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The Woman Scientist: Communal Goals as Predictors for Women’s Interest in STEM

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Abstract

Statistically, women are under-represented in science, technology, engineer, and mathematics (STEM), a fact that has attracted much focus in psychological research pertaining to its far-reaching implications in our workforce. According to previous research based on the measurement of the collaborative aspect of communality, or the work process, a possible explanation for this gender gap is that STEM careers do not afford a person communal goals (Diekman, Clark, Johnston, Brown & Steinberg, 2011). However, the purpose of one’s job, the work product, is an aspect of communality that has not been measured. We measured communality along the aspects of work process and work product. Previous research has also shown that role models influence women’s interest in STEM careers (Dasgupta, 2011), so we included the variable of target gender in our research. Measuring all three variables revealed that the work process aspect of communality shifts women’s perceptions of a person in a STEM career and the job they perform. We also found that women are more interested in STEM careers after being exposed to a male target as opposed to a female target.
The Woman Scientist: Communal Goals as Predictors for Women’s Interest in STEM

Two widely discussed areas where gender gaps exist are in an academic setting and the workforce, and more specifically, women in STEM (Science, Technology, Engineering and Mathematics) fields (Miyake, Kost-Smith, Finkelstein, Pollock, Cohen & Ito, 2010). Boys and girls are treated differently from their first steps into the classroom. Education is what shapes children into adults and prepares our newer generations to become the workforce of tomorrow. Justly, these settings become highly focused areas of research. Understanding where and why gender gaps exist is beneficial to learning how to close these gaps and create more equality in the classroom and the workforce. Some theories suggest genetic differences (Benbow & Stanley, 1980). However, most of the current literature focuses on environmental influences in the gender gap (Constantinople, Cornelius & Gray, 1988; Good, Rattan & Dweck, 2012; Meece, Eccles, Kaczala, Goff & Futterman, 1982 Schmader, Johns & Barquissau, 2004).

STEM majors and careers are a key domain where a gender gap exists. Historically, women have been underrepresented in this domain (Diekman, Brown, Johnston & Clark, 2010). Many possible reasons for this under-representation exist, however, one theory, posited by Diekman, provides the main motivation for the current study. Diekman identified that STEM careers are perceived as not allowing communal goals such as serving community, helping others, and connecting with others to be fulfilled. In fact, Diekman shows that among many other career categories, STEM careers are perceived as the least enabling for individuals to fulfill communal goals (Diekman et al., 2010). In support of the link between perceived goal affordances and career interests, Diekman et al. (2010) showed that men and women perceive STEM careers as low in communal goal affordance. Moreover, they showed that personally valuing communal goals predicted decreased interest in STEM careers. Because communal goals
are valued more by women than men, the perception that STEM does not allow pursuit of communal goals may partially explain the underrepresentation of women pursuing STEM education and careers.

In other research, Diekman, Clark, Johnston, Brown and Steinberg (2011) highlight the connection between the STEM career gender gap and communal goal perception by showing that a STEM career was perceived more positively when it was described in more communal terms by female but not male participants. They hypothesized that when a scientist career afforded communal goals, attitudes toward the career would be more positive than when it did not afford such goals (Diekman et al., 2011). To test their hypothesis, they had participants read about a “day in the life” of an entry-level scientist whose daily work tasks were described as either collaborative or independent. After subjects read about the collaborative or independent “day in the life” of the entry-level scientist, they completed a series of dependent measures, which assessed subjects’ perceptions of the career, which included perceived communal goal affordances, attitudes towards the scientist career and career positivity. Results confirmed their hypothesis showing that women rated the job as more positive when the scientist was framed as working collaboratively. Men reported equal positivity for the job framed as collaborative and the job framed as independent so framing the job as collaborative did not affect men’s positivity towards the scientist job, only women’s (Diekman et al., 2011).

Walton, Cohen, Cwir and Spencer (2011) also investigated the communality of work, framing the experiment differently. In their experiment, math was framed as either affording positive social interaction or skill-promotion. The study had subjects read a fabricated report supposedly written by a recent graduate in the math department. The relational context described “opportunities for positive, collaborative social interactions”. The skill-promotive
context described the math department “as providing students opportunities to develop their personal ability and interests in math.” After subjects read one of the two reports, they were measured on their self-reported motivation in math. The study showed that male and female subjects reported greater motivation in math when the math department was framed in a relational context (Walton et al., 2011). This finding suggests that people are more interested in the idea of pursuing a math career when the career is seen as collaborative.

Both Diekman and Walton found that communality is important in the work collaboration (or process) of STEM careers. This implies an effect on women’s interest in STEM careers by making subjects feel more connected to others and having them work with others. Importantly, however, the construct of communality as it has been described in the literature consists of two distinct aspects: one concerns the desire to interact with others (“working with people”, “connecting with others”; we refer to this as work process) and the other captures the desire to help others (“helping others”, “serving humanity”; we refer to this as work product). In the Diekman et al. (2011) study, communality was manipulated just with respect to the first of these, that is, work process. When the job was intended to be low in communality, the scientist spent most of the day working alone while the job high in communality was described as working mostly with other scientists. The jobs did not vary in the day-to-day tasks, only in the degree to which the scientist worked with others. In short, the study focused on the construct of communality along the aspect of interacting with others (the work process). Similarly, in Walton et al. (2011), communality of work was framed as skill promotive or relational, also in the context of process. A job can also be communal in the work product, or how much it betters the lives of others and serves humanity. Consider, for example, a woman engineer who creates water purification systems for a living. If her job was to create water purification systems to
provide clean water to poor villages in Africa, it would be considered to afford high
communality by the work product she is producing. If her job was to create water purification
systems to increase profit margins for large companies in the water industry it would be
considered low in communality in term of the work product.

