particular individual exhibited one of the eleven behaviors according to their interpretation of the vignette in the TBAS, they were asked to answer the question, "In what way do you feel _____'s behavior during the project is/was similar to the passage above? Please limit your response to 1-2 sentences". De-identified and randomized responses were coded according to the which behavior(s) they best matched. Co-occurrence counts of the eleven behavior codes are detailed in Table 16. Seven themes encompassing the responses gathered about the eleven behaviors are detailed in this section. These seven themes fall under three categories of student values as expressed by the direct experience of students:

- Quantity of work (Wholehearted contribution; Equity; Presence),
- Quality of Work (Quality of work), and
- Personal/relationship-oriented traits (Interpersonal; Motivations, attitudes, identity, or beliefs; and Trust**)**.

Though frequently certain themes may encapsulate certain behaviors, this is not always the case and excerpts must be evaluated on a case-by-case basis.

Table 16: Code co-occurrence counts

	Expecting too much from others	Failure to advance project toward completion	Failure to prioritize project	Inconsistency of contribution	Inconsistency with an engineering identity	Lack of communication	Lack of competence, experience, or skills	Lack of initiative	Procrastination	Restricting others'work	Unreliability	**Totals**
Expecting too much from others		4	3				1			2	1	**11**
Failure to advance project toward completion	4		6	3	3	1	7	14	2	2	5	**47**
Failure to prioritize project	3	6		3		7	5	4	4	2	1	**35**
Inconsistency of contribution		3	3		1			2	5			**14**
Inconsistency with an engineering identity		3		1			2					**6**
Lack of communication		1	7				1	1	3	5	2	**20**
Lack of competence, experience, or skills	1	7	5		2	1		5	2	11	2	**36**
Lack of initiative		14	4	2		1	5				2	**28**
Procrastination		2	4	5		3	2			4	3	**23**
Restricting others' work	2	2	2			5	11		4		4	**30**
Unreliability	1	5	1			2	2	2	3	4		**20**
Totals	**11**	**47**	**35**	**14**	**6**	**20**	**36**	**28**	**23**	**30**	**20**	

The code co-occurrence table was used as a tool for examining how behaviors were understood to coincide in addition to their specific language in each excerpt. When one student

response was coded with multiple codes, it indicated complexity. Some codes easily combined with many of the others (*Failure to advance project, Failure to prioritize project, Lack of competence, experience, or skills*) while others stood separate (*Inconsistency with an engineering identity*). Table 16 showcases interdependencies in the behaviors exhibited. If one behavior tended to be mentioned in conjunction with a particular other behavior within an excerpt, it may indicate that (1) the participant viewed it as one behavior rather than separate ones, and (2) the coded behavior(s) stem from similar issues or values. This helped decipher how behaviors might fit under the umbrella of different larger themes.

The themes relating to quantity of work produced are wholehearted contribution, equity, and presence. *Failure to advance project toward completion* co-occurs most frequently with *Lack of initiative* (Table 16). One quote, intended as *Unreliability* but coded with *Failure to advance project toward completion* and *Lack of initiative* states, "_____ didn't contribute to the capstone project throughout the course of the year. ___ didn't lead any aspect of the project or [take] any initiative." In some ways, these two concepts can be understood as degrees of the same theme – **wholehearted contribution**. *Failure to advance project toward completion* indicates complete disengagement from the project. One typical response given by participants that sums up this behavior is, "We all had jobs to do and ___ didn't pick up any particular work. ___'d just sort of sit around." *Lack of initiative* indicates someone did what they were supposed to but didn't take ownership over a piece of the project or go above and beyond their explicit assignment. Put another way, the difference between these two behaviors is between not doing anything and not doing enough, respectively. For peers, dissatisfaction can occur in either case. The expectation is that peers will demonstrate leadership – not necessarily over the team but by heading an aspect of the project.

A second theme is **equity** in terms of distribution of labor. Probably the behavior most often cited when anyone talks about poor team experiences is when one teammate expects to take credit for work to which he or she did not contribute. At different times this is called "grade scalping", "slacking", or even "social loafing". (Borrego et al. 472-512) No individual wants to feel that their work and time is not respected or that others are taking advantage of them. The following are examples of the rich language used to describe this behavior:

> "Counted on the rest of the group to do everything and rode on our backs."
>
> "Doesn't really care about the success of the project, just expects it to be done without doing anything."
>
> "Half of the team carried the weight as a result of these actions."

These excerpts indicate an attitude that the team should be "in it together". Teammates are expected to put in the effort as a unit. If a teammate does not hold up this end of the bargain, there is exasperation when they want to reap the benefits of others' labor later. This concept of imbalance of workload between group members is most commonly seen with *Expecting too much from others*, in which a teammate seems to expect that others will pick up their slack. This behavior is most correlated with the *equity* theme, though other behaviors also showed up. For example, one participant commented that their teammate "counted on the rest of the group to do everything and rode on our backs. Didn't really work on group work when [he/she] showed up." In this case, the *Failure to advance project toward completion* exhibited by just sitting around during group meetings was symptomatic of the more fundamental complaint: lack of equality of work.

A third theme is physical **presence**. This theme corresponds largely with the *Prioritization of Project* behavior. This theme is characterized by short comments that a

teammate was often absent or late to team meetings. The reason for this theme, if given, is typically that the project seemed to always come second to their other commitments.

One theme encapsulated issues with teammates' quality of work and was partially examined by considering the combinations of behavior definition codes. One pair of codes often co-occurring is *Lack of competence, experience, or skills* and *Restricting others' work* (Table 16). This relationship can be understood as cause-and-effect. A typical participant might say, "When they completed something, generally more needed to be done and often their part had to be redone". This indicates that the quality of their work was not up to par. Through the eyes of the actor (participant), the wayward teammate's work did not meet the team's standards and thus they were holding the team back by failing to add value and forcing other team members to spend valuable time redoing insufficient work. Both behaviors indicate dissatisfaction with the **quality of work** produced. To be considered a valuable team member, value must be added to the final project.

Finally, three other themes encapsulated the personal and relationship-oriented issues – trust, motivations/attitudes/identity/beliefs, and interpersonal clashes. Teammates expect to be able to rely on one another – to **trust** that when one person agrees to do something (a part of the report, an aspect of the analysis, etc.) Two representative expression of this sentiment are

> "Sometimes ___ would commit to doing a part of our analysis and then a day later someone else would have to do it instead."
>
> [He/She] usually disappointed us if we assigned [him/her] a piece of work. We ended up trying to involve [him/her in other ways in the project but as time went on and we lost motivation in the project, we just stopped asking [him/her] to do things."

In this way, the cognitive load is placed on the actor. Trust allows the actor to let go of the portions that are not their responsibility, and the idea that "many hands make light work" depends on this concept. When trust is violated, the actor worries about whether the target will follow through, make a contingency plan, and eventually gives up hope altogether. The behaviors that frequently mapped to this theme were *Procrastination* and *Unreliability.* *Procrastination* often fed into participants' fears that their teammate's job wouldn't get done. *Unreliability* also was about not being able to rely on others. This required taking on a mental burden of worry and furthermore feel that they might have to prepare to take on extra work themselves.

Then, there are the sources of disapproval that come, not from how the target acts, but from a presumption about the sources of that behavior. In these cases, the **motivations, attitudes, identity, or beliefs** of the target do not align with the actor's ideals. *Inconsistency with an Engineering Identity* frequently fits into this theme because it has to do with the idea that "who you are (or what you care about) doesn't match who I think you should be (as an engineer)". Here are some representative excerpts:

> "[He/She] was mostly concerned about the way in which things looked. Would build elaborate powerpoint decks that didn't convey any information to make it look like the team had accomplished something that week."
>
> "[He/She] would commit [him/her]self to the project, but only when [he/she] had to, like when in depth questions from the professor needed answering. A lot of times [he/she] would just sit there and work on other things unrelated to the Capstone project and think [he/she] was above doing the work for this project because it was trivial to [he/she]."

In the first quote, the actor believes that the target does not care about the right problems and, in the second, the actor is attributed a false sense of superiority to the target. There may or not be merit to these perspectives but the perception of them flavors the actor's interactions and experience with the target. Central to this theme is the actor's fundamental lack of respect for the qualities of the target.

Last, **interpersonal** clashes can ruin an otherwise functional team experience. Sometimes personalities simply do not align from the beginning and sometimes a breach in relationships occurs over the course of the project. Group members may know each other socially outside of the team context and can bring past resentments or baggage into the group setting on the first day.

> "Sometimes I feel like [she/he] had an idea and only [her/his] idea was valid and would work. So if I added a comment, it would be ignored."
>
> "Sometimes would hold meetings with only part of the team and without communicating that. Then would get mad that the rest of us weren't communicating."

These excerpts do not indicate when the interpersonal issues arose but regardless, personal offenses have a negative impact on group efficacy. They impede the ability to trust the other person and make people less willing to spend time working on a problem together.

Validity and Reliability

This study is concerned with *perceptions* of behavior, which should be distinguished from actual behavior. It may be argued that the perception of poor behavior by an individual is of much greater consequence to interpersonal dynamics on a team than some "objective" measure of what behaviors really took place, because the perceptions concern the lived experience of the team members.

Past work (Miller, Hirshfield, and Chachra) described eleven different negative team behaviors that peers may perceive about one another on engineering project teams and provided concise definitions for distinguishing each behavior from one another. The Team Behaviors and Attitudes Survey used eleven vignettes based on, but not identical to, these definitions to communicate the same ideas about types of behavior types to the participants. How can we know whether participants understood the same concepts that the vignettes were intended to portray?

Each time a participant indicated that a particular individual on their team exhibited a particular behavior based on their reading of the vignette, one of the open-ended questions asked was: "In what way do you feel _____'s behavior during the project is/was similar to the passage above?" These responses were randomized and de-identified. The web-based computer software Dedoose was used to code all three hundred sixty-six excerpts based on the eleven original behavior definitions, independently of which behavior the participant had intended to indicate. A given excerpt may be coded as more than one behavior according to the official definitions. Agreement between the intended behavior and the coded definition would indicate that the participants did understand the concept the vignette was intended to portray. In Table 17, the descriptor matrix rows show the behavior each vignette was intended to portray, and the code

columns show how the researcher coded each vignette according to the given definitions. Each row corresponds with one column, e.g. ETM corresponds with *Expecting too much from others*, LCOM corresponds with *Lack of communication*, etc. For most behaviors, the most frequently appearing behavior definition code was in fact the intended behavior. The exceptions to this are IC (Inconsistency of contribution), which was more often coded as *Failure to prioritize project*, and U (Unreliability) which was equally frequently coded as *Failure to advance project toward completion.*

By examining the excerpts, it seems that *Inconsistency of contribution*, a behavior meant to indicate long-term variability ("My teammate contributed at the beginning of the semester, but after they landed a job offer they lost interest in our project") was often misunderstood as short-term irregularities in performance ("Sometimes they didn't seem as responsive to the group text and sometimes they would"). Furthermore, *Unreliability* was a behavior meant to showcase lack of trust between teammates ("I didn't know if I could trust them to get their part done or whether I should just do it myself") that instead was often interpreted as simply not contributing the way they ought ("My teammate did little for the project"). Though some code accuracy ratios seem to be quite low (Table 18), 2% of excerpts had no discernible codes associated with them, which may be contributing toward the low code accuracy in some cases. On the other hand, some behaviors like *Failure to prioritize project* were extremely well-understood (in this case, as being dependent on a person's physical presence in group meetings).

Table 17: Descriptor fields by codes chart

Codes of responses Intended behavior	Expecting too much from others	Failure to advance project toward completion	Failure to prioritize project	Inconsistency of contribution	Inconsistency with an engineering identity	Lack of communication	Lack of competence, experience, or skills	Lack of initiative	Procrastination	Restricting others'work	Unreliability
Expecting too much from others	15	8	2				2	7		1	1
Failure to advance project toward completion	1	27	5		1	2	4	6	1	1	2
Failure to prioritize project			41								
Inconsistency of contribution	1	9	16	11	2	6	1	2	6		
Inconsistency with an engineering identity		5		1	8		3	1			
Lack of communication		4	8			29		2	3	4	
Lack of competence, experience, or skills	1	4	3		1	2	20	4		5	
Lack of initiative		4	2	2	1		3	39	3	1	2
Procrastination		6	2	1		1			15	4	6
Restricting others' work		5	3			2	5		1	9	
Unreliability	3	10	6			1	7	1	3	4	10

Table 18: Code accuracy of intended behaviors

Intended behavior based on vignette	Intended count	Accurate code count	Code accuracy
Expecting too much from others	31	15	48.4%
Failure to advance project toward completion	35	27	77.1%
Failure to prioritize project	41	41	100%
Inconsistency of contribution	36	11	30.6%
Inconsistency with an engineering identity	17	8	47.1%
Lack of competence, experience, or skills	26	20	76.9%
Lack of communication	38	29	73.7%
Lack of initiative	45	39	86.7%
Procrastination	24	15	62.5%
Restricting others' work	18	9	50%
Unreliability	26	10	38.5%

Because each team is composed of different individuals, typically reliability measures are inappropriate in the context of this study. For the TBAS, agreement was ascertained by comparing ratings of an individual target by multiple actors for each of the eleven behaviors. Teammates were considered in agreement if there is unanimity for whether an individual possessed a behavior or not – severity of scores was not taken into account. Only teams in which all members participated in the study were considered. Of targets with two teammates, 93.9% of behaviors were unanimous. Of targets with three teammates, 78.8% were unanimously rated. Of those with four teammates, 58.2% of behaviors were unanimously rated. Of those with five teammates, 28.8% of behaviors were unanimous. Reaching unanimity is considerably more difficult as more voices are added.

For the BPNS, Cronbach's alpha was calculated for the 21-item scale. Cronbach's alpha is 0.73. According to the rules of thumb presented by George and Mallery when considering reliability scores, this ranges from "Good" to "Acceptable"(George and Mallery). The item that is most detrimental to a high value is Question 19, which asks to what extent the participant

agrees with "When working, I do not feel very capable" and is a measure of Competence (Table 19).

