

UNDERSTANDING HOW CHEMISTRY HELPS CAN HELP: AN EXPERIMENTAL  
INVESTIGATION OF INCREASING WOMEN'S MOTIVATION TO  
PURSUE CHEMISTRY RESEARCH

by

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## ABSTRACT

What social factors play a role in women's interest in pursuing a scientific research career? Goal congruity theory posits that people pursue careers that fulfill important goals and values. Women may avoid pursuing chemistry, for example, because women tend to highly endorse communal goals (working with and helping others) and chemistry is viewed as unlikely to afford communal goals. Experiment 1 tested whether chemistry research is stereotyped as non-communal in nature. People rated an identical research task framed as either a "psychology" or "chemistry" task or no information was given. Unfortunately, the subtle manipulation of task frame failed to influence participants' ratings of communal and agentic affordances of the task. Nevertheless, exploratory analyses of data that did not rely on the manipulation found that people who personally endorsed agentic goals reported more belongingness in science, and women who personally endorsed agentic goals reported more interest in scientific research. This project also tested if self-generating the communal and agentic applications of a science task increases motivation to pursue chemistry research, and if such connections are especially successful in eliciting research motivation among women (Experiment 2). The hypotheses were not testable because analysis of the manipulation check revealed that fewer than 51% of participants successfully self-generated condition appropriate items. Discussion centers on exploratory results and future directions.

## INTRODUCTION

Women are underrepresented in chemistry research positions (NSF, 2011). For example, in one National Institute of Health (NIH) research program only 29% of the tenure-track investigators and 19% of tenured senior investigators are women (Martinez et al., 2007). Further, only 32% of academic research positions in chemistry belonged to women in 2005 (NSF, 2011). There is also a gender discrepancy in grant funding such that only 25% of NIH and 23% NSF faculty grants were awarded to women in 2007 (Nature Neuroscience, 2010). The current project aims to understand what social factors play a role in the gender discrepancy observed for research motivation. Specifically, why do women show low interest and motivation for chemistry research?

According to social role theory, the differing roles that women and men have traditionally filled have led to stereotypes of what roles women and men should fill (Eagly, 1987, 1997; Eagly et al., 2000). Traditionally, women were responsible for caring for children, whereas men were responsible for providing financially for the family (Eagly, 1987). Due to traditional gender roles, girls have been socialized to be communal and boys have been socialized to be agentic (Eagly & Wood, 1991). Accordingly, these stereotypic gender roles influence interests and career choices of men and women (Eagly, 1987). Goal congruity theory, which was derived from social role theory, posits that individuals seek a match between the roles they fill and the goals that are important to them (Diekmann & Eagly, 2008). Research has shown that individuals hope to occupy gender congruent roles and fear occupying gender incongruent roles in the future (Brown & Diekmann, 2010). Further, people are most interested in fields that

are perceived as affording the goals that are they personally endorse (Brown & Diekman, 2010). Importantly, women tend to highly endorse communal goals; therefore they also tend to select occupations and family roles that are perceived to fulfill those communal goals (Diekman & Eagly, 2008). Critically, STEM fields (including chemistry) are viewed as not affording communal goals, which is likely one reason women choose to avoid these fields (Diekman et al., 2010; Diekman et al., 2011).

According to goal congruity theory, one reason women do not pursue chemistry research is due to a mismatch between the goals that chemistry fields are perceived to afford and the goals that are important to women. Specifically, women tend to be highly communal and chemistry is stereotyped as not affording communal goals (e.g. helping and working with other people) (Diekman, Brown, Johnston, & Clark, 2010; Diekman et al., 2011). The stereotype that chemistry does not afford communal goals likely deters women from pursuing chemistry research. The first aim of this project was to test whether chemistry is stereotyped as less likely to afford communal goals than psychology (where women are over represented). The second aim of this project was to examine if making the communal value of chemistry explicit increases women's chemistry research motivation.