Many jobs that involve working mainly independently still serve humanity. Researchers
who find cures for disease or engineers who create water purification systems to bring poor
villages water are both examples of people who work to serve humanity but may spend their
days working relatively independently. Are women less interested in STEM careers because they
perceive these as requiring them to work alone rather than collaboratively (that is the process of
doing the career), or because the outcome (or product) of the job is not viewed as serving
humanity? Diekman et al. (2011) found that women are more interested in STEM careers when
the job was described as working with others as opposed to working alone. However, it may
also be the case that women’s interest in STEM could be increased when the job is described as
serving humanity as opposed to personal gain. Given the existing literature, it is clear that the
process aspect of communality matters. However, it is unclear whether the product aspect of
communality matters as well. It could be the case that the desire to work with others is
important, the desire to help others is important, or both are important in determining what
attracts women to STEM. It is important to determine which aspect or aspects of communality
are driving interest in STEM. In order to test which of the two variables is important in
determining STEM interest, work process and work product need to be manipulated
simultaneously and orthogonally to determine where the importance lies. The current study
hopes to do just this. Understanding how women perceive STEM majors and careers on both
levels of communality will provide further insight as to how best to increase interest in this domain.

In addition to communal goal affordance, research also suggests that the presence of female role models can increase women’s interest in STEM. Dasgupta (2011) investigated whether contact with female rather than male scientists, engineers and mathematicians could enhance women’s attitudes towards STEM and increase their interest in STEM careers. She found that long-term personal contact with female mathematicians and engineers improved women’s attitudes towards STEM, increased importance of STEM to their self-concept, as well as increased their career aspirations in STEM (Dasgupta, 2011). Because of the impact female role models have on women’s interest in STEM, in this study we wanted to investigate if the gender of the scientist was important in addition to the contexts of communality. Importantly, Diekman et al. (2011) left the gender of the scientist described in their study ambiguous. It is not clear what participants inferred the gender of the scientist was as they read about the scientist’s daily activities.

Thus in the current study we manipulated three variables of interest: communality of work process, communality of work product, and target gender. We changed the type of job from scientist (utilized by Diekman et al., 2011) to engineer in order to better manipulate the work product. We expected to replicate the results from Diekman et al.’s (2011) study by finding that when framed collaboratively, a STEM job would be perceived to afford communal goals and would increase women’s interest in STEM. We also hypothesized that subjects would perceive the job as affording communality goals when the job was framed as serving humanity, and hence to increase women’s interest in STEM. We also predicted that gender of the STEM expert would be important in predicting women’s interest in STEM. More specifically, subjects were
expected to have a greater interest in STEM if the engineer was female. All of these predictions concern participants expressed self interest in STEM.

In addition, we expected perceptions of the engineer to vary as a function of the independent variable manipulations. We predicted that subjects would have more positive perceptions of the engineer, his/her job, and his/her lifestyle if the engineer worked collaboratively and served humanity. We also predicted that whether or not the engineer was female would influence subject’s perceptions of the engineer. Finally, we predicted that subjects would perceive themselves as more similar to the engineer when the job afforded communality in the work process and product, and (because all of our participants were women) when the engineer was female. To test these hypotheses, we used the same “day in the life” procedure as Diekman et al. (2011), which manipulated communality of the process. We added a brief description of the engineer to convey that the job either did or did not allow this person to fulfill communality goals in the product of their work. We also varied the gender of the engineer. By testing these hypotheses, we hope to provide a clearer picture as to which variables are really important in driving women’s interest in STEM.

Method

Subjects

Two hundred fifty-five female undergraduate students at the University of Colorado Boulder enrolled in introductory psychology courses were recruited and participated for course credit. One subject was excluded from analyses because she opened an additional survey during her session. Because we were interested specifically in women’s interest in STEM majors and careers, all subjects included in the study were female. Subjects’ age ranged from 18 to 38 (M=18.78).
Design

A 2 x 2 x 2 between-subjects factorial design was used in this study. Three independent variables were manipulated to test the hypotheses: Work process (collaborative, independent), work product (serving humanity, corporate gain) and target gender (male, female). The dependent variables examined were perceived goal affordances of the engineer’s job, subjects’ STEM interest, perception of the engineer, and perceived similarity to the engineer.

Materials

The communality of both an engineers’ daily activities and overall job purpose were manipulated with modification to the “day in the life” passage previously used by Diekman et al. (2011). The only parts of the passage that varied in past research were the communality of the work activities, whether the engineer was working alone or collaboratively, while the tasks being completed remained the same (Diekman et al., 2011). The passage used in the current study varied on three levels.

The first variable, work process (collaborative, independent), varied by having subjects read about an engineer that spent his/her day working alone or working collaboratively. Like the Diekman et al. (2011) study, the “day in the life” portion of the materials only varied on the communality of the work process. The passage used in the previous study had subjects read the daily tasks of an entry-level scientist. For this study, the daily tasks of the employee were changed to present an entry-level chemical engineer (see Appendix A, Appendix B). The job title of the employee was changed for this study in order to accommodate our second independent variable, work product.

Work product (serving humanity, corporate gain), varied by having subjects read about an engineer who worked for corporate gain or who’s job allowed his/her to serve humanity. To
test this we had subjects read about an engineer that either worked to increase profit margins for a water-industry corporation (corporate gain) or worked to bring clean water to poor villages in Africa (serving humanity; see Appendix C). We created this segment of the passage to include the manipulation of work product for this study because we wanted to include a complete story of an engineer who could also vary on the purpose of his/her work.