Table 19: Cronbach's alpha in Basic Psychological Needs Scale by item

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q1	89	5.64	1.08
Q2	89	6.17	1.08
Q3	89	5.33	1.62
Q4	89	3.76	1.90
Q5	89	4.60	1.32
Q6	89	6.12	0.82
Q7	89	4.25	2.29
Q8	89	5.88	1.27
Q9	89	5.53	1.43
Q10	89	5.20	1.69
Q11	89	4.11	1.58
Q12	89	5.56	1.11
Q13	89	4.42	1.69
Q14	89	5.29	1.25
Q15	89	3.82	2.04
Q16	89	4.33	2.18
Q17	89	5.31	1.79
Q18	89	3.78	2.58
Q19	89	3.83	2.20
Q20	89	3.78	2.22
Q21	89	6.43	0.82
Total	89	103.12	14.05

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q1	97.48	13.83	0.1640	0.3934	0.7280
Q2	96.96	13.55	0.4303	0.4775	0.7144
Q3	97.80	13.74	0.1367	0.5060	0.7315
Q4	99.36	13.23	0.3726	0.4455	0.7125
Q5	98.53	13.63	0.2760	0.5434	0.7214
Q6	97.00	13.88	0.1740	0.3422	0.7277
Q7	98.88	13.17	0.3085	0.4141	0.7194
Q8	97.25	13.63	0.2903	0.5506	0.7207
Q9	97.60	13.32	0.4674	0.6219	0.7079
Q10	97.92	13.26	0.4147	0.5673	0.7097
Q11	99.01	13.73	0.1453	0.2562	0.7307
Q12	97.56	13.45	0.5064	0.6518	0.7099
Q13	98.71	13.14	0.4925	0.6838	0.7031
Q14	97.83	13.47	0.4264	0.6853	0.7127
Q15	99.30	13.38	0.2568	0.3775	0.7236
Q16	98.80	13.52	0.1686	0.4020	0.7333
Q17	97.81	13.51	0.2378	0.4916	0.7243
Q18	99.35	13.38	0.1686	0.5534	0.7381
Q19	99.29	13.12	0.3502	0.4065	0.7146
Q20	99.35	13.18	0.3173	0.5665	0.7182
Q21	96.70	13.68	0.4198	0.5215	0.7181

Chapter 5: Synthesis and Conclusion

Synthesis

When we are asked to judge one another's behavior, that estimation is impacted by more than just an "objective" observance of behavior itself. Factors related to the identity of both the actor and target play a role in shaping how we view one another. In this thesis, gender and the fulfillment of basic psychological needs in the team environment are explored as factors that may influence how people perceive others. Gender is shown here to be one factor that can impact the frequency and severity with which we perceive one another, but there may be many others. Evaluations of behavior is not an objective process. Because gender is shown to impact perceptions of behaviors, the respective genders of existing teams matter. For example, the one female on a team with mostly males may be disproportionately severely penalized in peer evaluations for failing to show enough initiative. Though this work focuses on undergraduate engineering classrooms, its findings extend to the workforce and wherever long-term teams are formed. Industries that disproportionately hire men, for example, will likely see more severe evaluations for faults like failing to communicate or contributing inconsistently. These evaluations can have huge implications on an employee's future (or a student's grade) and are to some extent subject to specific aspects of the actor and target's identities. Thus, those with influence should consider forming teams with this principle in mind and seek to balance gender representation within teams and, in a larger sense, within their organizations.

Some behaviors are influenced more by the actor's gender and some by the target's gender. This implies that some behaviors are more subject to the actor's interpretation of the behaviors while other behaviors can be observed objectively fairly easily. Based on Table 14, the

following groups are formed. Behaviors that can be observed straightforwardly (in terms of either frequency or severity) include lack of initiative and unreliability. Behaviors subject to the actor's interpretation of behaviors include failure to advance project toward completion, inconsistency of contribution, inconsistency with an engineering identity, lack of communication, and procrastination. Failure to prioritize the project is one behavior that had elements of being influenced by both the gender of the actor and target. In particular, male actors rated others as having this behavior more frequently than females did and males who were judged to exhibit this behavior were penalized more severely than the females judged to exhibit the behavior. Thus, experience of this behavior may be co-constructed by the relationship between the pair. One interpretation of this may be that failing to be physically present in group meetings is easily excused when the relationship with that individual is positive while the behavior is judged severely when the relationship between actor and target is poor.

In her work on expertise recognition, Joshi found that when the various levels of groups were examined (actor, target, dyad, and group), the greatest source of variance was not the "attributes (such as gender or education level completed) of the person being evaluated (i.e., the target) as one might expect, but rather through the attributes of the person providing the evaluation (i.e., the actor) and the relationship between the two individuals (i.e., the dyad)". Joshi considered all four levels of cross-level groups in conjunction with one another, without directly comparing one level to another. She indirectly says that when evaluating others' expertise, actors contribute more to the variance than targets. This study finds the opposite through the use of a multilevel model estimating the social relations model – that targets contribute more to the variance than actors. However, this study focuses on the evaluation of specific behaviors. Because evaluations of expertise may be more abstract and thus more subject to the identity of

the actor, more variance may come from the actor in that case. However, both studies consider only a subset of attributes that could contribute to variance: gender and education level completed in Joshi's case and gender and basic psychological needs experienced in this study, which could also contribute to the discrepancy. Furthermore, this study further attempted to compare the actor and target's influence on eleven specific behaviors despite the fact that because the four levels are crossed rather than nested, complicated relationships between them arise. Different behaviors showed different patterns of how the gender of the actor and target influenced them. It may be the case that more concrete concepts (like specific behaviors) yield perceptions that are based more heavily on the target, not the actor, while more abstract concepts (like a general evaluation of expertise) can be influenced more by the actor's attributes.

Though in most cases the fulfillment of basic psychological needs in the team context does not correlate with how those students perceive others, this relationship was found in the case of one behavior. Independent students who feel connected and safe with their teammates but who are not competent tend to think their (more competent) teammates do not prioritize the project sufficiently. Prioritization of the project is commonly understood as physical presence at group meetings. Less competent students could at least claim they showed up and built a relationship with their teammates. Then, they penalized other students for not showing the same type of commitment.

Limitations

Regardless of their sex, individuals can identify with a given gender to varying degrees. This study largely conflates the two constructs (sex and gender) rather than giving sufficient consideration to how individuals actually perceive their own place on the gender spectrum. One potential measurement tool is the gender-identity scale developed by Derks, van Laar, and Ellemers (Derks, van Laar, and Ellemers 183-202). This eight-item scale measures how important an individual's social group membership (in terms of gender) is to their gender identity. As it stands, this study is limited in that it does not take the individual's own sense of belonging to a particular gender group (male or female) into account. Furthermore, because the sex of targets was not collected, these measures were reconstructed and may not be a perfect representation of the true gender identities of the targets in this study.

This study collected information about the participants in this study – their demographics, their fulfillment of basic psychological needs and their perceptions of others' behaviors. The nature of this study is unbalanced, however, as much less information is known about targets. One way this effect manifests is through sample size. Though as a whole 89 participants may be reasonable for surveys, this study does not directly measure the basic psychological need fulfillment of targets as they did not consent to participation in the surveys. Individuals were incentivized to participate in conjunction with their other teammates, which allowed the creation of a reduced dataset in which all actors had themselves also been rated by at least one teammate. However, this dataset includes only sixty-six of the 89 actors. This reduced dataset is further segmented by limited instances of each of the eleven undesirable behaviors appearing (Table 20). Within a given behavior, measures of severity and frequency are restricted by the small sample size. Additionally, information was not collected about targets' basic psychological needs and

thus it was impossible to map which basic psychological needs were left unmet for students judged to actually exhibit a particular behavior. This limitation may have been mitigated by collecting a larger sample size overall such that, by extension, the reduced dataset would be large enough to support analysis specific to targets. Alternatively, Basic Psychological Needs Scales could have been distributed with consent forms to entire classes before individuals volunteered to be participants for the rest of the study. This may have increased the likelihood that relative autonomy, competence, and relatedness scores would be known for a particular identified target. By not having more information on the target such their autonomy, competence, and relatedness scores, analyses between Basic Psychological Need Fulfilment and behaviors of the target cannot be run.

Table 20: Instances of undesirable behaviors in reduced dataset

Behavior	**Number of instances**
Expecting too much from others	19
Failure to advance project toward completion	3
Failure to prioritize project	4
Inconsistency of contributions	5
Inconsistency with an engineering identity	0
Lack of communication	4
Lack of competence, experience, or skills	3
Lack of initiative	6
Procrastination	2
Restricting others' work	1
Unreliability	1

Furthermore, teams for this study were not artificially constructed and thus not randomly assigned. A number of factors are not evenly distributed across groups including sex, age, year in

school, major, number of teammates, and more. Teams with projects that are well-defined may encounter different difficulties than teams with projects that have less clarity. For example, teams that do not need to meet in person frequently may have less opportunity to notice aspects of a teammate's behavior that depend on presence. Some projects may require advanced subject matter expertise that teammates are likely to lack (perhaps leading to increased perceptions of *Lack of competence, experience, or skills*), while other teams do not. Students who are drawn to particular majors may be more or less inclined to see certain behaviors – for example, perhaps students drawn to a discipline like systems engineering which is thought to be a less traditional field are more forgiving of *Inconsistency with an engineering identity* than mechanical engineers, thought to be more traditional. In general, teammates were not equally likely to encounter a particular behavior on their teams or to experience motivation the same way. Though comparisons are made in this study between the genders of individuals, for example, there may be other uncontrollable factors affecting how frequently or severely behaviors are perceived. Blocking in Research Question 2 is one measure taken to mitigate the impact of such nuisance factors; blocking, however, comes at the price of a smaller sample size.

To demonstrate, distributions of age and major of people are considered for people perceiving *Inconsistency with an engineering identity* (Figure 16) and are compared to the overall distributions of age and major (Figure 15).

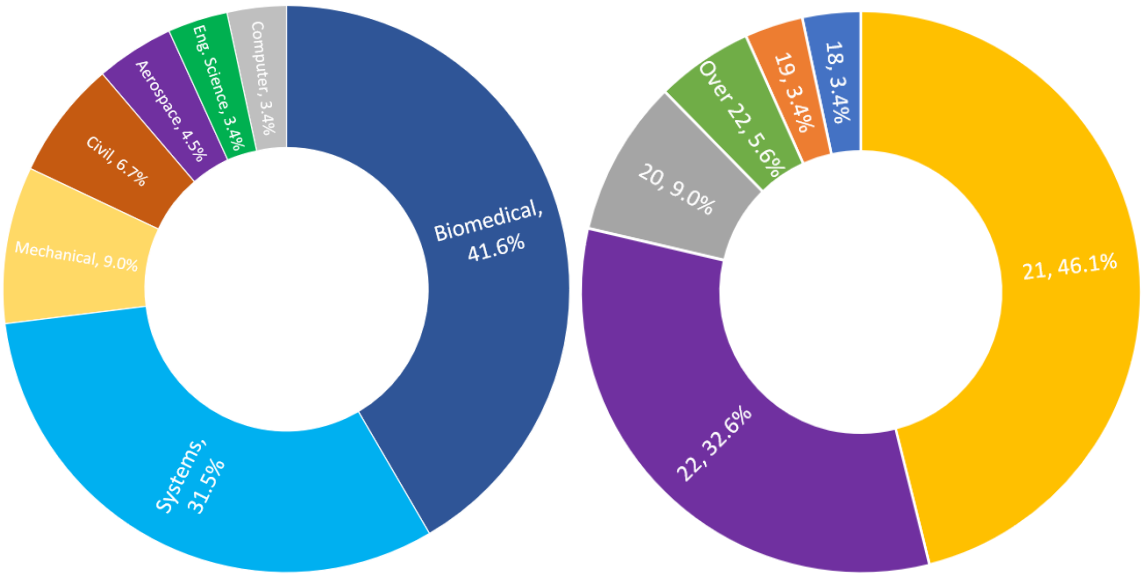


Figure 15: Relative major proportions (left) and age proportions (right) in overall data set

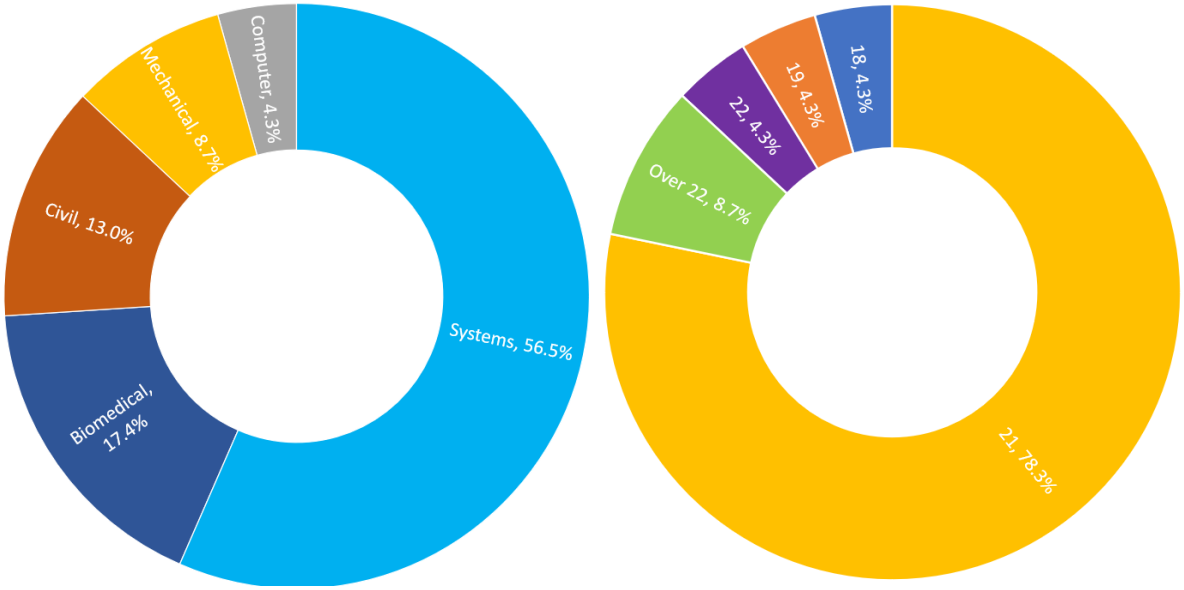


Figure 16: Relative major proportions (left) and age proportions (right) of participants perceiving *Inconsistency with an engineering identity*

Overall, 46.1% of participants are 21 years old. Of those reporting at least one instance of *Inconsistency with an engineering identity*, a huge proportion (78.3%) are 21 years old. In terms

of major discipline, the proportion of computer engineers and mechanical engineers stays largely constant – about 4% and 9% respectively. In contrast 56.5% of students reporting this behavior are enrolled in systems engineering as compared to 31.5% of participants overall. Students reporting this behavior were more likely to be enrolled in the systems engineering major, contrary to the hypothesis above. As a wide variety of classes are represented regardless of major, this discrepancy is more likely to be a result of major than particular class. This may suggest that being enrolled in systems engineering has some effect that makes students more likely to see *Inconsistency with an engineering identity* in others. In this study, the only factor with sample sizes large enough to test with traditional statistical methods was gender, but if a larger sample size could be attained the effect of other factors like major discipline or age might be better understood.

Future Work

Six motivation "profiles" of participants were identified in this work, and basic psychological need fulfillment scores of participants were mapped to their perceptions of other teammates' behaviors. While the insights developed do have implications for instructors overseeing project teams, it may be more intuitive for instructors to ask, "If I see members on a team exhibiting certain undesirable behaviors, then which basic psychological needs are likely to be missing in the group context (and how can those needs be supported)?" By asking participants to corroborate perceptions of one another's behaviors within a team, strength is lent to the argument that a particular individual was in fact exhibiting a particular behavior. In this way, agreement of perceptions of behavior can be used as a proxy for actual behavior. Only actors in this study were subject to taking the Basic Psychological Needs Scale – not targets. Thus, information about the basic psychological need fulfillment of targets in this study was limited to the reduced dataset created by including only actors who had themselves also been rated by other teammates. This dataset had a sample size too small to form the basis for reasonable statistical analyses, with instances of certain behaviors being as low as 0 (*Inconsistency with an engineering identity)* and only as high as 19 *(Expecting too much from others)*. Thus, future work should include collection of target motivations to predict basic psychological needs that are lacking using what instructors can easily observe – behaviors.

One extension of this work is determining which behaviors most affect overall perceptions of behavior. For example, *Inconsistency of contribution* may be viewed as a much bigger fault than *Procrastination.* Beyond simply classifying which behaviors are considered "worse", this can to some extent be mapped to how the individual was themselves judged to behave. Perhaps the

behaviors are considered less acceptable when the actor does not themselves identify with that behavior.