### Representation of Women in Chemistry and Psychological Science

Women are a minority in chemistry (NSF, 2011). For instance, in 2008, 50% of bachelor's degrees in chemistry were awarded to women (NSF, 2011). However, women represented only 46% of awarded master's degrees and 34% of awarded PhD's in

chemistry (NSF, 2011). Thus, the pipeline appears to “leak” women as they progress along the chemistry career path. Indeed, only 31% of federal chemistry positions belong to women (NSF, 2011). What these data suggest is women are entering chemistry fields at an equal rate as men, but leave at a higher rate (NSF, 2011).

The gender disparity observed in chemistry does not exist in all science fields. For example, women are over represented in psychology at both undergraduate and graduate training levels. For instance, 77% bachelor’s degrees in psychology are awarded to women (NSF, 2011). Additionally, 58.6% master’s degrees and 56.2% of PhD’s in psychological science are awarded to women (APA, 2013). Further, 48% of federal psychology research positions belong to women (NSF, 2011). However, it is important to note that some subfields still show a disparity; and the rates of faculty are not on par with these graduation numbers. These numbers indicate that unlike chemistry, women in psychology are over represented. Given both chemistry and psychological science emphasize research, why might women be more drawn to psychology versus chemistry?

### The Role of Domain Stereotypes

One explanation for the under representation of women in chemistry is that stereotypes of chemistry as a discipline are incongruent with the goals and values that are often important to women (Diekman & Eagly, 2008). Stereotypes often aid people in deciding whether a potential field is a good fit for them (Allen & Smith, 2010). For example, one reason men are underrepresented in elementary education and nursing

careers is due to stereotypes that these fields are non-masculine and non-heterosexual (Allen & Smith). In one study, heterosexual men and women participants completed an elementary education task. Participants completed the task either under gay salience conditions (i.e., they were led to believe the project was funded by a gay friendly organization) or neutral conditions. Men's task performance and future motivation for elementary education was low when completing the task under gay salience. Women's experience remained unaffected by the gay salience condition. In a second experiment, researchers manipulated whether the same task was viewed as masculine or feminine (Allen & Smith). Specifically, heterosexual men and women participated in a medical task described as either a doctor (masculine domain) or a nursing (feminine domain) task under either neutral or gay salience conditions. The doctor and nursing tasks were identical and only the task frame differed. Heterosexual men who were told the task was a nursing task reported a less positive experience compared to women. Additionally, heterosexual men who were told the task was a doctor task reported a more positive experience compared to women. This research indicates that stereotypes about how masculine a field is influences men's experiences within these fields.

Women also use field stereotypes to determine whether a given field is a good fit for them (Smith, Lewis, Hawthorn, & Hodges, 2013). For instance, in one study women relied on stereotypes about a science field's emphasis on "innate" (versus incremental) talent to determine their fit and belonging in the science field (Smith et al., 2013). In this study, participants rated a new accelerated master's program. This ostensible master's program was in a novel domain (eco-psychology). Participants were provided with a

brochure of information about eco-psychology. Depending on condition, the program was depicted as either male-dominated or gender equal. Women who viewed the male-dominated brochure reported feeling they would need to exert more effort than most people to achieve success. However, informing women that all people had to put forth high effort to achieve success elevated women's reported belonging and motivation for the field. These results suggest that there is a stereotype that male-dominated fields require natural, innate talent, rather than effortful hard work. Women used this stereotype to conclude that they must exert more effort than an average person if they were to succeed in a male-dominated science field.

Research has also shown that domain stereotypes about male-dominated fields impact women's experience in those fields. For instance, in the male dominated field of mathematics, telling women math intelligence is innate and the stereotype that women are bad at math lowers sense of belonging (Good, Rattan, & Dweck, 2011). Sense of belonging is an individual's belief that they are an accepted and appreciated member of the academic community to which they belong (Good et al., 2011). In this study, researchers surveyed university calculus students three times over the semester. Women who felt their math community was high in stereotyping or endorsing an innate view of math ability reported low sense of belonging. Low sense of belonging in mathematics was associated with low future motivation and poor performance in mathematics. When women perceived a malleable view of intelligence in their learning environment, their sense of belonging was protected from stereotypes. This research shows women's

perception of their learning environment is important in their motivation to pursue a given field.