The third variable by which the passage differed was target gender (male, female) in which the subject read about either an engineer named Christopher Adams or Christine Adams (see Appendix C). The passage only varied by the three independent variables, the rest of the passage (all subjects read about a chemical engineer who worked in the water industry) remained the same.

**Dependent Measures**

**Perceived Goal Affordances.** Like Diekman et al.’s (2011) study, we asked participants to consider how much they believed the job to fulfill communal goals. These measures allow us to determine how our independent variables affect perceptions of the goals people can achieve in the job we described. While communal goal affordances have been of theoretical interest in explaining gender disparities in STEM, social psychological research suggests that agency is a second main goal dimension. Agency refers to concerns for oneself and one's own goals and it includes traits such as independence, autonomy and competence (Stein, Newcomb & Bentler, 1992). To see whether our manipulations affect agency as well as communality, we included this construct along with communal goal affordances. Perceived goal affordances were measured by having subjects rate the engineers’ job on six communal items ($a = .84$) and six agency items ($a = .70$) using a Likert scale (1 = *Not at all*, 7 = *Very much*) in a random order. Items used in
this scale were taken from previous studies measuring this variable (Diekman et al., 2011; Stout et al., 2010) and are shown in Table 1.

**STEM Self-interest.** In order to determine if our independent variables affected subjects’ interest in a STEM career, we included items measuring different aspects of the subjects’ perceptions of STEM careers. Subjects’ self-reported interest in STEM was measured using 15 items (see Table 1). The self-interest measure was introduced by asking subjects to think more broadly about “careers known as STEM fields.” The STEM self-interest items looked at how positively subjects viewed STEM, how much the felt they belonged in STEM majors/careers, how successful they thought they would be in a STEM major, to what extent they identified with science, and their interest in STEM majors. Subjects rated agreement using a Likert scale (1 = *Strongly disagree*, 7 = *Strongly agree*). While the items measured many different constructs, responses tended to be highly intercorrelated. A factor analysis revealed that when combining all 15 items, the first factor accounted for 80.51% of variance. Because it was clear that all items were representing this variable, we averaged all responses into a single response (*a* = .98).

**Perceptions of Target Engineer.** In addition to examining differences in perceptions of STEM careers, we were also interested in whether subjects used the information we gave them about the engineer’s job and daily work activities to make inferences about them as a person. This construct was measured looking at five different aspects of perceptions to get a comprehensive assessment of how subjects perceived the engineer with respect to his/her job and personal life (see Table 1).

**Warmth of target.** We included the warmth of the target in our analyses because traits that describe warmth (e.g. likeable, helpful) are traits that are also associated with communality.
This measure therefore allows us to determine if the features of the job affect inferences the subjects make about the engineer’s personal traits. To measure how warm subjects perceived the engineer to be, we used four items ($a = .91$; see Table 1) using a Likert scale ($1 = \text{Not at all}, 7 = \text{Very much}$).\(^1\)

**Target positivity.** This measure used six items that allowed us to get a general understanding of how positive subjects perceived the engineer. The analyses ran on target positivity included the constructs of how interesting the engineer was perceived to be, how well-rounded s/he was, and how satisfied and successful s/he was in his/her professional and personal life. Because items measuring target positivity were highly correlated, they were averaged together ($a = .73$). Items used to measure target positivity were rated using the same Likert scale as the warmth rating.

**Target stress.** Like target positivity, we also wanted to see how varying aspects of the job affected how stressed subjects perceived the engineer to be. We used one item to assess subjects’ perception of the engineer’s stress level which was also rated using the same Likert scale as warmth and target positivity ratings (see Table 1).

**How target spends his/her time.** How the target spends his/her time was measured to help us understand how subjects perceive the engineer’s lifestyle. Spending time alone and interacting with friends offer parallels to both levels of the independent variable of work process.\(^2\) Subjects rated the engineer on how much time they perceived him/her to spend alone and with friends on a 10-point scale in three hour increments (0-3 hours to 31-33 hours).

**Salary of target.** In addition to how the engineer spends his/her time outside of work, we also used the salary of the target as a measurement to make inferences about the engineer’s
perceived lifestyle. Perceived salary of the target was measured using a 6-point scale in $20,000 increments ($20,000-$39,000 to $120,000-$140,000).

**Perceived Similarity to Target Engineer.** Perceived similarity to the engineer was included as a dependent measure because we wanted to determine whether working with others, serving humanity or the gender of the target affected how the female subjects’ felt they related to the engineer. We tested perceived similarity to the target engineer using two items asking how much subjects felt they personally related to the engineer and how similar they felt to him/her. We used means of both items together during analysis because they were highly correlated, \( r = .76, p < .01 \) (see Table 1). Subjects rated agreement using a Likert scale (1 = Not at all, 7 = Very).

**Demographics.** Subjects also answered demographic questions asking their gender, age, academic year, academic major and job if applicable.

**Procedure**

Before each group of subjects arrived, each of ten computer workstations was set up with the Qualtrics link that provided the experiment. Subjects were randomly assigned to one of eight conditions via Qualtrics. Two consent forms were placed at each workstation. When subjects entered the lab they were asked to sit at any open workstation. The computers showed a screen that asked subjects to “Please wait for experimenter to proceed”. Once all subjects were seated and ready to begin, the experimenter instructed them to read through the consent form that was placed in front of them, to keep one copy, and to sign and date the other copy to be collected. The consent form explained that the purpose of the study was to “understand how different types of careers are perceived by undergraduate students, and how these perceptions affect interest in pursuing career paths.” All consent forms were collected and checked for signature and date.
After the collection of consent forms, the experimenter then read a script giving a brief
description about what the subjects would be doing. The instruction asked all subjects to silence
any mobile devices and put them away. Subjects were also asked to take their time and read all
materials carefully. They were allowed 30 minutes to complete the experiment, were informed
that they would stay for the entire time, were asked to sit at their workstations quietly until
everyone was finished and told to begin.