This work is based on framing the behaviors as negative. Doing so may draw out complaints where they otherwise did not exist. Focusing on the negative behaviors may also create frameworks in the mind of the actor that influence how they think about their teammates – their minds may be primed to think about certain behaviors that did not actually stand out. Therefore, one important question is whether the differences in perceptions of behaviors between men and women change when the behaviors are phrased positively. By focusing on positive behaviors, different patterns could emerge. Furthermore, it is possible that by asking students to describe others' behaviors in an open-ended fashion rather than using pre-determined behavior vignettes that more subtlety in defining the behaviors would be obtained.

More work should be done in translating findings to future applications. One potential application would be the creation of a peer assessment tool that is more robust to factors relating to the identity of the actor and target. Differences between actors and targets will always exist, but by understanding how these differences can impact subjective assessments, tools can be created that help control for these factors. Moreover, much of the subjectivity is derived simply from the identities of the individuals making up a group. Guidelines can be created that help managers and instructors create teams that optimize each individual's experience and thus create healthy working environments that allow productivity to flourish.

Furthermore, expansion of the material in this paper using the PROC MIXED COVTEST dummy variable method (Kenny) of estimating the Social Relations Model to obtain accurate actor-partner covariance and group variance measures of the dataset is recommended for future

work. Round-robin data is somewhat unique in that perceptions of individuals exist with cross-classified variables (individuals, dyads, and groups).

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Appendix A: Comparison of original and modified Basic Psychological Need Satisfaction Scale for Team Domain (Ryan and Deci 68-78; Gagné 199-223)

General Scale	Modified Team Domain Scale
1. I feel like I am free to decide for myself how to live my life.	I feel like I am free to decide how my job gets done.
2. I really like the people I interact with.	I really like the people I work with.
3. Often, I do not feel very competent.	I do not feel very competent when working on this project.
4. I feel pressured in my life.	I feel pressured in this project.
5. People I know tell me I am good at what I do.	People tell me I am good at what I do.
6. I get along with people I come into contact with.	I get along with people.
7. I pretty much keep to myself and don't have a lot of social contacts.	I pretty much keep to myself and don't socialize much.
8. I generally feel free to express my ideas and opinions.	I feel free to express my ideas and opinions for this project.
9. I consider the people I regularly interact with to be my friends.	I consider my teammates to be my friends.
10. I have been able to learn interesting new skills recently.	I have been able to learn interesting new skills through this project.
11. In my daily life, I frequently have to do what I am told.	When working on this project, I have to do what I am told.
12. People in my life care about me.	My teammates care about me.
13. Most days I feel a sense of accomplishment from what I do.	Most days I feel a sense of accomplishment from working on this project.
14. People I interact with on a daily basis tend to take my feelings into consideration.	Those around me take my feelings into consideration.
15. In my life I do not get much of a chance to show how capable I am.	In this project I do not get much of a chance to show how capable I am.
16. There are not many people that I am close to.	There are not many people I am close to on this project.
17. I feel like I can pretty much be myself in my daily situations	I feel like I can pretty much be myself while working on this project.
18. The people I interact with regularly do not seem to like me much.	The people on my team do not seem to like me much.
19. I often do not feel very capable.	While working, I often do not feel very capable.
20. There is not much opportunity for me to decide for myself how to do things in my daily life.	There is not much opportunity for me to decide for myself how to go about my work.

21. People are generally pretty friendly towards me.	My teammates are generally pretty friendly towards me.

Appendix B: Behaviors, Definitions, and Associated Vignettes

Behavior	**Definition from past work**	**Vignette**
Expecting too much from others	Expecting other teammates to contribute beyond their "fair share", especially to avoid responsibility themselves	*"This person expected others to pick up their slack, as they wanted to avoid responsibilities themselves. I felt that they took advantage of other teammates by asking them to take on more than their "fair share"."*
Failing to advance toward project's completion	Passively failing to add value to activities that move the project forward	*"Generally, my teammate just didn't seem to move the project closer to completion or add any value. They were not actively engaged - you could often find them watching others work, sitting idly, or simply listening to group discussions. They seemed unwilling to participate in the work itself."*
Failing to prioritize project	Demonstrating that other commitments take precedence over the project; often an unwillingness to devote time resources to the course	*"To my teammate, other commitments always seemed to take precedence over our project. They were unwilling to devote much of their time to making the project the best it could be. They may have been frequently absent in team meetings."*
Inconsistency of contribution	Exhibiting widely-varying contribution levels over the course of the project	*"Sometimes my teammate was available and an active contributor, and sometimes they were not. Sometimes they seemed committed to the project's success, and sometimes they seemed to fall off the grid. Perhaps they were complacent until a deadline loomed, or perhaps they helped until deciding to accept a job offer. Either way, my attitude toward them changed drastically over the course of the project."*
Inconsistency with an engineering identity	Possessing personality traits or performing activities that the interviewee deemed inconsistent with their vision of how an engineer should behave or feel	*"Their attitude toward the project did not align with how I feel an engineer should behave or feel. I identify as an engineer more than I believe this person does. For example, it bothered me that they took on tasks that were not technical in nature. I may have felt that while I was truly enthusiastic about the engineering work, my teammate was mostly concerned about getting an A."*
Lack of communication	Failing to disseminate information important to the group's	*"This person was not an effective communicator, either within the team or with others. They didn't work to make sure we were all on the same page.*

	effectiveness, or to connect with teammates in general	*They may have failed to distribute information important for everyone to have, gotten easily off track, or generally failed to connect with the rest of the team."*
Lack of competence, experience, or skills	Demonstrating a lack of understanding or ability necessary to complete a task	*"My teammate lacked the requisite competence, experience, and/or skills to effectively contribute to the project. They sometimes seemed to be "behind" the rest of the group members in terms of content understanding. Sometimes the work they'd present to the group was incorrect or needed to be reworked. I was constantly spending group work time explaining (what I considered to be) obvious questions about content, rather than focusing on important issues."*
Lack of initiative	Unwilling to take on tasks beyond clearly articulated expectations of teammates	*"This person was willing to complete tasks explicitly assigned to them, but never seemed to take the next step. I can't point to one aspect of the project over which my teammate seemed to take ownership."*
Procrastination	Delaying the completion of tasks required for the project until absolutely necessary	*"My teammate seemed to always wait until the last possible moment to get their work done. Even if they thrived under the pressure and did manage to pull off a successful finished product, it was done at the last minute. This habit put a strain on my schedule, especially when I depended on them to finish their part before I could do mine."*
Restricting others' work	Directly or indirectly inhibiting the group from completing its work in a timely manner	*"My teammate directly or indirectly prevented the group from making effective progress on the project. They may have demanded work that I felt was sufficient needed to be redone, or simply redoing it themselves. They were active team members, but I felt that they detracted from the work's quality."*
Unreliability	Not trusted to follow through on tasks they promise to complete	*"I couldn't really trust my teammate to follow through on what they promised to do. I was always worrying and wondering whether they were spending their time getting their work done or if I should just do it myself. I felt like I needed to keep reminding them about their obligations."*

Appendix C: Team Behaviors and Attitudes Survey - Demographics

Please indicate your age (in years)

- Under 18
- 18
- 19
- 20
- 21
- 22
- Over 22

Please indicate your sex.

- Male
- Female

Please indicate your year in school.

- First year
- Second year
- Third year
- Fourth year
- Fifth year
- Longer than five years

Please indicate the option that best describes your race.

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander
- Other

What major are you enrolled in/do you intend to enroll in?

- Aerospace Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Computer Science
- Electrical Engineering
- Engineering Science
- Mechanical Engineering
- Systems Engineering

- Other. Please indicate: _____

What class were you enrolled in?

- ENGR 1420
- CE 4991
- Etc.

How many people (not including yourself) were on your team? _____

Appendix D: Teammate Behaviors and Attitudes Survey – Behavior Information

How do you believe _____'s behavior impacted the overall success of the team?

1. It strongly hindered the team's success
2. It somewhat hindered the team's success
3. It somewhat supported the team's success
4. It strongly supported the team's success

How do you believe _____'s behavior affected your overall personal experience working on the project?

1. Strong negative impact
2. Slight negative impact
3. Slight positive impact
4. Strong positive impact

How frequently did you enjoy working with _____?

1. Never
2. Less than half the time
3. More than half the time
4. Always

For each teammates (computer autofills each team member's name)

For each member of your team, indicate whether you recognize this type of behavior in the way they conducted themselves throughout the course of the project. If the behavior occurred at least **once**, please indicate "yes".

"This person expected others to pick up their slack, as they wanted to avoid responsibilities themselves. I felt that they took advantage of other teammates by asking them to take on more than their "fair share"." ***Yes No***

"Generally, my teammate just didn't seem to move the project closer to completion or add any value. They were not actively engaged - you could often find them watching others work, sitting idly, or simply listening to group discussions. They seemed unwilling to participate in the work itself." ***Yes No***

“To my teammate, other commitments always seemed to take precedence over our project. They were unwilling to devote much of their time to making the project the best it could be. They may have been frequently absent in team meetings.” ***Yes No***

“Sometimes my teammate was available and an active contributor, and sometimes they were not. Sometimes they seemed committed to the project's success, and sometimes they seemed to fall off the grid. Perhaps they were complacent until a deadline loomed, or perhaps they helped until deciding to accept a job offer. Either way, my attitude toward them changed drastically over the course of the project.” ***Yes No***

“Their attitude toward the project did not align with how I feel an engineer should behave or feel. I identify as an engineer more than I believe this person does. For example, it bothered me that they took on tasks that were not technical in nature. I may have felt that while I was truly enthusiastic about the engineering work, my teammate was mostly concerned about getting an A.” ***Yes No***

“This person was not an effective communicator, either within the team or with others. They didn't work to make sure we were all on the same page. They may have failed to distribute information important for everyone to have, gotten easily off track, or generally failed to connect with the rest of the team.” ***Yes No***

“My teammate lacked the requisite competence, experience, and/or skills to effectively contribute to the project. They sometimes seemed to be "behind" the rest of the group members in terms of content understanding. Sometimes the work they'd present to the group was incorrect or needed to be reworked. I was constantly spending group work time explaining (what I considered to be) obvious questions about content, rather than focusing on important issues.” ***Yes No***

“This person was willing to complete tasks explicitly assigned to them, but never seemed to take the next step. I can't point to one aspect of the project over which my teammate seemed to take ownership.” ***Yes No***

“My teammate seemed to always wait until the last possible moment to get their work done. Even if they thrived under the pressure and did manage to pull off a successful finished product, it was done at the last minute. This habit put a strain on my schedule, especially when I depended on them to finish their part before I could do mine.” ***Yes No***

“My teammate directly or indirectly prevented the group from making effective progress on the project. They may have demanded work that I felt was sufficient needed to be redone, or simply redoing it themselves. They were active team members, but I felt that they detracted from the work's quality.” ***Yes No***

“I couldn't really trust my teammate to follow through on what they promised to do. I was always worrying and wondering whether they were spending their time getting their work done

or if I should just do it myself. I felt like I needed to keep reminding them about their obligations." ***Yes No***

For each member and behavior they respond "yes" to…

In what way do you feel _____'s behavior during the project is/was similar to the passage above? Please limit your response to 1-2 sentences.

How frequently did this behavior bother you over the course of the project?

1. Almost never
2. Rarely
3. Sometimes
4. About half the time
5. Often
6. Usually
7. Almost always

To what extent did this behavior affect your overall personal experience working on the project?

1. The behavior had a strong negative impact
2. The behavior had a moderate negative impact
3. The behavior had a slight negative impact
4. No effect
5. The behavior had a slight positive impact
6. The behavior had a moderate positive impact
7. The behavior had a strong positive impact

How specifically do you feel this behavior impacted your own experience working on the project?

To what extent did this behavior affect the quality of work your team was able to achieve?

1 - The behavior strongly hindered the quality of work
2- The behavior moderately hindered the quality of work
3 - The behavior slightly hindered the quality of work

4 - No effect
5 - The behavior slightly supported the quality of work
6 - The behavior moderately supported the quality of work
7 - The behavior strongly supported the quality of work

To what extent did this behavior affect the team's overall success?

1 - The behavior strongly hindered the team's success
2- The behavior moderately hindered the team's success
3 - The behavior slightly hindered the team's success
4 - No effect
5 - The behavior slightly supported the team's success
6 - The behavior moderately supported the team's success
7 - The behavior strongly supported the team's success

How specifically do you feel this behavior impacted the team's overall success?

Appendix E: Sign In Form

What is your first and last name? _____

What is your UVA email ID? _____

What class are you enrolled in for the purposes of this study? _____

Please list the names of each of your teammates, not including yourself. Leave extra spaces blank. (Choose the team you've worked with in the class listed above lasting the longest/that you are in currently.)

Teammate #1 _____

Teammate #2 _____

Teammate #3 _____

Teammate #4 _____

Teammate #5 _____

Teammate #6 _____

Are you interested in being considered for a follow-up interview? _____

As these interviews will be conducted at the end of the school year, we anticipate that some interviews may need to be conducted over the phone. If you are interested, please provide a phone number at which you can be reached. _____

You may pick up your $10 or $20 gift card in one of two ways. Please choose one.

- (•) I want to pick up my gift card on Tuesday, May 9 in Olsson 018 between 9 a.m. and 5 p.m.
- ( ) I would like to receive an e-giftcard emailed to me.

If your whole team participates, you get a choice of $20 gift cards.

NOTE: If you choose to receive an E-giftcard, it will be from Starbucks. (Starbucks giftcards may be E-giftcards or physical gift cards).

- ( ) Boylan Heights
- ( ) Roots Natural Kitchen
- ( ) Starbucks

Appendix F: Abbreviations

For the purposes of the appendix, the following abbreviations for the eleven behaviors may be used:

Behavior Abbreviations

Behavior	**Abbreviation**
Expecting too much from others	ETM
Failure to advance project toward completion	FA
Failure to prioritize project	FP
Inconsistency of contribution	IC
Inconsistency with an engineering identity	IEI
Lack of communication	LCOM
Lack of competence, experience, or skills	LCES
Lack of initiative	LI
Procrastination	P
Restricting others' work	R
Unreliability	U

Appendix G: Survey Protocol

Study Overview: Give a brief overview of your project. Consider the following when framing your response:

- What is your purpose in conducting this research? What makes the project interesting and worth doing?
- Include information about the study's logistics (where and when it will be conducted, what instruments you will use, etc). What will you be asking participants to do, and what do you hope to learn from these activities?
- If your study has more than one phase, please clearly map out the different phases.
- If your study is a multi-site study, please describe.

Response 1: (enter response below this header)

Understanding the subjective student experience in project teams is important in terms of better designing relevant peer assessments, helping students learn how to be better teammates in school and the workplace, and ultimately positively impacting students' motivation and persistence in engineering. In our past research, we learned that students are dissatisfied with the work of peers in ways not captured by instructor expectations. Some of these behaviors fit our idea of a "slacker," like failing to prioritize the project. Others are unexpected, more active behaviors such as expecting too much from others or restricting others' work. This study focuses on addressing the next phase of the research: identifying reasons why negative team behaviors occur on student project teams. In particular, we plan to map which basic psychological needs are met through the project for each student to the behaviors they exhibit to better understand their underlying motivation.