Important to the current project, there are domain stereotypes that science is not altruistic (Steinke et al., 2007). Research has shown that children view science as a masculine domain (Steinke et al., 2007). Additionally, when prompted to draw a scientist students of all ages tend to depict the scientist as a man rather than a women (Steinke et al., 2007). Further, research has shown that there is a persistent stereotype that science is not viewed as altruistic (Weisgram & Bigler, 2006). Because girls tend to value altruism, this stereotype is problematic (Steinke et al., 2007). Although this stereotype exists, some successful interventions are able to combat the effect of this stereotype. For example, one study demonstrated that when young girls were explicitly told about the altruistic value of science they showed more interest for science fields (Weisgram & Bigler, 2006).

Similar to altruism, research has shown that STEM fields are not viewed as affording communal goals. For example, interest in STEM is lower when communal goals are activated (Diekmann et al., 2011). In one study, participants completed a writing task designed to either activate communal goals or a neutral writing task. Specifically, participants either wrote about a time they tried to help or care for someone but failed (communal goals activated) or wrote about the forest floor (neutral). Participants then rated their interest in different types of careers. When communal goals were activated, both men and women showed low STEM career interest, whereas interest in other types

of careers was not affected. These data suggest that stereotypes of how communal a field undermines motivation for STEM fields.

There is significant evidence that perceived communal value is important in women's decisions to pursue certain scientific fields. For example, women are best represented in STEM fields where communal applications are most obvious (Diekmann et al., 2010; Diekmann et al., 2011). Likewise, people who highly value communal goals show the least interest in STEM fields regardless of experience and ability in STEM (Diekmann et al., 2010). Additional research has shown that when a science career is viewed as affording communal goals, people show more interest in that career (Diekmann et al., 2011). In one experiment, all participants read a description of a day in the life of a scientist. The daily activities of the scientist were either framed to be highly collaborative (communal) or independent (not communal). Participants then rated the career. Women showed significantly more positivity towards the science career when it was framed as communal. Men's ratings of the science career were not influenced by task framing. Results of this study suggest that women are uniquely influenced by stereotypes of a field's communal value. The current project (experiment 1) intends to evaluate whether chemistry is stereotyped as affording fewer communal goals than psychology.

### The Importance of Communal Value

Communion and agency have long been considered important aspects of the human experience (Bakan, 1966). Agency was first described as the "existence of the



organism as an individual”, which can be described as the determination of a person to achieve success in their field (Bakan, 1966, p. 242). Personal goals, accomplishments, and independence are important to people who value agency (Guisinger & Blatt, 1994). Additionally, agentic goals include the goal to be individually successful, to gain power, to be a leader, and to be recognized for accomplishments. (Diekman et al., 2010). The current project focused on the importance of communal value in women’s decision to pursue or avoid chemistry.

Communion was first described by Bakan (1966) as the “participation of the individual in some larger organism of which the individual is a part” (p. 242). As such, relationships with other people and feelings of belonging are particularly important to people who value communion (Guisinger & Blatt, 1994). Drawing from this original definition, communion is defined as an orientation to help others (Diekman et al., 2010; Diekman et al., 2011). Communal goals include the goal to serve a greater good, to positively impact the community, and to connect and care for others (Diekman et al., 2010). Research suggests that the communal nature of a field is often very important to people, and especially women (Diekman et al., 2010; Diekman et al., 2011; Eagly, Wood, & Diekman, 2000; Lippa, 1998; Weisfram & Bigler, 2006). Women tend to be high in communion (Costa, Terracciano, & McCrae, 2001; Schwartz & Rubel, 2005) and highly value the communal nature of a field (Diekman et al., 2010; Diekman et al., 2001; Eagly, Wood, & Diekman, 2000; Lippa, 1998; Weisfram & Bigler, 2006). For example, women prefer to work with people rather than things, (Isaac, Sansone & Smith, 1999; Lippa, 1998) and this preference predicts gender differences in career choices (Lippa, 1998).

The current experiments focused on how the perceived communal nature of a field impact decisions to pursue certain fields.