The first screen subjects saw was a welcome screen where they read “We are interested
in student’s perceptions of different kinds of jobs – what they think would be interesting or not
very interesting about these jobs, and whether they think they would like these jobs or not. You
will be asked to read a passage about the daily activities of an employee. Please read all
instructions and materials carefully. After you read through the passage, you will be asked about
your perceptions of the person and the career. You may begin.”

When subjects began, the first screen that appeared was the first portion of the
manipulation, which included the independent variables of target gender and work product.
Subjects received one of four vignettes (see Appendix C). Each vignette included three bullet
points that included the name of the engineer identifying them as male or female, where the
engineer went to school and his/her degree (this information was the same in all vignettes) and a
brief description of his/her job. The description of the job included the third independent
variable, job outcome, which was described as corporate gain or serving humanity. After
reading about the information provided, subjects were asked three questions to ensure they read
the first portion thoroughly. If they were unable to answer the questions, they were allowed to
revisit the information and then allowed to answer the questions again (see Appendix D).
Subjects proceeded to read about the daily tasks of an entry-level civil engineer that varied along
the work process variable of communality. They received either the independent (see Appendix A) or collaborative vignette (see Appendix B).

The questionnaire followed the summary portion of the process manipulation and was structured by the dependent variables we were interested in measuring. Directly after the manipulation, subjects were instructed they would be asked some questions about the person and job they just read about. They were asked to use the impression they formed based on reading about the person and the job to answer the questions. First, subjects rated perceived goal affordances of the engineer’s job. Subjects were then asked to rate their perceptions of the target engineer and their perceived similarity to the target engineer. Next, subjects reported their STEM Interest (STEM was explained as science, technology, engineering and math). Finally, subjects answered demographic questions including their gender, age, academic year, academic major and their job (if applicable).

Subjects were allowed up to 30 minutes to complete the experiment. After completing the passage and questionnaire, subjects waited quietly at their workstations for all to finish. Once all subjects were finished they were given a debriefing form disclosing the full nature of our research and instructed to collect a receipt for participation. After all subjects left the experiment room, all computers were checked to ensure each subject completed the experiment in entirety.

Results

Our primary interest in the study was to determine which constructs of communality are driving women’s interest in STEM and whether the presence of a female expert is additionally important. First, because we were interested in subjects’ perception of communality of the job, we examined subjects’ rating of the job on communal and agentic goal affordances. Next, we measured subject’s self-rated interest in STEM. Because we were interested in how information
about the job might affect inferences made about the employee, we also examined subjects’ perceptions of the target engineer. In addition to perceptions of the job and engineer, we wanted to know whether the job features affected how they related to the engineer so we examined their perceived similarity to the engineer. All data were analyzed using a 2 (Work Process: collaborative, independent) x 2 (Work Product: serving humanity, corporate gain) x 2 (Target Gender: male, female) analysis of variance (ANOVA) with all variables as between subjects. As results are discussed, the replication of the Diekman et al. (2011) findings becomes apparent. Perceptions of the job, the engineer and subjects’ perceived similarity to the engineer are largely motivated by whether the job was framed as collaborative or independent (the work process), while STEM interests appear to be motivated by the target gender. By contrast, there were few effects of Work Product.

**Perceived Goal Affordances.** We expected to replicate Diekman et al.’s (2011) findings that the job, when framed as collaborative in process, would be perceived to afford communal goals. We also predicted that subjects would perceive the job to afford communal goals when the job served humanity and was performed by a woman. As predicted, we replicated Diekman et al.’s results by finding that the job was rated higher for allowing communal goals when the job was framed as collaborative (\(M = 6.12\)), as opposed to when the job was framed as independent (\(M = 4.60\)), as reflected in the Work Process main effect, \(F(1, 246) = 170.06, p < .0001\) (see Figure 1). Also as predicted, there was a Work Product main effect, with higher perceived communal goal affordances when the job was framed as serving humanity (\(M = 5.68\)), as opposed to when it was framed for corporate gain (\(M = 5.05\)), \(F(1, 246) = 29.10, p < .0001\). No other effects were significant.
We assumed the job framed independently (low in communal work process) and for corporate gain (low in communal work product) would be perceived as more agentic. Additionally, we predicted the job would be perceived as more agentic when performed by a male. When the job was rated for allowing agentic goals, there was a Work Process main effect. Agentic goal affordances were higher when the job was framed as independent ($M = 5.12$) as compared to collaborative ($M = 4.46$), $F(1, 246) = 45.90, p < .001$ (see Figure 1). There was also a Target Gender main effect, with the job perceived to allow agency more when the engineer was male ($M = 4.93$), rather than when the engineer was female ($M = 4.70$), $F(1, 246) = 4.67, p < .05$.