The study will be conducted in two parts. First, participants will complete two surveys: a context-specific modified Basic Psychological Needs Survey (BPNS) and a second survey focusing on teammate perceptions of negative team behaviors. The BPNS gives a score for how well each need (including autonomy, competence, and relatedness) was met in the context of the project. The team behaviors survey will measure the effect and severity of the negative behaviors exhibited by each teammate. By comparing perceptions of multiple students on the same team, we will get a more holistic view of how each teammate behaved. From here, a profile of each student can be created and analyzed. These surveys will be conducted toward the end of the 2017 spring semester at the University of Virginia in small conference rooms in Olsson Hall. Following some initial analysis, some participants will be selected to return for interviews , allowing the researchers to probe the connection between negative team behaviors and motivation more fully.

1. **Participants: Please describe as best you can the population(s) you plan to work with.** Please describe them in the terms that are most pertinent to your project. We need to understand how working with them will further your research objectives and what steps need to be taken in order to minimize risk to them. **Please respond to questions a-e in this section.**

a. Please fill in the following blanks below. If you are working with more than one population, please provide information for each group.

Response 2-a: (enter response below this header)

Age: 18-22
Gender: Male and Female
Race: Any
Estimated number of participants: 30-40

b. Describe how participants will be identified and selected to participate in the study. Are there specific populations that you will be targeting and if so, why? Are there potential participants that you will exclude from the study and if so, why?

Response 2-b: (enter response below this header)

Participants will be recruited from within the engineering school at the University of Virginia. In particular, they will be recruited from undergraduate classes that involve a team project lasting at least 4-6 weeks. Participants must be currently enrolled in a class fitting this description, as the study considers the motivation of students working in engineering project teams and how this correlates with the behavior they exhibit throughout the project. No undergraduate engineering students fitting this description will be excluded.

c. Is the population and/or individual participant "risk-sensitive"? (You will have an opportunity to discuss the risks in more detail in the "Risks" section.) Is the population and/or individual participant "vulnerable"? (This issue relates to the participant's capacity consent; you will have an opportunity to discuss your consent procedures in more detail in the "Consents" section.)

Response 2-c: (enter response below this header)

No, the populations studied are neither risk-sensitive nor vulnerable.

d. Will you deceive and/or withhold information from the participants about the study? If so, please justify why deception and/or withholding information from the participants is necessary and describe the deception. Using deception requires specific consent forms and processes; please describe this process in the **Consent section** under **Response 3-a** and **3-b**.

Response 2-d: (enter response below this header)

N/A

e. What special experience or knowledge do you have that will allow you to work productively and respectfully with your participants? What special experience or knowledge does your faculty sponsor have in relation to your research participants?

Response 2-e: (enter response below this header)

Professor Reid Bailey has sixteen years of experience in teaching undergraduate engineering students at several universities and performing research in engineering education. He conducted several studies of undergraduate engineering courses at the University of Arizona and the University of Virginia. Emily Miller has three years of experience as a teaching assistant for undergraduate engineering students. She is the lead author on the motivating study for this project, and has also contributed to other research in engineering education for three years.

2. **Consent:** Consent is an on-going process that starts when you first inform your participant about the study through your recruitment/advertising efforts and ends when the participant's data are no longer needed. The federal regulations require a formal consent process takes place where you provide participants with specific information about the study (usually provided in the consent form, see General Consent Template) and the participants are required to sign the form. Not every study will fit this mold and there are some alternative methods for conducting the formal consent procedure. **In general, the Board needs to understand how participants will be recruited and consented to participate in the study.** Please note that if your study qualifies for exemption, you will not be required to follow the federal regulations for consent, but the Board may require that you provide information about the study to the participant. **Please respond to questions a-d in this section.**
    a. How will you approach/recruit participants to participate in your research? **Please provide all materials used to contact participants in this study. These materials could include letters, emails, flyers, advertisements, etc. If you will contact participants verbally, please provide a script that outlines what you will say to participants.**

Response 3-a: (enter response below this header)

Participants will be recruited from engineering project classes with the permission of the instructor. Based on how much time the instructor can allow in class, we will recruit participants by coming into class and giving a pitch. Regardless, potential participants will receive an email detailing the opportunity, purpose of the study, time we expect participation to take, and reward system.

What is your consent process? Who will present the consent information and how will it be presented? How will you document consent? Are your participants able to sign a form, and if not, how will you document consent? Will you use more than one form (if you use more than one version of the consent form, each form needs to have a unique title in order for our staff to keep track of the different forms)? When and where will participants receive the consent form? Who will give them the consent form? Will you pay participants?

Response 3-b: (enter response below this header)

When participants arrive to complete the survey portion of the study, they will first be given a consent form to sign on paper by Emily. Students completing the survey outside of the lab will sign an electronic consent form. A different consent form will be given to participants by Emily to be signed when participants arrive for the interview portion of the study. Participants will be assured they can back out at any time and still receive payment in the form of gift cards ($10 for the survey portion, $10 for the interview portion). To incentivize whole teams to participate, anyone with all team members participating will receive $20 gift cards to the Charlottesville restaurant of their choice: Roots, Boylan Heights, or Starbucks.

Are any of your participants unable to consent (i.e. vulnerable population)? These populations include (but are not limited to): minors (participants under the legal age of consent), prisoners, and participants with diminished mental capacity. These participants generally need a parent (or surrogate) consent form and a participant assent form (prisoners being the likely exception unless they are minors too).

Response 3-c: (enter response below this header)

The participants are not considered vulnerable.

What is your relationship to your participants? Do you know them personally or hold any position of authority over them? Do any of the researchers (including the faculty advisor) have positions of authority over the participants, such as grading authority, professional authority, etc.? Are there any relevant financial relationships?

Response 3-d: (enter response below this header)

Emily is currently a graduate teaching assistant in the systems engineering department at UVa. Though we will not be pulling participants directly from those classes, it is possible she may know some students but will not be a position of authority over them. We will be recruiting students in part from capstone classes – in which there are some teams that Reid advises. Therefore, he will not see any data until after final spring 2017 grades have been assigned.

Materials/Data collected: For most SBS studies, the risk to participants often lies in the information that is collected from them. Thus the manner in which the data are collected, how they are stored, and how the data are reported in your research is an important part of determining the risk to participants. When you develop your procedures, consider **minimizing or eliminating the collection of identifying information** where possible and **provide justification** as to why it needs to be collected. **Please respond to questions a-d in this section.**

Are any of the data already collected? (If you are only using archival data, please use the Archival Data protocol form instead of this form.) Are the data publicly available or part of a private collection? Please describe the data set(s) and provide a list of data fields you will use (when applicable). What will you do to protect the confidentiality of the pre-existing data?

Response 4-a: (enter response below this header)

None of the data are already collected, and the data are not publicly available. Demographics collected during the survey will include year in school, class enrolled in, ethnicity, age, sex, and major. Collecting information on ethnicity, age, sex, and major are important given the role that they can play in shaping team dynamics. In the first survey, questions will relate to overall impressions of each of their teammates as well as thoughts about specific behaviors their teammates may have acted on, including: expecting too much from others, failing to advance toward project's completion, failing to prioritize project, inconsistency of contribution, inconsistency with an engineering identity, lack of communication, lack of competence, experience, or skills, lack of initiative, procrastination, restricting others' work, and unreliability. The second survey will assess to what extent each of three psychological needs (autonomy, competence, and relatedness) is met in the context of the project environment. The surveys will be administered using UVa's "moderately sensitive" portal to Qualtrics.

What will you do to protect the privacy of your participants? Describe the process for collecting data from your participants. What will you do to protect the confidentiality of your participants? Describe the kinds of information you will gather and the material forms it will take. Describe the level to which the participant's identity will be known, if that information will be collected (and why), and how the identifying information will be linked with the participant's data. If you don't intend to collect identifying information, describe your process for keeping the data anonymous.

Response 4-b: (enter response below this header)

Participants will sign a consent form, and will be allowed to skip any questions they do not wish to answer without penalty. When participants first express interest in participating in the study, they will

provide the names of their teammates and will not be permitted to take the surveys at the same time as anyone else on their team, so as to reduce any fear of discomfort.

During the survey, participants will be asked both closed-ended and open-ended questions about their perception of their teammates' behavior over the course of the project. Students will need to recognize their teammates' names during the survey, but after the survey data is collected, the data will be de-identified using ID codes. The key for these codes will be kept on a secure network drive (a private Collab page), only accessible by the main researchers.

Will you use audio recordings, photographs, video recordings or other similar data recording devices? Please justify why it is necessary to use these devices, how you will use them, and what you will do with the data after they are collected.

Response 4-c: (enter response below this header)

During the interview portion, we will use audio recordings to allow interviews to be transcribed later. Once they have been transcribed into text, these recordings will be deleted.

How will your materials be stored? Discuss both how you plan to store it while you are collecting and actively analyzing it, and your long-term plan for maintaining it when the active research phase is finished. How will your data be reported in your study? Will you report the results in aggregate or will individual data be discussed?

Response 4-d: (enter response below this header)

Audio data will be stored electronically on a password protected secure network drive within Olsson Hall. Random ID numbers will be given to students to use in place of their real names. The key that links each student's name to their ID number will also be stored on the password protected secure network drive. Only the investigator and faculty advisor will have access to both the electronic data and the key. The key will be destroyed three years after the final paper related to this dataset has been published, while the data itself will not be destroyed.

3. **Risks**: Almost any intervention into other people's lives carries with it the potential to cause them social, psychological, physical, or legal harm. However, not every interaction will put a participant at risk beyond what is considered minimal. **Please describe to the Board the potential risks and the probability of harm to the participants in your study.** In this section, consider the following when framing your response:
    - Describe the risks to the participants in your study. Does your study include "risk-sensitive" participants (as identified in the Participants section)? What is the probability that harm could occur?
    - Describe what you will do to minimize those risks. Describe what you will do if a harmful situation occurs.
    - Would a loss of confidentiality of any of your materials put participants at risk? If so, how will you prevent this from happening?

Response 5: (enter response below this header)

The only foreseeable risk for participating in this study is that participants will be asked questions about their teammates' behaviors during the project. Some of this information could be information they would not normally share with their teammates. Nothing about these particular students make them more vulnerable to this risk than the larger population. Participants will be allowed to skip questions or stop their participation in the study if they feel uncomfortable in any way. Furthermore,

students will discouraged from participating in the study at the exact same time as any of their teammates and will be assured their data will be handled confidentially. Once the interview portion is over, we will de-identify the materials. Loss of confidentiality of materials before de-identification could reveal sensitive information to a subject's teammates; therefore, we will de-identify the material as soon as it is downloaded and only store the key on the private Collab page.

4. **Benefits**: Benefits help to outweigh the risks to the participants, though not every study will have direct benefits to the participants. In this section, consider the following when framing your response:
    - Will there be any benefits to the participants in your study? If so, what are they?
    - What is the general importance of the knowledge you expect to gain?

Response 6: (enter response below this header)

There is no direct benefit to the participants of this study. The proposed research would add to the body of knowledge in engineering education literature, and may help faculty of undergraduate engineering project courses to design teams and classes more effectively. Future students of these classes may therefore stand to benefit from course improvements.

Appendix H: Hypothesis testing details

Table H1: Tests of proportions by behavior: Actor

***Note: Sample 1 is males, Sample 2 is females*

Expecting too much from others

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	22	0.134969
Sample 2	166	22	0.132530

Estimation for Difference

Difference	95% CI for Difference
0.0024392	(-0.071127, 0.076005)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	0.06	0.948
Fisher's exact		1.000

Failure to advance project toward completion

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	23	0.141104
Sample 2	166	22	0.132530

Estimation for Difference

Difference	95% CI for Difference
0.0085742	(-0.065700, 0.082848)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	0.23	0.821
Fisher's exact		0.873

Failure to prioritize project

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	34	0.208589
Sample 2	166	20	0.120482

Estimation for Difference

Difference	95% CI for Difference
0.0881070	(0.008466, 0.167748)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	2.17	0.030
Fisher's exact		0.037

Inconsistency of contribution

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	19	0.116564
Sample 2	166	37	0.222892

Estimation for Difference

Difference	95% CI for Difference
-0.106327	(-0.186547, -0.026107)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-2.60	0.009
Fisher's exact		0.012

Inconsistency with an engineering identity

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	11	0.067485
Sample 2	166	12	0.072289

Estimation for Difference

Difference	95% CI for Difference
-0.0048045	(-0.059896, 0.050287)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.17	0.864
Fisher's exact		1.000

Lack of communication

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	18	0.110429
Sample 2	166	27	0.162651

Estimation for Difference

Difference	95% CI for Difference
-0.0522212	(-0.126159, 0.021717)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-1.38	0.166
Fisher's exact		0.200

Lack of competence, experience, or skills

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	14	0.085890
Sample 2	166	17	0.102410

Estimation for Difference

Difference	95% CI for Difference
-0.0165201	(-0.079588, 0.046547)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.51	0.608
Fisher's exact		0.707

Lack of initiative

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	31	0.190184
Sample 2	166	32	0.192771

Estimation for Difference

Difference	95% CI for Difference
-0.0025870	(-0.087621, 0.082447)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.06	0.952
Fisher's exact		1.000

Procrastination

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	19	0.116564
Sample 2	166	12	0.072289

Estimation for Difference

Difference	95% CI for Difference
0.0442753	(-0.018803, 0.107353)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	1.38	0.169
Fisher's exact		0.190

Restricting others' work

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	11	0.067485
Sample 2	166	10	0.060241

Estimation for Difference

Difference	95% CI for Difference
0.0072437	(-0.045607, 0.060094)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	0.27	0.788
Fisher's exact		0.825

Unreliability

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	163	18	0.110429
Sample 2	166	13	0.078313

Estimation for Difference

Difference	95% CI for Difference
0.0321162	(-0.031014, 0.095247)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	1.00	0.319
Fisher's exact		0.350

Table H2: Tests of proportions by behavior: Target

***Note: Sample 1 is males, Sample 2 is females*

Expecting too much from others

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	30	0.150000
Sample 2	129	14	0.108527

Estimation for Difference

Difference	95% CI for Difference
0.0414729	(-0.031534, 0.114480)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	1.11	0.266
Fisher's exact		0.322

Failure to advance project toward completion

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	27	0.135000
Sample 2	129	18	0.139535

Estimation for Difference

Difference	95% CI for Difference
-0.0045349	(-0.080813, 0.071743)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.12	0.907
Fisher's exact		1.000

Failure to prioritize project

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	32	0.160000
Sample 2	129	22	0.170543

Estimation for Difference

Difference	95% CI for Difference
-0.0105426	(-0.092968, 0.071882)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.25	0.802
Fisher's exact		0.879

Inconsistency of contribution

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	32	0.160000
Sample 2	129	24	0.186047

Estimation for Difference

Difference	95% CI for Difference
-0.0260465	(-0.110254, 0.058161)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.61	0.544
Fisher's exact		0.551

Inconsistency with an engineering identity

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	11	0.055000
Sample 2	129	12	0.093023

Estimation for Difference

Difference	95% CI for Difference
-0.0380233	(-0.097275, 0.021228)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-1.26	0.208
Fisher's exact		0.192

Lack of communication

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	27	0.135000
Sample 2	129	18	0.139535

Estimation for Difference

Difference	95% CI for Difference
-0.0045349	(-0.080813, 0.071743)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	-0.12	0.907
Fisher's exact		1.000

Lack of competence, experience, or skills

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	21	0.105000
Sample 2	129	10	0.077519