Past research has shown that there are gender differences in communion, such that women tend to be more communal than men (Costa et al., 2001; Schwartz & Rubel, 2005). The results of two meta-analyses have shown that compared to men, women report higher tender-mindedness (nurturance) and warmth, which are considered elements of communion (Costa et al., 2001; Feingold, 1994). Furthermore, when compared to men, women report universalistic and benevolent values, which are considered communal (Schwartz & Rubel, 2005). Although women tend to be higher in communion, both men and women tend to value communion and endorse communal goals (Diekmann et al., 2010; Fiske, 2010; Helgeson & Fritz, 1998).

Communal tasks are more appealing to women and less appealing to men (Horgan & Smith, 2006). In one study, men and women were recruited for a “social perception” and “judgment skills” study (Horgan & Smith, 2006). Participants were told they would be participating in and evaluating a task as part of the study. The task was framed as either a “helper” task (communal frame), a “hunter” task (agentic frame), or no information was given (neutral frame). Regardless of condition, participants then received identical instructions for completing the same exact task. Women’s performance was enhanced when the task was framed as communal compared to when it was framed as agentic or when no frame was given. Results also showed that men performed better when the task was framed as agentic compared to when it was framed as communal or when no frame was given. The results indicated that women viewed the

communal task as more compatible with their goals, and men viewed the agentic task as more compatible with their goals. Importantly, the results indicated that when people perceive a match between the task and their goals, performance on that task is facilitated. The current research intends to test if making the communal value of a chemistry task evident increases research motivation for a chemistry task (experiment 2).

### Project Overview

The current research addressed two questions: 1) is chemistry stereotyped as unlikely to facilitate communal goal affordance, especially compared to other fields such as psychology (experiment 1)? 2) When communal affordance is made salient for a chemistry research task, is motivation enhanced for all people, and especially for women (experiment 2)?

## EXPERIMENT 1

To understand if some science fields are stereotyped as less likely to facilitate communal goal affordance than others, the same science task was framed as either a chemistry or psychology task. A 3(task frame: chemistry vs. psychology vs. neutral) x 2 (gender: men vs. women) between subjects design was employed. Communal goal affordance served as the main dependent variable.

Hypothesis

A main effect of task frame was expected such that both men and women would report the highest communal goal affordance when the same task was framed as a psychology task compared to when framed as a chemistry task. The neutral task frame was expected to be equivalent to the chemistry frame, as people were likely to assume the task is a chemistry task when no information is given.

## EXPERIMENT 1 METHOD

Participants

Participants were 430 men and women (53% women) drawn from the general population using Amazon's Mechanical Turk program. A variety of ethnicities (66% white, 12.3% African American, 9% Asian, 7% Hispanic, .4% Native American, 5.3% other) and age groups (60.5% 18-24 years old, 21.5% 25-30 years old, 11.7% 31-40 years old, 3.9% 41-50 years old, 2.3% above 50 years old) were represented. All participants were at least 18 years old and from the United States. All participants self-identified as university students. All participants willingly signed up to participate in online studies with the Mechanical Turk program.

Procedure

Participants were recruited for an on-line study ostensibly intended to research how to best train undergraduate research assistants. After indicating informed consent, participants read about a professor (Dr. Lindeman) and a science laboratory. Participants then read that they would be reviewing an actual science task that is commonly completed in Dr. Lindeman's laboratory. Participants were informed that after reviewing the science task, they would provide their opinions and feelings about the task and laboratory. Participants then viewed a photo of a laboratory which was made to appear very scientific in nature. For example, the lab had a sink, several microscopes, a refrigerator, test tubes in view, and various scientific posters. Next, participants read the

instructions needed to complete the research task. The instructions were identical regardless of task frame condition. The research task used was a Protein Quantification Task, which is commonly used in introductory chemistry classes. In order to actually complete the research task, a person would take each unknown serum and pipette it from a test tube into a spectrometer cuvette, insert the cuvette into the spectrometer, and read the spectrometer output. A person would then plot the output on a pre-charted protein quantification curve, and record the correct value of the unknown in the appropriate place on the data collection sheet. Because experiment 1 was completed on-line, participants simply read instructions for how to complete the Protein Quantification Task. Next, participants completed survey measures of the dependent variables. Participants were then thanked, debriefed, and awarded \$.50 payment.