**STEM Self-interest.** We hypothesized that subjects would self-report increased interest in STEM majors/careers if the engineer they read about was female and the job was portrayed communally in both its process and product. It is important to note again that subjects self-reported interest in STEM were considered thinking about STEM fields in general as opposed to the entry-level chemical engineer they read about. This variable includes subjects’ judgments on several items: how positively they viewed a career in STEM, how much they felt they belonged in a STEM major or career, how successful they thought they would be in the STEM field and their interests in a STEM major and career. When running analyses using the $2 \times 2 \times 2$ ANOVA, we found a Target Gender main effect but the direction of the effect was opposite to predictions. Subjects reported higher interest in STEM after reading about the male engineer ($M = 4.08$) as opposed to the female engineer ($M = 3.41$), $F(1, 246) = 8.66, p < .05$. As shown in Figure 2, we also found a significant three way ($2 \times 2 \times 2$) interaction $F(1, 246) = 4.32, p < .05$. To further understand this finding, we performed separate $2 \times 2$ ANOVAs for male and female targets. The $2 \times 2$ ANOVA for the female target yielded no significant
findings. This indicates that after reading about a female engineer, subjects’ own interest in STEM was not affected by the level of communality in either the work process or work product. In the 2 x 2 ANOVA for the male targets, the Work Process x Work Product interaction was marginally significant, $F(1, 123) = 3.10, p = .08$. Follow-up pairwise comparisons showed that work process mattered in the corporate gain condition such that subjects reported higher interest in STEM when he worked collaboratively ($M = 4.64$), and lower STEM interest when he worked independently ($M = 3.39$), $F(1, 123) = 6.49, p < .05$. When the male engineer was serving humanity, it did not matter if he worked independently or collaboratively ($F = 0.002$, ns).

**Perceptions of Target Engineer.** We wanted to determine if we could identify differences between the collaborative and independent engineer as well as the engineer serving humanity and the engineer working for corporate gain. We expected that subjects would rate the engineer who worked collaboratively and served humanity as warmer and have a more positive impression of them overall. We also expected subjects to rate the engineer who worked independently and for corporate gain as less warm and have a less positive impression of them overall. Additionally, we wanted to determine if the gender of the engineer affected these results. We also expected variability in ratings of perceptions of the engineers’ lifestyle (how s/he spends his/her time and his/her salary) based on work process, work product and target gender.

**Warmth of target.** Our hypothesis about the perceived warmth of the engineer was partially confirmed as we found a Work Process main effect. The engineer who spent his/her day collaboratively was rated higher in warmth ($M = 5.84$) than the engineer who worked independently ($M = 4.60$), $F(1, 246) = 93.24, p < .001$ (see Figure 1). There was no main effect of Work Product. We also found a Work Process x Target Gender interaction, $F(1, 246) = 6.27,$
As shown in Figure 3, in the independent work process condition, subjects perceived the engineer to be warmer if the target was female ($M = 4.87$) rather than male ($M = 4.33$), $F(1, 246) = 8.75, p < .005$. When the engineer worked communally, target gender did not matter ($F = 0.32, ns$).

**Target positivity.** The target positivity variable include the ratings of how interesting the engineer was perceived to be, how well-rounded s/he was, and how satisfied and successful s/he was in his/her professional and personal life. As predicted, we found a Work Process main effect such that the collaborative engineer was rated as more satisfied ($M = 5.04$) than the independent engineer ($M = 4.68$), $F(1, 246) = 13.60, p < .001$ (see Figure 1). No other findings were significant.

**Target stress.** We found a Work Process main effect such that the collaborative engineer was less stressed ($M = 4.43$) than the independent engineer ($M = 4.76$), $F(1, 246) = 4.32, p < .05$ (see Figure 1). Also, as shown in Figure 4, there was also a Work Process x Target Gender interaction, $F(1, 246) = 5.95, p < .05$, showing that when working collaboratively, the engineer was equally stressed if male or female ($F = 0.37, ns$). However, when working independently, the female engineer was more stressed ($M = 5.07$) than the male engineer ($M = 4.45$), $F(1, 246) = 7.97, p = .005$.

**How target spends his/her time.** We measured how much time subjects perceived the engineer to spend alone and interacting with others. Because there was a fair amount of between-subject variability in how much total time subjects allotted to these categories, we calculated within subject $z$-scores for time spent alone and interacting with friends. The resulting $z$-score tells us, for example, how much time a particular subject thought the target was
spending alone as compared to how much time that same subject thought s/he was spending doing other things.

There was a Process main effect on time alone estimates, $F(1, 246) = 38.13, p < .001$. The engineer who worked independently ($M = .66$) was assumed to spend more time alone than the engineer who worked communally ($M = -.09$). There was also a Process main effect on time spent with friends, $F(1, 246) = 64.21, p < .001$. The engineer who worked communally ($M = .42$) was assumed to interact with friends more than the engineer who worked independently ($M = -.37$; see Figure 5). No other findings were significant.

**Salary of target.** When analyzing the salary of the engineer, we found a Work Process main effect, such that the engineer who worked independently received a higher salary ($M = 3.46$) than the engineer who worked communally ($M = 3.17$), $F(1, 246) = 4.19, p < .05$ (see Figure 1). Given the scale used, the mean rating in the independent condition was between the $60,000$-$79,000$ and $80,000$-$99,000$ salary ranges, which corresponded to ratings of 3 and 4, respectively.

Overall, the engineer that works independently is perceived as spending more time alone and as more stressed but with a higher salary. The engineer that works collaboratively is viewed as warmer and spending more time with friends. Additionally subjects had more positive ratings of the collaborative engineer, viewing him/her as more satisfied with his/her job and personal life, more successful in his/her job, more interesting and more well rounded. Most importantly, when making perceptions about the target, what mattered when making judgments was the work process.

**Perceived Similarity to Target Engineer.** We expected to find that subjects would relate more to the engineer when the engineer was perceived as collaborative and serving
humanity. We also expected that subjects would feel more similar to the engineer if the engineer was female. We found a Work Process main effect such that subjects felt more similar to the collaborative engineer \((M = 3.15)\) than the independent engineer \((M = 2.66)\), \(F(1, 246) = 8.45, p < .005\) (see Figure 1). Perceived similarity between the engineer who serves humanity as opposed to the engineer working for corporate gain was not statistically significant. Also, gender of the engineer produced no significant results. When rating how much they related to the engineer, it was the work process that was important. Subjects felt similar to the engineer who collaborated with others more so than the engineer that worked independently.