Estimation for Difference

Difference	95% CI for Difference
0.0274806	(-0.035245, 0.090206)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	0.86	0.391
Fisher's exact		0.446

Lack of initiative

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	42	0.210000
Sample 2	129	21	0.162791

Estimation for Difference

Difference	95% CI for Difference
0.0472093	(-0.037908, 0.132327)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	1.09	0.277
Fisher's exact		0.317

Procrastination

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	22	0.110000
Sample 2	129	9	0.069767

Estimation for Difference

Difference	95% CI for Difference
0.0402326	(-0.021517, 0.101982)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	1.28	0.202
Fisher's exact		0.251

Restricting others' work

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	14	0.070000
Sample 2	129	7	0.054264

Estimation for Difference

Difference	95% CI for Difference
0.0157364	(-0.036976, 0.068449)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	0.59	0.558
Fisher's exact		0.649

Unreliability

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	200	24	0.120000
Sample 2	129	7	0.054264

Estimation for Difference

Difference	95% CI for Difference
0.0657364	(0.006100, 0.125373)

CI based on normal approximation

Test

Null hypothesis	$H_0: p_1 - p_2 = 0$
Alternative hypothesis	$H_1: p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	2.16	0.031
Fisher's exact		0.054

Table H3: Severity descriptive statistics

Descriptive Statistics: ETM Severity

Results for ETM Actor = Female

Statistics

Variable	ETM Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
ETM Severity	Female	7	0	3.238	0.297	0.787	1.667	3.000	3.667	3.667
	Male	12	3	3.250	0.154	0.534	2.000	3.000	3.333	3.583

Variable	ETM Target	Maximum
ETM Severity	Female	4.000
	Male	4.000

Results for ETM Actor = Male

Statistics

Variable	ETM Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
ETM Severity	Female	7	0	3.238	0.202	0.535	2.333	3.000	3.333	3.667
	Male	15	0	2.933	0.273	1.056	1.000	2.333	3.000	3.667

Variable	ETM Target	Maximum
ETM Severity	Female	4.000
	Male	4.000

Descriptive Statistics: FA Severity

Results for FA Actor = Female

Statistics

Variable	FA Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
FA Severity	Female	8	0	3.333	0.209	0.591	2.333	3.000	3.333	3.917	4.000
	Male	11	3	3.455	0.121	0.402	3.000	3.000	3.667	3.667	4.000

Results for FA Actor = Male

Statistics

Variable	FA Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
FA Severity	Female	10	0	3.033	0.292	0.922	1.000	2.750	3.167	3.750	4.000
	Male	12	1	2.583	0.315	1.093	1.000	1.250	3.000	3.250	4.000

Descriptive Statistics: FP Severity

Results for FP Actor = Female

Statistics

Variable	FP Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
FP Severity	Female	8	1	3.500	0.227	0.642	2.000	3.417	3.667	3.917	4.000
	Male	11	0	3.121	0.164	0.543	2.333	2.667	3.000	3.667	4.000

Results for FP Actor = Male

Statistics

Variable	FP Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
FP Severity	Female	13	0	3.385	0.180	0.650	2.333	2.833	3.667	4.000	4.000
	Male	21	0	2.857	0.208	0.952	1.000	2.167	3.000	3.333	4.000

Descriptive Statistics: IC Severity

Results for IC Actor = Female

Statistics

Variable	IC Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
IC Severity	Female	13	1	3.641	0.122	0.440	2.667	3.333	3.667	4.000
	Male	17	6	3.5686	0.0893	0.3683	3.0000	3.3333	3.6667	4.0000

Variable	IC Target	Maximum
IC Severity	Female	4.000
	Male	4.0000

Results for IC Actor = Male

Statistics

Variable	IC Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
IC Severity	Female	10	0	3.133	0.330	1.045	1.000	2.583	3.333	3.500	5.000
	Male	9	0	3.370	0.171	0.512	2.667	3.000	3.333	4.000	4.000

Descriptive Statistics: IEI Severity

Results for IEI Actor = Female

Statistics

Variable	IEI Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
IEI Severity	Female	6	0	3.833	0.282	0.691	3.000	3.250	3.833	4.250
	Male	5	1	3.733	0.125	0.279	3.333	3.500	3.667	4.000

Variable	IEI Target	Maximum
IEI Severity	Female	5.000
	Male	4.000

Results for IEI Actor = Male

Statistics

Variable	IEI Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
IEI Severity	Female	6	0	2.500	0.411	1.006	1.000	1.750	2.500	3.417
	Male	5	0	2.133	0.696	1.556	1.000	1.000	1.000	3.833

Variable	IEI Target	Maximum
IEI Severity	Female	3.667
	Male	4.000

Descriptive Statistics: LCOM Severity

Results for LCOM Actor = Female

Statistics

Variable	LCOM Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
LCOM Severity	Female	13	0	3.179	0.281	1.015	1.000	2.667	3.667	4.000	4.000
	Male	11	3	3.667	0.216	0.715	2.333	3.000	4.000	4.000	5.000

Results for LCOM Actor = Male

Statistics

Variable	LCOM Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
LCOM Severity	Female	5	0	2.333	0.380	0.850	1.000	1.500	2.667	3.000	3.000
	Male	13	0	2.769	0.371	1.336	1.000	1.333	3.000	3.833	5.000

Descriptive Statistics: LCES Severity

Results for LCES Actor = Female

Statistics

Variable	LCES Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
LCES Severity	Female	6	0	3.278	0.547	1.340	1.000	2.500	3.333	4.250	5.000
	Male	9	2	3.444	0.176	0.527	2.333	3.167	3.667	3.833	4.000

Results for LCES Actor = Male

Statistics

Variable	LCES Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
LCES Severity	Female	4	0	3.0833	0.0833	0.1667	3.0000	3.0000	3.0000	3.2500
	Male	10	0	2.967	0.356	1.127	1.000	2.500	3.000	4.000

Variable	LCES Target	Maximum
LCES Severity	Female	3.3333
	Male	4.000

Descriptive Statistics: LI Severity

Results for LI Actor = Female

Statistics

Variable	LI Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
LI Severity	Female	8	0	3.208	0.274	0.775	1.667	2.750	3.333	3.917	4.000
	Male	23	1	3.739	0.118	0.568	2.667	3.333	4.000	4.000	5.000

Results for LI Actor = Male

Statistics

Variable	LI Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
LI Severity	Female	13	0	3.282	0.226	0.815	1.000	3.000	3.333	4.000	4.000
	Male	18	0	3.583	0.158	0.672	2.000	3.000	3.667	4.000	5.000

Descriptive Statistics: P Severity

Results for P Actor = Female

Statistics

Variable	P Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
P Severity	Female	4	0	3.500	0.397	0.793	2.333	2.667	3.833	4.000	4.000
	Male	7	1	3.190	0.280	0.742	2.000	2.667	3.000	4.000	4.000

Results for P Actor = Male

Statistics

Variable	P Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
P Severity	Female	5	0	2.533	0.416	0.931	1.000	1.667	3.000	3.167	3.333
	Male	14	0	2.548	0.251	0.939	1.000	2.000	2.667	3.333	3.667

Descriptive Statistics: R Severity

Results for R Actor = Female

Statistics

Variable	R Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
R Severity	Female	4	0	3.167	0.441	0.882	2.000	2.250	3.333	3.917	4.000
	Male	6	0	2.833	0.352	0.863	1.667	1.917	3.000	3.500	4.000

Results for R Actor = Male

Statistics

Variable	R Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
R Severity	Female	3	0	3.0000	0.000000	0.000000	3.0000	3.0000	3.0000	3.0000
	Male	8	0	2.542	0.475	1.344	1.000	1.000	3.000	3.833

Variable	R Target	Maximum
R Severity	Female	3.0000
	Male	4.000

Descriptive Statistics: U Severity

Results for U Actor = Female

Statistics

Variable	U Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
U Severity	Female	3	0	3.333	0.333	0.577	2.667	2.667	3.667	3.667	3.667
	Male	10	0	3.167	0.181	0.572	2.000	2.917	3.167	3.667	4.000

Results for U Actor = Male

Statistics

Variable	U Target	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
U Severity	Female	4	0	2.833	0.167	0.333	2.333	2.500	3.000	3.000	3.000
	Male	14	0	2.762	0.253	0.947	1.000	2.000	3.000	3.667	4.000

Table H4: Multifactor ANOVA results – No blocking

Expecting too much from others

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Actor	1	0.2301	0.2301	0.35	0.556
Target	1	0.1968	0.1968	0.30	0.586
Actor*Target	1	0.2301	0.2301	0.35	0.556
Error	37	24.1675	0.6532		
Total	40	25.0840			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.808192	3.65%	0.00%	0.00%

Failure to advance project toward completion

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
FA Actor	1	3.4359	3.4359	5.11	0.030
FA Target	1	0.2708	0.2708	0.40	0.529
FA Actor*FA Target	1	0.8173	0.8173	1.22	0.277
Error	37	24.8551	0.6718		
Total	40	29.8916			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.819609	16.85%	10.11%	0.00%

Failure to prioritize project

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
FP Actor	1	0.4229	0.42292	0.71	0.402
FP Target	1	2.4124	2.41241	4.07	0.049
FP Actor*FP Target	1	0.0649	0.06493	0.11	0.742
Error	49	29.0423	0.59270		
Total	52	32.5409			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.769870	10.75%	5.29%	0.00%

Inconsistency of contribution

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
IC Actor	1	1.4368	1.43680	3.94	0.053
IC Target	1	0.0781	0.07815	0.21	0.646
IC Actor*IC Target	1	0.2761	0.27605	0.76	0.389
Error	45	16.4157	0.36479		
Total	48	18.1814			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.603981	9.71%	3.69%	0.00%

Inconsistency with an engineering identity

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
IEI Actor	1	11.7333	11.7333	12.11	0.003
IEI Target	1	0.2970	0.2970	0.31	0.587
IEI Actor*IEI Target	1	0.0970	0.0970	0.10	0.755
Error	18	17.4444	0.9691		
Total	21	29.4747			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.984447	40.82%	30.95%	10.62%

Lack of communication

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LCOM Actor	1	6.8355	6.83546	6.22	0.017
LCOM Target	1	1.9158	1.91582	1.74	0.195
LCOM Actor*LCOM Target	1	0.0059	0.00591	0.01	0.942
Error	38	41.7778	1.09942		
Total	41	49.7354			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.04853	16.00%	9.37%	0.00%

Lack of competence, experience, or skills

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LCES Actor	1	0.7198	0.719813	0.79	0.382
LCES Target	1	0.0040	0.003982	0.00	0.948
LCES Actor*LCES Target	1	0.1279	0.127876	0.14	0.711
Error	25	22.7204	0.908815		
Total	28	23.8927			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.953318	4.91%	0.00%	0.00%

Lack of initiative

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LI Actor	1	0.0224	0.02239	0.05	0.827
LI Target	1	2.3005	2.30051	4.95	0.030
LI Actor*LI Target	1	0.1750	0.17503	0.38	0.542
Error	58	26.9562	0.46476		
Total	61	29.6402			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.681734	9.06%	4.35%	0.00%

Procrastination

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
P Actor	1	3.8998	3.8998	5.04	0.034
P Target	1	0.1312	0.1312	0.17	0.684
P Actor*P Target	1	0.1578	0.1578	0.20	0.655
Error	26	20.1254	0.7741		
Total	29	24.3852			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.879803	17.47%	7.95%	0.00%

Restricting others' work

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
R Actor	1	0.2401	0.24008	0.22	0.646
R Target	1	0.7163	0.71627	0.65	0.431
R Actor*R Target	1	0.0179	0.01786	0.02	0.900
Error	17	18.7083	1.10049		
Total	20	19.9048			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.04904	6.01%	0.00%	0.00%

Unreliability

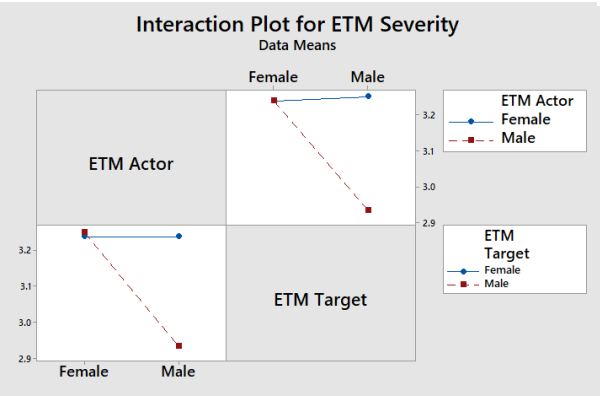
Analysis of Variance

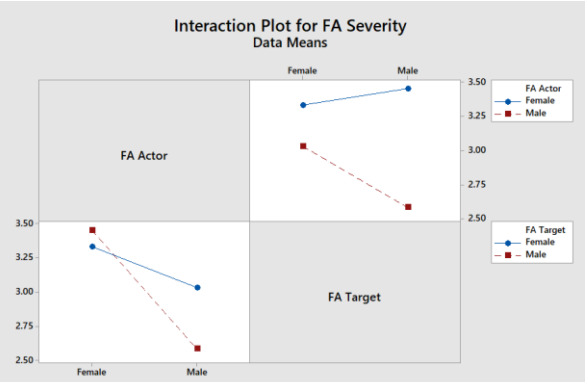
Source	DF	Adj SS	Adj MS	F-Value	P-Value
U Actor	1	1.0846	1.08457	1.88	0.182
U Target	1	0.0751	0.07511	0.13	0.721
U Actor*U Target	1	0.0120	0.01202	0.02	0.886
Error	27	15.5952	0.57760		
Total	30	17.0538			

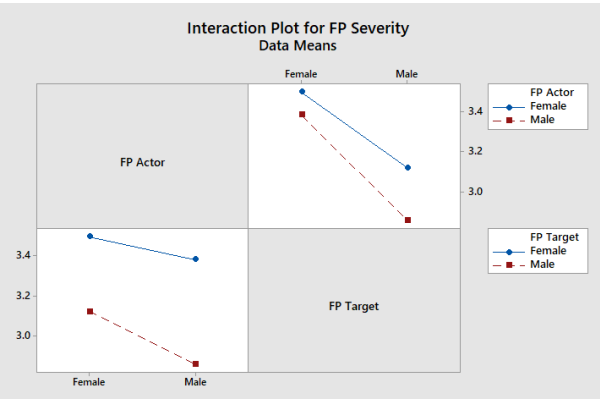
Model Summary

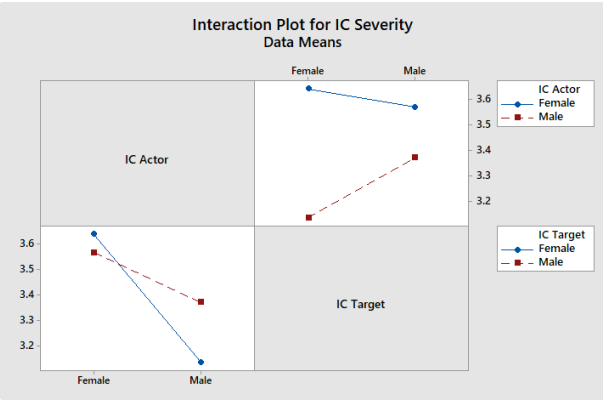
S	R-sq	R-sq(adj)	R-sq(pred)
0.760001	8.55%	0.00%	0.00%