### Independent Variables

Gender. Gender served as a quasi-independent variable.

Task Frame. Task frame was manipulated via the description of laboratory, description of the professor, and the description of the science task. In the psychology frame condition, participants read the laboratory was in the psychology department, Dr. Lindeman was a psychology professor, and the research task was a psychology task. In the chemistry frame condition, participants read the laboratory was in the chemistry department, Dr. Lindeman was a chemistry professor, and the research task was a chemistry task. In the neutral condition no information was given about the type of task.

The manipulation was presented to participants three times; otherwise descriptions of the research task were identical.

### Exploratory Independent Variable

Personal Goal Endorsement. Personal goal endorsement served as a trait independent variable for exploratory analyses. Survey measures of personal goal endorsement were adapted from Diekmann et al. (2010). Participants rated how much they personally endorse different types of communal and agentic goals. Agentic goal items included “status”, “financial rewards”, and “self-promotion”. Communal goal items included “serving the community”, “caring for others” and “connection with others”. Items were evaluated on a 7 point (1= not at all to 7=extremely) Likert scale. The mean response to the communal goal endorsement items and agentic goal endorsement items was calculated. Higher scores indicated more personal goal endorsement.

### Dependent Variables

#### Manipulation Check

Participants completed survey items to ensure that they were paying attention to the study details and had received the manipulation. Participants responded to the items “What is the name of the research task you will be reviewing today?” and “What is the name of the primary investigator for the project you will be reviewing?” in an open response format. Participants also responded to the item “What department is the

primary investigator located in?” in a multiple choice format with six (physics, chemistry, biology, psychology, immunology, anthropology) options.

### Research Task Goal Affordances

Communal Goal Affordance of Task. Communal goal affordance was measured using a two item scale adapted from Diekmann et al. (2010). Items included, “How much do you believe this research task fulfills goals such as working with people, helping others, and serving the community?” and “How much do you believe a career that uses this type of research in general fulfills goals such as working with people, helping others, and serving the community?” Items were rated on a 7 point (1=*not at all* to 7=*extremely*) Likert scale.

Agentic Goal Affordance of Task. Agentic goal affordance was measured using a two item scale adapted from Diekmann et al. (2010). Items included, “How much do you believe that this research task fulfills goals such as power, achievement and seeking new experiences or excitement?” and “How much do you believe a career that uses this type of research in general fulfills goals such as power, achievement and seeking new experiences or excitement?” Items were rated on a 7 point (1=*not at all* to 7=*extremely*) Likert scale.



### Prospective Task Experience

Experience of Interest. Experience of interest was measured with three items adapted from Smith, Sansone and White (2007). Items included “I would describe this research task as very interesting.” and “I enjoyed doing this research task very much” and “I think this was a boring research task” (reverse coded). Items were rated on a 7 point (1= *strongly disagree* to 7=*strongly agree*) Likert scale.

Experience of Task Value. Experience of task value was measured with three items adapted from Smith, Sansone and White (2007). Items included “I think this research task is a valuable task” and “Doing this research task was a worthwhile way to spend my time” and “This was a useful research task”. Items were rated on a 7 point (1= *strongly disagree* to 7=*strongly agree*) Likert scale.

Future Motivation for Task. Survey measures of future motivation to participate in similar research tasks were adapted from Smith, Sansone and White (2007). Future motivation for research was measured with three items. Items included, “How willing would you be to complete a research task similar to the one described in the future?” and “How willing would you be to work in a laboratory like Dr. Lindeman’s in the future?” and “I would like to do this type of task in the future”. Items were rated on a 7 point (1= *not at all* to 7=*very willing*) Likert scale.

Belongingness in Science. A seven item survey measure of belongingness in science was adapted from Good, Rattan, and Dweck (2012). Example items included

“When I am in a scientific research setting I feel that I am a part of the science community” and “When I am in a scientific research setting I feel that I am accepted”. All items were rated on a 7 point (1= *strongly disagree* to 7=*strongly agree*) Likert scale.