**Discussion**

The results of the present study confirm findings from Diekman et al. (2011) that subjects perceived an engineer who spent his/her day working with others (collaboratively) to afford communal goals as opposed to the engineer who spends his/her day alone (independently). That is, the work process manipulation affected perceived goal affordances. The work process manipulation also pushed female subjects to have more positive impressions of the engineer and his/her job in the collaborative condition as opposed to the independent condition. In addition to influencing women’s perceptions of the engineer, how the engineer spent his/her day also was the variable that affected whether or not women felt they related to the engineer. Our study clarifies that communal goals, in the aspect of work process, has consistent effects on many outcomes about the engineer and his/her job, which have both theoretical and practical implications. In theoretical terms, our experimental manipulation of work process establishes that communality, in the aspect of how an engineer spends his/her day, has a causal role in how s/he is perceived and if women feel similar/relatable to him/her. In practical terms, the
establishment that this aspect of communality is able to move around perceptions tells us that it is an important construct in finding possible interventions to increase women’s interest in STEM.

We hoped to find that serving humanity would also increase female subjects’ perceptions of STEM careers and drive interest in STEM but we found very little effect of the work product manipulation. While we did not get the results we anticipated, we did confirm that our manipulation of work product (serving humanity, corporate gain) was successful. We identified this by finding that our manipulation of work product did affect perceptions of communal goal affordances. As we saw with the collaborative framing, subjects also rated the engineers job to afford communal goals when it served humanity meaning that subjects were able to identify that the engineer serving humanity afforded communal goals more than the engineer who was working for corporate gain. We also found that our work product manipulation affected women’s interest in STEM when interacting with work process and target gender. While the 3-way interaction told us that work product had some affect on interest in STEM, we ran two 2-way interactions after finding that work product and work process were affecting males only. The 2-way interaction identified that our work product manipulation affected women’s interest in STEM when it interacted with work process for the male target. Overall, we found that what is really driving women’s perceptions of STEM careers is how they perceive a person working in this field to spend his/her workday. What this means in terms of our work product manipulation is that whether the engineer was serving humanity or working for corporate gain made no difference in women’s perceptions of STEM careers but whether the engineer worked collaboratively or independently. Also, that our work product manipulation alone is not driving women’s interest in STEM careers. Women are not more or less interested in a STEM career if they think the job will allow them to serve humanity.
We also did not find the gender main effects we hoped to find. While there were no gender main effects, the one of most importance we were looking for was women’s interest in STEM. We thought by providing women with a female role model in the form of a female engineer, women would be more interested in STEM majors/careers. Surprisingly, we found that subjects were more interested in STEM if the engineer was male. In fact, subjects were most interested in STEM if the engineer was a male that worked collaboratively. It is unclear from the results why women would be more interested in STEM if the engineer were male instead of female though there are a few possible explanations. Marx and Roman (2002) found in their study that the female role model’s success needed to be perceived as attainable and she needed to be perceived as similar. While our findings reveal that the gender of the engineer did not influence women’s perceived similarity to him/her, it could also be the case that subjects did not view the job as attainable for themselves. Additionally, Dasgupta (2011) stated in her research that seeing a few female scientists/engineers was not enough to change women’s global stereotype associating STEM with maleness. She also described the contact with a female role model that was driving women’s interest in STEM careers was “long-term” and “personal” (Dasgupta, 2011). It could be that our representation of a single female engineer was not enough to motivate female subjects’ interest in STEM or change their assumptions about the field as being male dominated. It could also be the case that a female role model is simply unimportant in determining women’s interest in STEM careers.

There are some other possible limitations in our research. In our study, we used a brief description that stated the engineer’s name, where he/she attended school and what his/her job is. The description included two of the three of our independent variables (target gender, work product). Subjects were asked to answer questions to reinforce this information before they
moved on to the work process manipulation. It could be the case that the length of the “day in the life” overshadowed the work product manipulation when subjects moved onto the dependent measures. Target gender was reinforced throughout the dependent measures by including the engineer’s name in questions. The work product variable was last seen before the work process manipulation so it could be the case that that affected why results were heavily driven by process. In future studies, it would be good to reinforce the work product manipulation in the summary portion of the “day in the life” to remind subjects of the purpose of the engineers work.

Another possible limitation in our research is how we chose to frame questions in our dependent measures. When subjects were making judgments about the target and his/her job, they were thinking about an engineer. However, when we asked subjects about their “impression of careers in what are known as STEM fields: specifically, careers in Science, Technology, Engineering and/or Math,” they were thinking about STEM as a whole. Additionally, in Diekman et al.’s (2011) study, in answering questions about STEM self-interest they referred subjects back to “the entry-level scientist” they had read about “a day in the life of,” while we did not. This disconnect in framing what subjects were asked to think about could have caused the disconnect that we see in results between STEM interests and our other dependent measures.

Overall, what we learned is that how a person in a STEM career spends his/her day impacts perceptions of what goals a STEM job affords, perceptions of what a person in STEM careers is like and how similar women feel to a person in STEM careers. In addition, we learned that the purpose/outcome of one’s job in STEM impacts perceptions of what goals a STEM job affords. It was our atypical finding in measuring women’s interest in STEM that needs further explaining and calls for further exploration. It could be the case that our study did not manipulate our three independent variables thoroughly. The study needs to be replicated to see if similar
results are found or if our findings were just chance. Either way, the importance of understanding women’s under-representation in STEM remains. Continued research in this area is crucial to identifying how to reduce the gender gap to create a more equal work force.
References


Footnotes

1 The four trait items used to measure warmth of target were measured in a matrix table that also included three competency items (competent, skillful, and capable). Because the three competency items yielded no significant results, they were not reported.