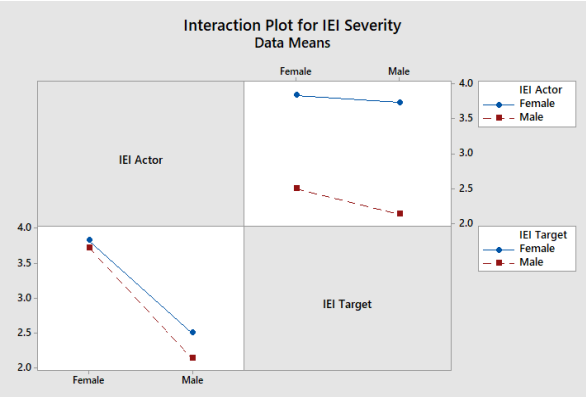
Figure H1: Interaction plots for behavior, actor gender, target gender

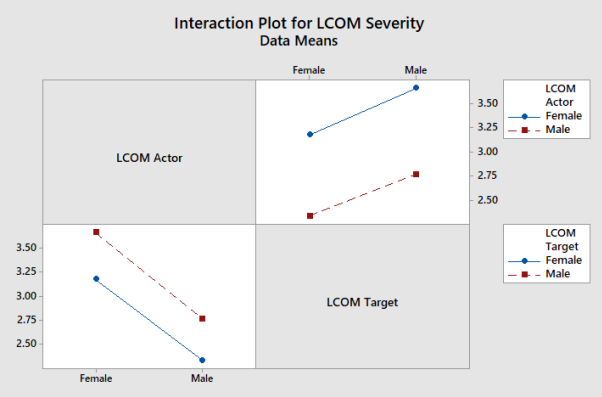


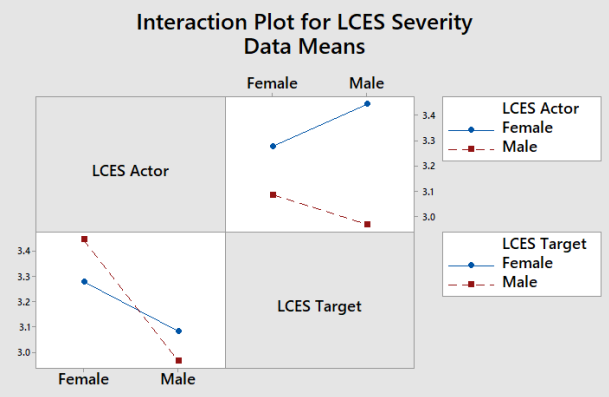


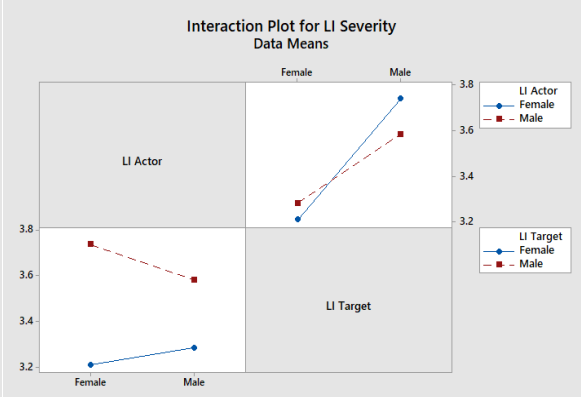


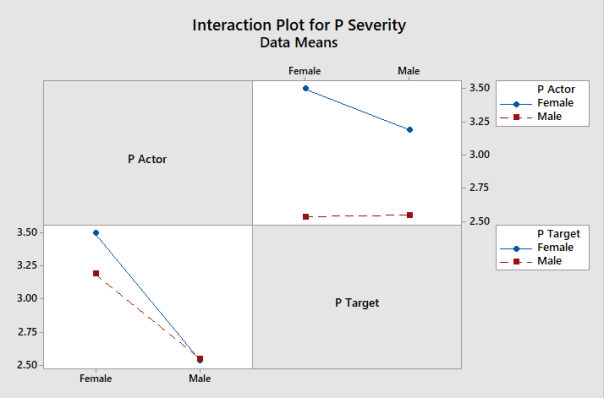


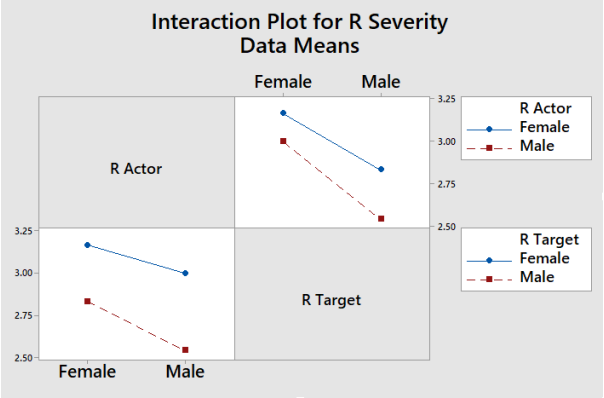

Interaction Plot for IEI Severity
Data Means
Female
Male
IEI Actor
IEI Target
IEI Actor
Female
Male
IEI Target
Female
Male


Interaction Plot for LCOM Severity
Data Means
Female
Male
LCOM Actor
LCOM Target
LCOM Actor
Female
Male
LCOM Target
Female
Male


Interaction Plot for LCES Severity
Data Means
Female
Male
LCES Actor
LCES Target
LCES Actor
Female
Male
LCES Target
Female
Male
Female
Male


Interaction Plot for LI Severity
Data Means
Female
Male
LI Actor
LI Target
LI Actor
Female
Male
LI Target
Female
Male
Female
Male


Interaction Plot for P Severity
Data Means
Female
Male
P Actor
P Target
P Actor
Female
Male
P Target
Female
Male
Female
Male


Interaction Plot for R Severity
Data Means
Female
Male
R Actor
R Target
R Actor
Female
Male
R Target
Female
Male
Female
Male

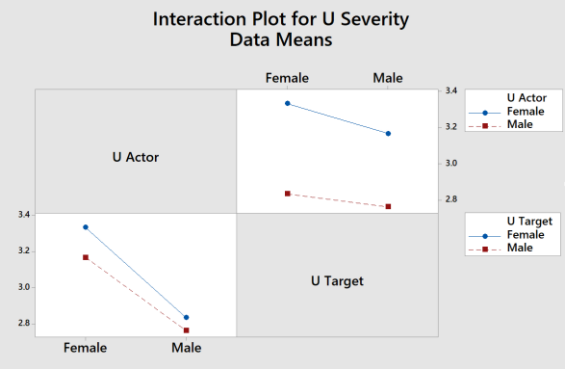
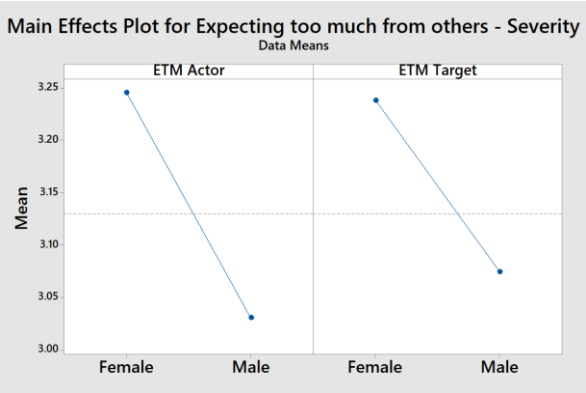
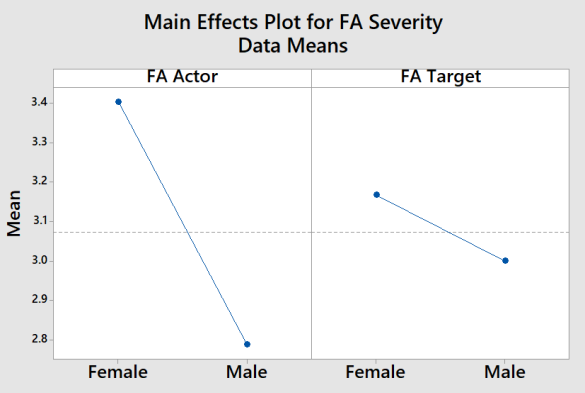
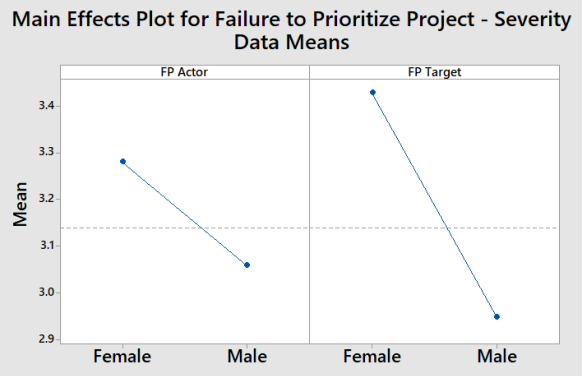
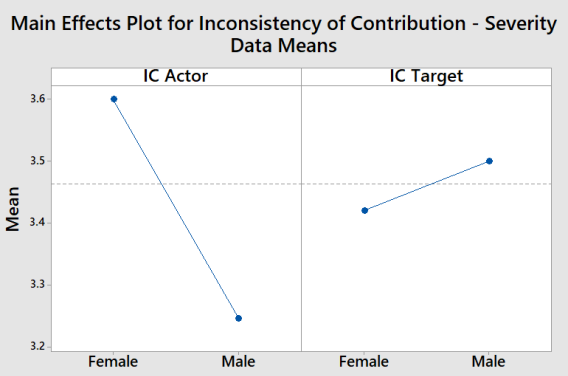

Interaction Plot for U Severity
Data Means
Female
Male
U Actor
U Target
U Actor
Female
Male
U Target
Female
Male
Female
Male

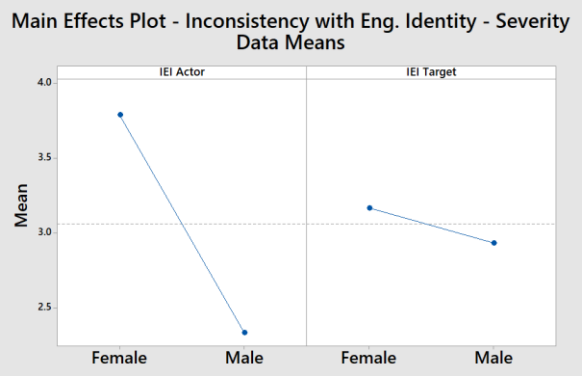
Figure H2: Main effects plots for behavior, actor gender, target gender

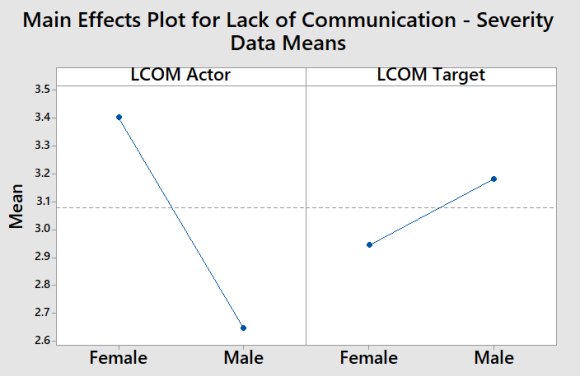


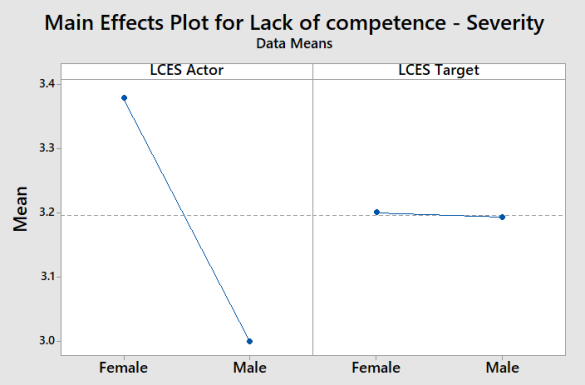


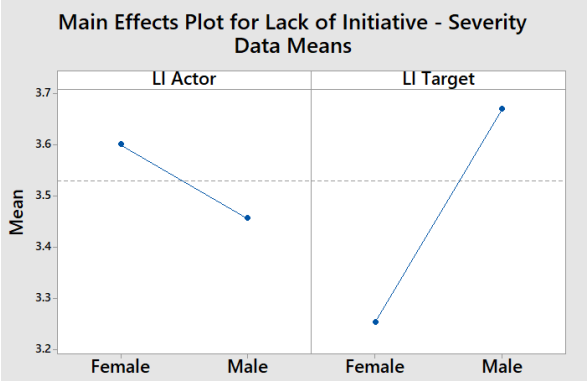


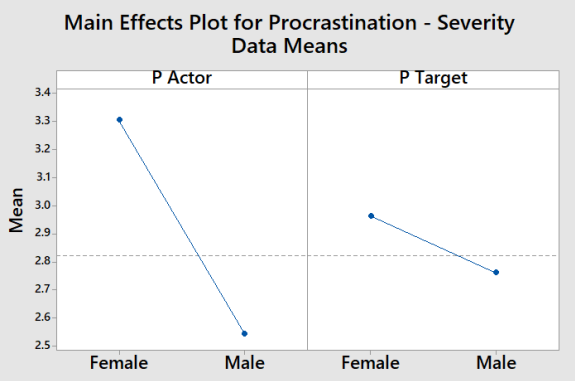


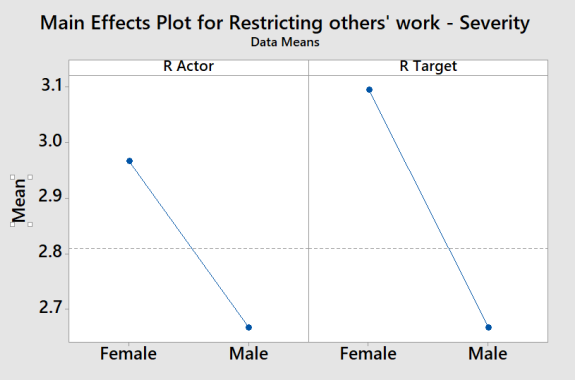





Main Effects Plot for Lack of competence - Severity
Data Means
LCES Actor
LCES Target
Mean
3.4
3.3
3.2
3.1
3.0
Female
Male
Female
Male


Main Effects Plot for Lack of Initiative - Severity
Data Means
LI Actor
LI Target
Mean
3.7
3.6
3.5
3.4
3.3
3.2
Female
Male
Female
Male


Main Effects Plot for Procrastination - Severity
Data Means
P Actor
P Target
Mean
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
Female
Male
Female
Male


Main Effects Plot for Restricting others' work - Severity
Data Means
R Actor
R Target
Mean
3.1
3.0
2.9
2.8
2.7
Female
Male
Female
Male