2 How target spends his/her time was rated using six dependent variables. In addition to time spent alone and interacting with friends, we also had subjects rate how much time they perceived the target to spend exercising, relaxing, spending time with family, and enjoying hobbies using a matrix table. We only reported time spent alone and time interacting with friends because the other four items did not produce any clear or significant results.

3 To calculate z-scores we first computed the mean time estimates across six dependent variables for each subject. We then got the standard deviation for each subject around their mean. Finally, for each subject, we computed their time estimates to z-scores using the standard formula \(((\text{individual variable score} - \text{mean time estimate})/\text{standard deviation})\).
Table 1

*Dependent variable constructs and their items*

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Individual Item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived goal affordances</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Communal Goal Affordances</strong></td>
</tr>
</tbody>
</table>
| | • Serving community
| | • Working with people
| | • Helping others
| | • Connecting with others
| | • Serving humanity
| | • Caring for others
| | • Personal recognition
| | • Independence
| | • Self-direction
| | • Competition
| | • Success
| | • Power |
| **STEM self-interest** | • Overall, I have a positive impression of a career in a STEM field.
| | • I would find a career in STEM enjoyable.
| | • I feel like I would belong in a STEM career.
| | • I feel like I would fit in well in a STEM career.
| | • I feel like I would belong in a STEM major at CU.
| | • I feel like I would fit in well in a STEM major at CU.
| | • I feel like I would be successful if I majored in a STEM field.
| | • I would perform well if I majored in a STEM field.
| | • I am likely to pursue a major in STEM.
| | • I am likely to take a STEM class.
| | • I am interested in taking a STEM class.
| | • I think I would find STEM an interesting area of study.
| | • I would be interested in learning more about STEM careers.
| | • Science is one of my best subjects.
| | • It is important to me that I am good at science. |
| **Perceptions of target engineer** | **Warmth of Target** |
| | • To what extent do you think each of the following characteristics could be used to describe [Christopher/Christine]?
| | o Warm
| | o Helpful
| | o Friendly
| | o Likeable |
Target Positivity
- How interesting do you think [Christopher/Christine] is?
- How well-rounded do you think [Christopher/Christine] is?
- How satisfied do you think [Christopher/Christine] is with [his/her] job?
- How successful do you think [Christopher/Christine] is in [his/her] job?
- How successful do you think [Christopher/Christine] is in [his/her] personal life?
- How satisfied do you think [Christopher/Christine] is in [his/her] personal life?

Target Stress
- How stressed do you think [Christopher/Christine] is?

How Target Spends His/Her Time
- In an average week, how many hours do you think [Christopher/Christine] spends doing each of the following?
  - Spending time alone
  - Interacting with friends

Target Salary
- What is your best guess of the salary [Christopher/Christine] receives?

Perceived similarity to target engineer
- How much would you say you personally relate to [Christopher/Christine]?
- How similar are you to [Christopher/Christine]?

Note. Perceived goal affordances were measured having subjects rate the scientists’ job on six communal items (e.g., *working with people, serving humanity*) and six agency items (e.g., *independence, success*) using a Likert scale (1 = *Not at all*, 7 = *Very much*).
Figure 1. Ratings of perceived goal affordances, perceptions of the target and perceived similarity to the target along the work process variable. Communal goal affordance of target job, agency goal affordance of target job, warmth of target, target positivity, target stress and similarity to target ranged from 1 “Not at all” to 7 “Very much”. Salary of target was scaled on a 6-point scale from “$20,000-$39,000” to “$120,000-$140,000”.
Figure 2. 3-way interaction between work process, work product and target gender on self-reported STEM interest. Agreement with statements in this measure regarding STEM interest were rated using scale from 1 “Strongly disagree” to 7 “Strongly agree”.
**Figure 3.** Trait rating of perceived warmth of engineer. Trait rating scale ranged from 1 “Not at all” to 7 “Very much”.
Figure 4. Perceived stress of the engineer. Item scale ranged from 1 “Not at all” to 7 “Very much”.
Figure 5. Perceptions of how much time engineer spends alone and interacting with friends.

Hours scale was ranged using a 10-point scale from “0-3” to “31-33”.

APPENDIX A
Vignette for Independent Work Process

Entry-Level Civil Engineer Career Description

Morning

8:15 am
I come in and check my e-mail then plan the day. I usually have to check a database maintained by the Operations Group (they run the high-throughput screens) to learn the status of ongoing experiments so I can go from primary to secondary characterizations.

9:15 am
I go to the lab after about an hour to check on samples left overnight (for example, to see if a water sample has purified), characterize samples from the previous afternoon to integrate the data collected the previous day, and characterize new samples that have come in that day. I look up relevant past research to consult about the procedures.

12:00 pm
The company runs presentations during lunch, where we learn what else is going on both within the company and with the other water and chemical companies who supply us with oxidation and treatment processes. I watch video feed of these presentations at my desk while I eat. Speakers might be a researcher from a different lab giving an update, a patent lawyer briefing us on legal issues in patent protection, or a member of the Treatments Group describing ongoing treatment development work.

Afternoon

1:00 pm
Do data analysis (e.g., advanced oxidation treatments, centrifugation analysis, membrane-based separation, distillation analysis) and troubleshoot any problems that come up by myself.

3:00 pm
Go to meeting to update my supervisor on the status of my projects, which are typically independent. My supervisor will tell me what further experiments to run or additional data points to collect. My supervisor also gives me a heads-up on what treatment samples are coming in during the next few weeks. This gives me an idea of what my own workload will be like.