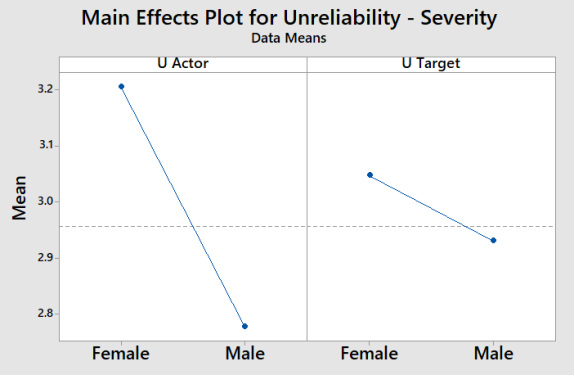
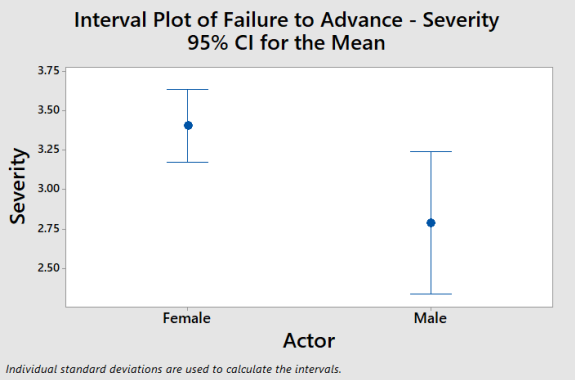
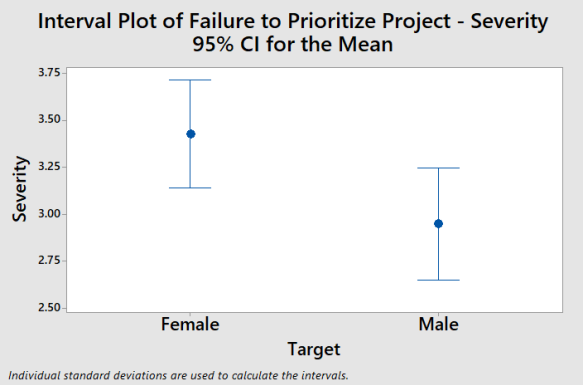
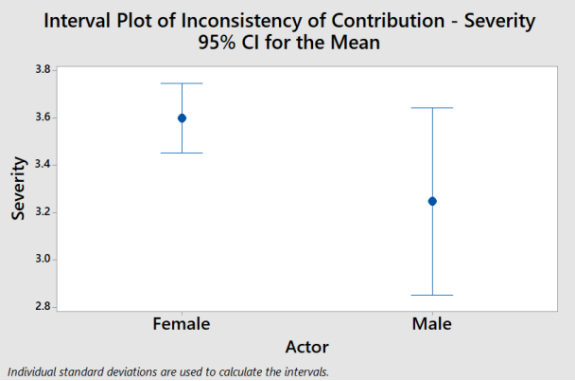
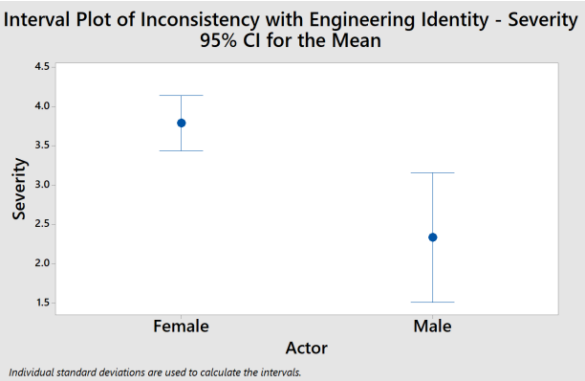

Main Effects Plot for Unreliability - Severity
Data Means
U Actor
U Target
Mean
3.2
3.1
3.0
2.9
2.8
Female
Male
Female
Male

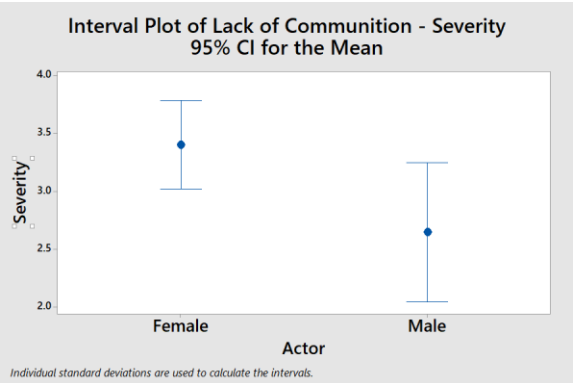
Figure H3: Selected interval plots for behavior, actor gender, target gender

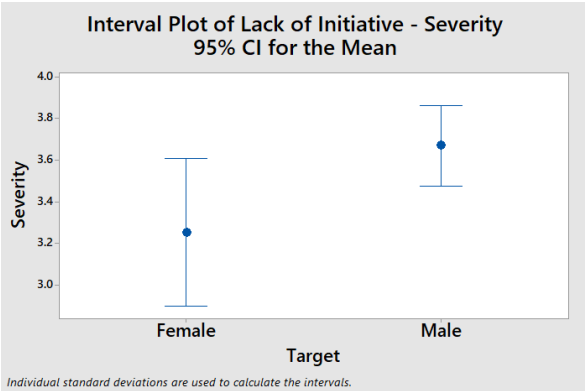












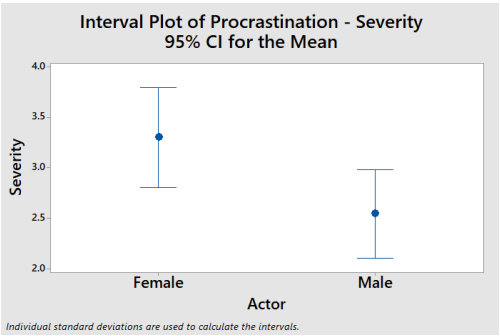


Table H5: ANOVA results with blocking by class

Expecting too much from others

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	2.3084	0.46169	0.62	0.688
Blocks	2	0.0761	0.03806	0.05	0.951
Linear	2	0.8187	0.40934	0.55	0.585
ETM Actor	1	0.7568	0.75683	1.01	0.324
ETM Target	1	0.0843	0.08426	0.11	0.740
2-Way Interactions	1	0.3770	0.37704	0.50	0.484
ETM Actor*ETM Target	1	0.3770	0.37704	0.50	0.484
Error	26	19.4554	0.74829		
Lack-of-Fit	4	3.6406	0.91016	1.27	0.313
Pure Error	22	15.8148	0.71886		
Total	31	21.7639			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.865036	10.61%	0.00%	0.00%

Failure to advance project toward completion

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	6	4.7677	0.79462	1.23	0.320
Blocks	3	2.3765	0.79216	1.23	0.318
Linear	2	1.0452	0.52262	0.81	0.455
FA Actor	1	1.0090	1.00901	1.56	0.222
FA Target	1	0.0721	0.07211	0.11	0.741
2-Way Interactions	1	0.0225	0.02254	0.03	0.853
FA Actor*FA Target	1	0.0225	0.02254	0.03	0.853
Error	29	18.7477	0.64647		
Lack-of-Fit	6	3.7748	0.62913	0.97	0.469
Pure Error	23	14.9729	0.65099		
Total	35	23.5154			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.804035	20.27%	3.78%	0.00%

Failure to prioritize project

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	4.2440	0.84880	1.06	0.402
Blocks	2	0.1254	0.06270	0.08	0.925
Linear	2	1.3953	0.69765	0.87	0.429
FP Actor	1	0.2439	0.24389	0.31	0.585
FP Target	1	1.3141	1.31414	1.65	0.210
2-Way Interactions	1	0.7597	0.75966	0.95	0.338
FP Actor*FP Target	1	0.7597	0.75966	0.95	0.338
Error	27	21.5607	0.79855		
Lack-of-Fit	3	1.4728	0.49092	0.59	0.630
Pure Error	24	20.0880	0.83700		
Total	32	25.8047			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.893614	16.45%	0.97%	0.00%

Inconsistency of contribution

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	1.7532	0.35064	0.79	0.568
Blocks	2	0.5299	0.26496	0.59	0.559
Linear	2	1.3421	0.67103	1.50	0.238
IC Actor	1	1.1704	1.17039	2.62	0.116
IC Target	1	0.0597	0.05969	0.13	0.717
2-Way Interactions	1	0.1036	0.10358	0.23	0.633
IC Actor*IC Target	1	0.1036	0.10358	0.23	0.633
Error	30	13.3826	0.44609		
Lack-of-Fit	4	0.6771	0.16926	0.35	0.844
Pure Error	26	12.7056	0.48868		
Total	35	15.1358			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.667897	11.58%	0.00%	0.00%

Inconsistency with an engineering identity

Insufficient data

Lack of communication

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	6	11.5050	1.91751	1.84	0.121
Blocks	3	3.6461	1.21535	1.17	0.336
Linear	2	5.3134	2.65671	2.55	0.093
LCOM Actor	1	5.1934	5.19338	4.99	0.032
LCOM Target	1	0.0655	0.06550	0.06	0.803
2-Way Interactions	1	0.0422	0.04220	0.04	0.842
LCOM Actor*LCOM Target	1	0.0422	0.04220	0.04	0.842
Error	33	34.3172	1.03991		
Lack-of-Fit	7	6.9220	0.98885	0.94	0.494
Pure Error	26	27.3952	1.05366		
Total	39	45.8222			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.01976	25.11%	11.49%	0.00%

Lack of competence, experience, or skills

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	4	2.4913	0.62283	0.65	0.638
Blocks	1	0.2413	0.24131	0.25	0.624
Linear	2	0.8946	0.44731	0.46	0.637
LCES Actor	1	0.8211	0.82109	0.85	0.371
LCES Target	1	0.0642	0.06425	0.07	0.800
2-Way Interactions	1	0.4733	0.47334	0.49	0.494
LCES Actor*LCES Target	1	0.4733	0.47334	0.49	0.494
Error	15	14.4587	0.96391		
Lack-of-Fit	1	1.2587	1.25869	1.33	0.267
Pure Error	14	13.2000	0.94286		
Total	19	16.9500			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.981791	14.70%	0.00%	0.00%

Lack of initiative

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	2.8728	0.57456	1.06	0.397
Blocks	2	0.4405	0.22026	0.41	0.668
Linear	2	1.9892	0.99461	1.84	0.174
LI Actor	1	0.0224	0.02242	0.04	0.840
LI Target	1	1.4642	1.46425	2.71	0.109
2-Way Interactions	1	0.0551	0.05514	0.10	0.751
LI Actor*LI Target	1	0.0551	0.05514	0.10	0.751
Error	34	18.3466	0.53961		
Lack-of-Fit	4	1.0167	0.25416	0.44	0.779
Pure Error	30	17.3300	0.57767		
Total	39	21.2194			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.734579	13.54%	0.82%	0.00%

Procrastination

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	6.7472	1.34944	1.41	0.280
Blocks	2	3.7620	1.88100	1.97	0.177
Linear	2	2.1673	1.08367	1.13	0.350
P Actor	1	2.0112	2.01120	2.10	0.169
P Target	1	0.1032	0.10324	0.11	0.747
2-Way Interactions	1	0.0128	0.01281	0.01	0.910
P Actor*P Target	1	0.0128	0.01281	0.01	0.910
Error	14	13.3862	0.95615		
Lack-of-Fit	5	10.2380	2.04760	5.85	0.011
Pure Error	9	3.1481	0.34979		
Total	19	20.1333			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.977831	33.51%	9.77%	0.00%

Restricting others' work

Insufficient data

Unreliability

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	4	1.0688	0.26720	0.30	0.870
Blocks	1	0.0247	0.02469	0.03	0.869
Linear	2	0.3462	0.17309	0.20	0.823
U Actor	1	0.3460	0.34602	0.39	0.541
U Target	1	0.0583	0.05832	0.07	0.801
2-Way Interactions	1	0.0129	0.01290	0.01	0.905
U Actor*U Target	1	0.0129	0.01290	0.01	0.905
Error	13	11.4065	0.87743		
Lack-of-Fit	1	0.0494	0.04938	0.05	0.823
Pure Error	12	11.3571	0.94643		
Total	17	12.4753			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.936710	8.57%	0.00%	0.00%

Table H6: Full canonical Correlation results – Failure to prioritize project

```
* * * * * * * * * * * * * * * * * * A n a l y s i s   o f   V a r i a n c e * * * * * * * * * * * * * * * * * *

The default error term in MANOVA has been changed from WITHIN CELLS to
WITHIN+RESIDUAL.  Note that these are the same for all full factorial designs.

* * * * * * * * * * * * * * * * * * A n a l y s i s   o f   V a r i a n c e * * * * * * * * * * * * * * * * * *


        89 cases accepted.
         0 cases rejected because of out-of-range factor values.
         0 cases rejected because of missing data.
         1 non-empty cell.

         1 design will be processed.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * * * * * * * * * * * * * * * * * A n a l y s i s   o f   V a r i a n c e -- Design   1 * * * * * * * * * * * * * * * * * *

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41 )

Test Name            Value        Approx. F       Hypoth. DF        Error DF        Sig. of F

Pillais               .13304          2.01907            6.00          170.00             .066
Hotellings            .14588          2.01800            6.00          166.00             .066
Wilks                 .87002          2.01881            6.00          168.00             .066
Roys                  .10344
Note.. F statistic for WILKS' Lambda is exact.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Eigenvalues and Canonical Correlations

Root No.       Eigenvalue           Pct.       Cum. Pct.      Canon Cor.         Sq. Cor

       1           .11538       79.09000        79.09000         .32162          .10344
       2           .03050       20.91000       100.00000         .17205          .02960
```

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.87002	2.01881	6.00	168.00	.066
2 TO 2	.97040	1.29640	2.00	85.00	.279

EFFECT .. WITHIN CELLS Regression (Cont.)
Univariate F-tests with (2,86) D. F.

Variable	Sq. Mul. R	Adj. R-sq.	Hypoth. MS	Error MS	F	Sig. of F
Autonomy	.03240	.00990	.90385	.62775	1.43983	.243
Competen	.04513	.02293	1.09693	.53971	2.03245	.137
Relatedn	.05885	.03697	1.77576	.66040	2.68893	.074

Raw canonical coefficients for DEPENDENT variables

	Function No.	
Variable	1	2
Autonomy	.58925	-.04382
Competen	-1.07964	.97358
Relatedn	.72338	.67845

Standardized canonical coefficients for DEPENDENT variables

	Function No.	
Variable	1	2
Autonomy	.46919	-.03490
Competen	-.80241	.72358
Relatedn	.59903	.56183

Correlations between DEPENDENT and canonical variables

	Function No.	
Variable	1	2
Autonomy	.48246	.53021
Competen	-.48013	.84803
Relatedn	.64833	.72065

Variance in dependent variables explained by canonical variables

CAN. VAR.	Pct Var DEP	Cum Pct DEP	Pct Var COV	Cum Pct COV
1	29.45432	29.45432	3.04680	3.04680
2	50.65407	80.10839	1.49939	4.54619

Raw canonical coefficients for COVARIATES
Function No.

COVARIATE	1	2
PerFP	1.40173	2.68791
AvgSevFP	-2.19653	3.83341

Standardized canonical coefficients for COVARIATES
CAN. VAR.

COVARIATE	1	2
PerFP	.54915	1.05303
AvgSevFP	-.59044	1.03044

Correlations between COVARIATES and canonical variables
CAN. VAR.

Covariate	1	2
PerFP	.86766	.49716
AvgSevFP	-.88667	.46240

Variance in covariates explained by canonical variables

CAN. VAR.	Pct Var DEP	Cum Pct DEP	Pct Var COV	Cum Pct COV
1	7.95991	7.95991	76.95086	76.95086
2	.68227	8.64218	23.04914	100.00000

Regression analysis for WITHIN CELLS error term
--- Individual Univariate .9500 confidence intervals
Dependent variable .. Autonomy

COVARIATE	B	Beta	Std. Err.	t-Value	Sig. of t	Lower -95%	CL- Upper
PerFP	.3684312845	.1812714039	.25604	1.43898	.154	-.14055	.87741
AvgSevFP	.0070508322	.0023802717	.37315	.01890	.985	-.73476	.74886

Dependent variable .. Competence

COVARIATE	B	Beta	Std. Err.	t-Value	Sig. of t	Lower -95%	CL- Upper
PerFP	.1305932132	.0688383086	.23740	.55009	.584	-.34135	.60254
AvgSevFP	.6677735586	.2415194750	.34600	1.92999	.057	-.02005	1.35560

Dependent variable .. Relatedness

COVARIATE	B	Beta	Std. Err.	t-Value	Sig. of t	Lower -95%	CL- Upper
PerFP	.5180191799	.2450697568	.26261	1.97258	.052	-.00403	1.04007
AvgSevFP	.0143050364	.0046435080	.38273	.03738	.970	-.74655	.77516

Table H7: Abbreviated canonical correlation results – other 10 behaviors

Expecting too much from others

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.00830	.11807	6.00	170.00	.994
Hotellings	.00835	.11545	6.00	166.00	.995
Wilks	.99171	.11676	6.00	168.00	.994
Roys	.00655				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.00659	78.94056	78.94056	.08090	.00655
2	.00176	21.05944	100.00000	.04189	.00175

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.99171	.11676	6.00	168.00	.994
2 TO 2	.99825	.07470	2.00	85.00	.928

Failure to advance project toward completion

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.08000	1.18057	6.00	170.00	.319
Hotellings	.08430	1.16612	6.00	166.00	.327
Wilks	.92117	1.17342	6.00	168.00	.323
Roys	.06064				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.06456	76.58213	76.58213	.24626	.06064
2	.01974	23.41787	100.00000	.13914	.01936

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.92117	1.17342	6.00	168.00	.323
2 TO 2	.98064	.83898	2.00	85.00	.436

Inconsistency of contribution

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.02574	.36939	6.00	170.00	.898
Hotellings	.02611	.36123	6.00	166.00	.903
Wilks	.97441	.36531	6.00	168.00	.900
Roys	.01720				

Note.. F statistic for WILKS' Lambda is exact.

- -

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.01750	67.00423	67.00423	.13113	.01720
2	.00862	32.99577	100.00000	.09243	.00854

- -

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.97441	.36531	6.00	168.00	.900
2 TO 2	.99146	.36619	2.00	85.00	.694

Inconsistency with an engineering identity

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.05877	.85773	6.00	170.00	.527
Hotellings	.06237	.86285	6.00	166.00	.524
Wilks	.94126	.86044	6.00	168.00	.525
Roys	.05829				

Note.. F statistic for WILKS' Lambda is exact.

- -

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.06189	99.22750	99.22750	.24142	.05829
2	.00048	.77250	100.00000	.02195	.00048

- -

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.94126	.86044	6.00	168.00	.525
2 TO 2	.99952	.02048	2.00	85.00	.980

Lack of communication

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.03814	.55081	6.00	170.00	.769
Hotellings	.03928	.54338	6.00	166.00	.775
Wilks	.96204	.54713	6.00	168.00	.772
Roys	.03280				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.03391	86.32964	86.32964	.18110	.03280
2	.00537	13.67036	100.00000	.07308	.00534

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.96204	.54713	6.00	168.00	.772
2 TO 2	.99466	.22821	2.00	85.00	.796

Lack of competence, experience, or skills

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.04549	.65949	6.00	170.00	.682
Hotellings	.04699	.65006	6.00	166.00	.690
Wilks	.95482	.65481	6.00	168.00	.686
Roys	.03708				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.03851	81.93978	81.93978	.19256	.03708
2	.00849	18.06022	100.00000	.09174	.00842

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.95482	.65481	6.00	168.00	.686
2 TO 2	.99158	.36070	2.00	85.00	.698

Lack of initiative

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.08752	1.29664	6.00	170.00	.261
Hotellings	.09317	1.28881	6.00	166.00	.265
Wilks	.91368	1.29286	6.00	168.00	.263
Roys	.07052				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.07587	81.43951	81.43951	.26556	.07052
2	.01729	18.56049	100.00000	.13038	.01700

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.91368	1.29286	6.00	168.00	.263
2 TO 2	.98300	.73492	2.00	85.00	.483

Procrastination

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.05780	.84317	6.00	170.00	.538
Hotellings	.05978	.82702	6.00	166.00	.551
Wilks	.94292	.83512	6.00	168.00	.544
Roys	.03994				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.04160	69.58834	69.58834	.19985	.03994
2	.01818	30.41166	100.00000	.13363	.01786

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.94292	.83512	6.00	168.00	.544
2 TO 2	.98214	.77271	2.00	85.00	.465

Restricting others' work

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.03373	.48602	6.00	170.00	.818
Hotellings	.03443	.47624	6.00	166.00	.825
Wilks	.96650	.48114	6.00	168.00	.822
Roys	.02441				

Note.. F statistic for WILKS' Lambda is exact.

Eigenvalues and Canonical Correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.02502	72.67455	72.67455	.15623	.02441
2	.00941	27.32545	100.00000	.09654	.00932

Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.96650	.48114	6.00	168.00	.822
2 TO 2	.99068	.39981	2.00	85.00	.672

Unreliability

EFFECT .. WITHIN CELLS Regression
Multivariate Tests of Significance (S = 2, M = 0, N = 41)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.03860	.55755	6.00	170.00	.764
Hotellings	.03966	.54870	6.00	166.00	.770
Wilks	.96163	.55315	6.00	168.00	.767
Roys	.03135				

Note.. F statistic for WILKS' Lambda is exact.

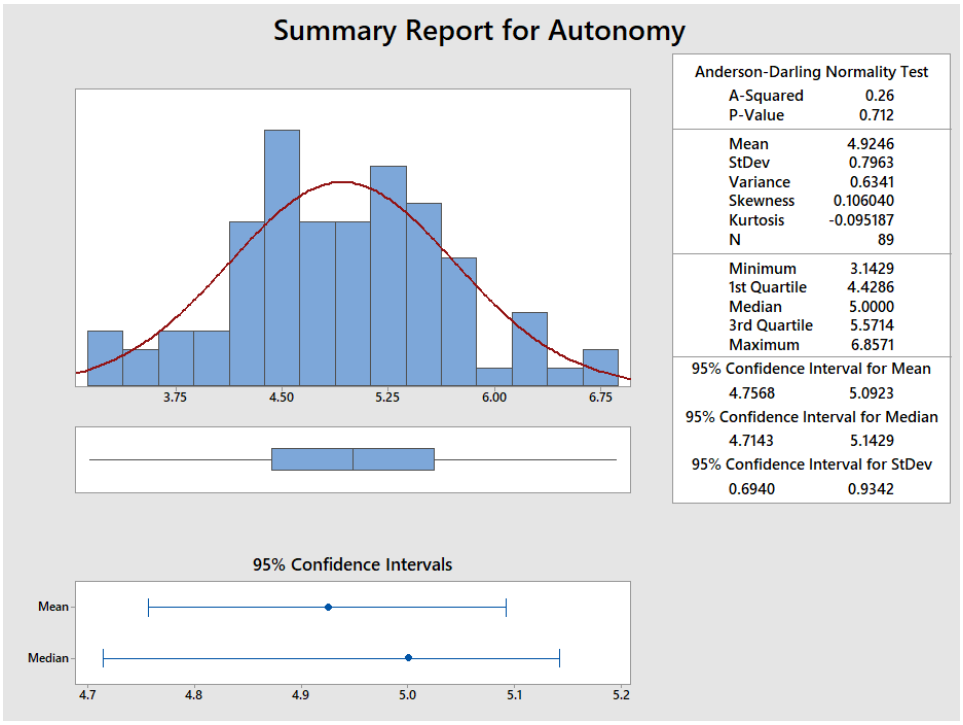
Eigenvalues and Canonical Correlations

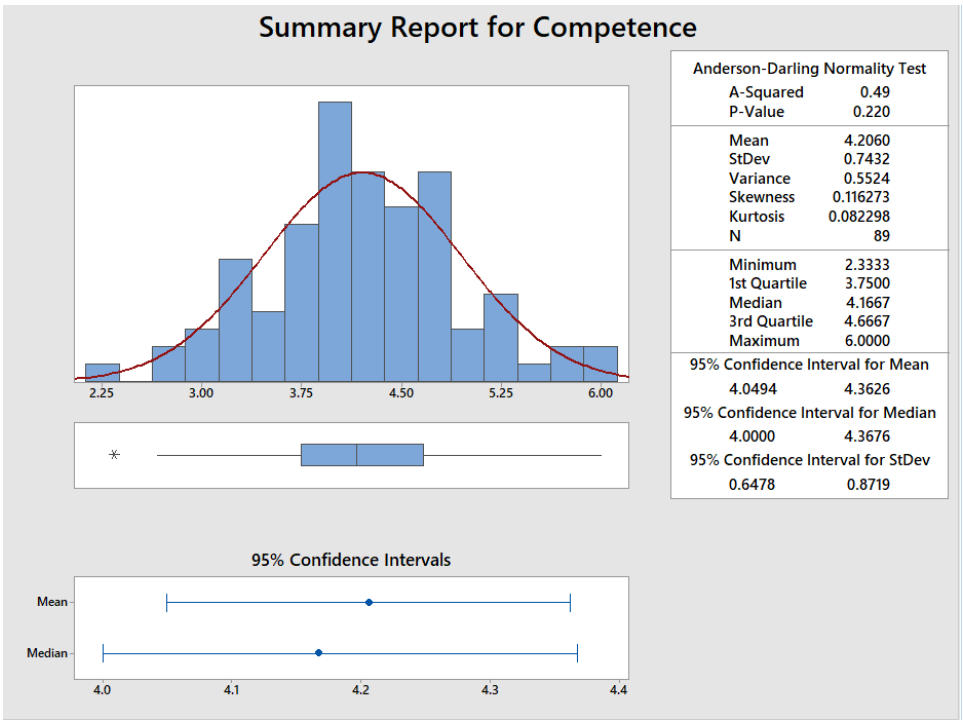
Root No.	Eigenvalue	Pct.	Cum. Pct.	Canon Cor.	Sq. Cor
1	.03237	81.60093	81.60093	.17707	.03135
2	.00730	18.39907	100.00000	.08512	.00725

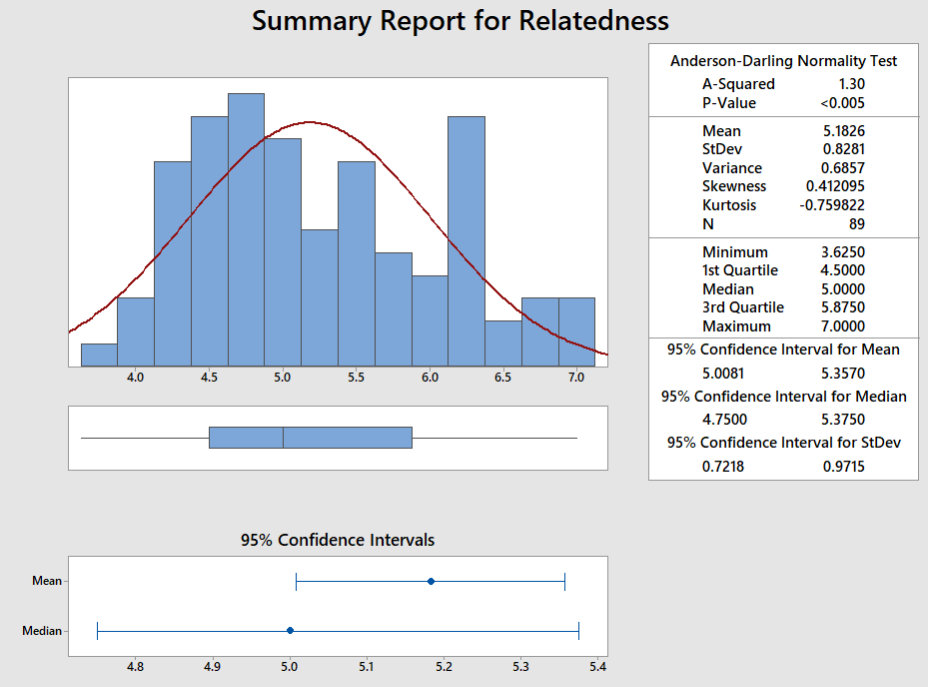
Dimension Reduction Analysis

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
1 TO 2	.96163	.55315	6.00	168.00	.767
2 TO 2	.99275	.31016	2.00	85.00	.734

Figure H4: Graphical summaries of basic psychological need scores







Anderson-Darling Normality Test	
A-Squared	1.30
P-Value	<0.005
Mean	5.1826
StDev	0.8281
Variance	0.6857
Skewness	0.412095
Kurtosis	-0.759822
N	89
Minimum	3.6250
1st Quartile	4.5000
Median	5.0000
3rd Quartile	5.8750
Maximum	7.0000
95% Confidence Interval for Mean	
5.0081	5.3570
95% Confidence Interval for Median	
4.7500	5.3750
95% Confidence Interval for StDev	
0.7218	0.9715

Table H8: Cronbach's alpha data for BPNS scores

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q1	89	5.64	1.08
Q2	89	6.17	1.08
Q3	89	5.33	1.62
Q4	89	3.76	1.90
Q5	89	4.60	1.32
Q6	89	6.12	0.82
Q7	89	4.25	2.29
Q8	89	5.88	1.27
Q9	89	5.53	1.43
Q10	89	5.20	1.69
Q11	89	4.11	1.58
Q12	89	5.56	1.11
Q13	89	4.42	1.69
Q14	89	5.29	1.25
Q15	89	3.82	2.04
Q16	89	4.33	2.18
Q17	89	5.31	1.79
Q18	89	3.78	2.58
Q19	89	3.83	2.20
Q20	89	3.78	2.22
Q21	89	6.43	0.82
Total	89	103.12	14.05

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q1	97.48	13.83	0.1640	0.3934	0.7280
Q2	96.96	13.55	0.4303	0.4775	0.7144
Q3	97.80	13.74	0.1367	0.5060	0.7315
Q4	99.36	13.23	0.3726	0.4455	0.7125
Q5	98.53	13.63	0.2760	0.5434	0.7214
Q6	97.00	13.88	0.1740	0.3422	0.7277
Q7	98.88	13.17	0.3085	0.4141	0.7194
Q8	97.25	13.63	0.2903	0.5506	0.7207
Q9	97.60	13.32	0.4674	0.6219	0.7079
Q10	97.92	13.26	0.4147	0.5673	0.7097
Q11	99.01	13.73	0.1453	0.2562	0.7307
Q12	97.56	13.45	0.5064	0.6518	0.7099
Q13	98.71	13.14	0.4925	0.6838	0.7031
Q14	97.83	13.47	0.4264	0.6853	0.7127
Q15	99.30	13.38	0.2568	0.3775	0.7236
Q16	98.80	13.52	0.1686	0.4020	0.7333
Q17	97.81	13.51	0.2378	0.4916	0.7243
Q18	99.35	13.38	0.1686	0.5534	0.7381
Q19	99.29	13.12	0.3502	0.4065	0.7146
Q20	99.35	13.18	0.3173	0.5665	0.7182
Q21	96.70	13.68	0.4198	0.5215	0.7181

* NOTE * Maximum rows or columns exceeded for MATRIXPLOT.