4:00 pm
Update lab notebook with either data collected that day or experiments started. Get started on experiments that can be set up and run overnight.

5:00 pm
Prepare for weekly meetings with the entire Solid State Chemistry Group (15 members). Typically, I make a PowerPoint presentation using tables and charts of data, a summary, and discussion points.

5:30 pm
Commute home.

Summary

I like that so much of my work involves working by myself and solving problems. My work really lets me advance at a quick pace, and I get the sense that I am achieving a great deal through my projects and individual accomplishments. I like having a variety of tasks, gathering data through multiple methods, and trying to interpret data from both high-throughput experiments and bench-top experiments. I like the sense of contributing to understanding development and solutions to treatment and purification processes. I like being exposed to industry and to the various issues in water-purification and wastewater-treatment industry, both within my field and outside—largely from presentations—from the senior scientists and other experts.
APPENDIX B
Vignette for Collaborative Work Process

Entry-Level Civil Engineer Career Description

Morning

8:15 am
I come in and check my e-mail then plan the day. I usually have to communicate closely with the Operations Group (they run the high-throughput screens) to check on the status of ongoing experiments so we can go from primary to secondary characterizations.

9:15 am
I go to the lab after about an hour to check on samples left overnight (for example, to see if a water sample has purified), characterize samples from the previous afternoon to integrate the data collected the previous day, and characterize new samples that have come in that day. I meet some of my lab group in the lab and consult with them about the procedures.

12:00 pm
I join co-workers from other labs at lunch. The company runs presentations during lunch, where we learn what else is going on both within the company and with the other water and chemical companies who supply us with oxidation and treatment processes. Speakers might be a group member from a different group giving an update, a patent lawyer briefing us on legal issues in patent protection, and a member of the Treatments Group describing ongoing treatment development work. Lunch is a good chance to catch up on the progress that other labs are making, and to share our ideas and feedback.

Afternoon

1:00 pm
Mentor new members of my statistics group in doing data analysis (e.g., advanced oxidation treatments, centrifugation analysis, membrane-based separation, distillation analysis).

3:00 pm
Collaborate with my group (which has 6 members) to prepare for a meeting with our supervisor. Go to meeting to update our supervisor on the status of our projects, which are typically larger projects that have several team members. Our supervisor will ask questions and give advice on running further experiments or collecting additional data points. Our supervisor also gives us a heads-up on what treatment samples are coming in during the next few weeks. This gives us an idea of the workload of the group.

4:00 pm
Update lab notebook with either data collected that day or experiments started. Get started on experiments that can be set up and run overnight.

5:00 pm
Prepare for the monthly presentation my lab group gives at local schools to inform interested students about our research. Typically, I make a PowerPoint presentation using tables and charts of data, a summary, and discussion points.

5:30 pm
Commute home.

Summary

I like that so much of my work involves working closely with other people and helping them solve problems. The interactions we have are really fun, and I get the sense that I am contributing a great deal to their projects. I like having a variety of tasks, gathering data through multiple methods, and trying to interpret data from both high-throughput experiments and bench-top experiments. I like the sense of contributing to understanding development and solutions to treatment and purification processes. I like being exposed to industry and to the various issues in the water-purification and wastewater-treatment industry, both within my field and outside—largely from presentations—from the senior scientists and other experts.
APPENDIX C

Vignettes for Target Gender and Work Product

| Male, Low Product | On the following page you will read about the daily activities of Christopher Adams.
|                  | • Christopher majored in chemical engineering at the California Institute of Technology.
|                  | • Christopher received a Bachelor of Science degree from Cal Tech.
|                  | • Christopher is an entry-level chemical engineer working on a purification and treatment system for cleaning water to increase efficiency and profit margins for utility companies.

Please reread this information once. On the next page you will be asked to summarize it.

| Male, High Product | On the following page you will read about the daily activities of Christopher Adams.
|                   | • Christopher majored in chemical engineering at the California Institute of Technology.
|                   | • Christopher received a Bachelor of Science degree from Cal Tech.
|                   | • Christopher is an entry-level chemical engineer working on a purification and treatment system to bring clean water to poor villages in Africa.

Please reread this information once. On the next page you will be asked to summarize it.

| Female, Low Product | On the following page you will read about the daily activities of Christine Adams.
|                    | • Christine majored in chemical engineering at the California Institute of Technology.
|                    | • Christine received a Bachelor of Science degree from Cal Tech.
|                    | • Christine is an entry-level chemical engineer working on a purification and treatment system for cleaning water to increase efficiency and profit margins for utility companies.

Please reread this information once. On the next page you will be asked to summarize it.

| Female, High Product | On the following page you will read about the daily activities of Christine Adams.
|                     | • Christine majored in chemical engineering at the California Institute of Technology
|                     | • Christine received a Bachelor of Science degree from Cal Tech
|                     | • Christine is an entry-level chemical engineer working on a purification and treatment system to bring clean water to poor villages in Africa

Please reread this information once. On the next page you will be asked to summarize it.
## APPENDIX D
Manipulation Check Questions

<table>
<thead>
<tr>
<th>Target Gender</th>
<th>Questions</th>
</tr>
</thead>
</table>
| **Male**      | What is the name of the engineer you will be reading about?  
                Where did he get his degree?  
                What does he do? That is, what is his job? |
| **Female**    | What is the name of the engineer you will be reading about?  
                Where did she get her degree?  
                What does she do? That is, what is her job? |
| **All**       | We'd like you to try to answer the questions above but if you can't remember you can ask to resee the information. Do you need to resee the information? You'll have a chance to answer the questions after you resee the information.  
                o Yes  
                o No |