Interest in Scientific Research. A six item survey measure of interest in scientific research was adapted from Linnenbrink-Garcia et al. (2010). Example items included, “Chemistry research fascinates me” and “To be honest, I just don’t find chemistry research interesting” (reverse coded). Items were rated on a 7 point (1= *strongly disagree* to 7=*strongly agree*) Likert scale.

## EXPERIMENT 1 RESULTS

Manipulation Check

Data were coded for manipulation check accuracy. Only 108 (25.3% of the original sample) participants passed the manipulation check. Of the remaining 108 participants, 26 participants were in the psychology condition, 41 were in the chemistry condition, and 42 were in the no information condition. Only data from participants who passed the manipulation check were submitted to analyses. Although manipulation of task frame failed, exploratory analyses of dependent variables were conducted.

Research Task Goal AffordancesCommunal Goal Affordance of Task

The mean response of the 2 items assessing the perceived communal goal affordance of the task was calculated and submitted to a 2 (men vs. women) x 3(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=1.95, p = .17, R^2 = .07$ . No main effect of task frame emerged,  $F(2, 102)=2.85, p = .06, R^2 = .07$ . No interaction between gender and task frame emerged,  $F(2, 102)=.01, p = .99, R^2 = .07$ . In total, communal goal affordance was not affected by the study manipulations, which given the failed manipulation check was not unexpected.

### Agentic Goal Affordance of Task

The mean response of the 2 items assessing the perceived agentic goal affordance of the task was calculated and submitted to 2 (men vs. women) x 3(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=1.87, p = .17, R^2= .09$ . No main effect of task frame emerged,  $F(2, 102)=3.05, p = .05, R^2= .09$ . No interaction between gender and task frame emerged,  $F(2, 102)=.32, p = .73, R^2= .09$ . Agentic goal affordance was not affected by the study manipulations.

### Prospective Task Experience

#### Experience of Interest

The mean response of the 3 items assessing experience of interest was calculated and submitted to a 2 (men vs. women) x 3(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=.75, p = .39, R^2= .03$ . No main effect of task frame emerged,  $F(2, 102)=.84, p = .43, R^2= .03$ . No interaction between gender and task frame emerged,  $F(2, 102)=.75, p = .47, R^2= .03$ . Experience of interest was not affected by the study manipulations.

#### Experience of Task Value

The mean response of the 3 items assessing task value was calculated and submitted to a 2(men vs. women) x 2(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=.10, p = .75, R^2= .05$ . No main effect of task frame emerged,  $F(2, 102)=1.50, p = .23, R^2= .05$ . No interaction

between gender and task frame emerged,  $F(2, 102)=1.54, p = .22, R^2= .05$ . Experience of task value was not affected by the study manipulations.

#### Future Motivation for Task

The mean response of the 3 items assessing future motivation for research was calculated and submitted to a 2 (men vs. women) x 3(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=.01, p = .93, R^2= .01$ . No main effect of task frame emerged,  $F(2, 102)=.17, p=.84, R^2= .01$ . No interaction between gender and task frame emerged,  $F(2, 102)=.64, p = .53, R^2= .01$ . Future motivation was not affected by the study manipulations.

#### Belongingness in Science

The mean response of the 7 items assessing belongingness in science was calculated and submitted to a 2 (men vs. women) x 3(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=.04, p = .85, R^2= .01$ . No main effect of task frame emerged,  $F(2, 102)=.02, p = .98, R^2= .01$ . No interaction between gender and task frame emerged,  $F(2, 102)=.52, p = .60, R^2= .01$ . Belongingness in science was not affected by the study manipulations.

#### Interest in Scientific Research

The mean response of the 6 items assessing interest in scientific research was calculated and submitted to a 2 (men vs. women) x 3(chemistry vs. psychology vs. no information) analysis of variance. No main effect of gender emerged,  $F(1, 102)=.00, p = .96, R^2= .01$ . No main effect of task frame emerged,  $F(2, 102)=.66, p = .52, R^2= .01$ . No

interaction between gender and task frame emerged,  $F(2, 102) = .17, p = .85, R^2 = .01$ .

Interest in scientific research was not affected by the study manipulations.

### Exploratory Analyses

#### Relationship among the Variables

As shown in Table 1, personal communal goal endorsement was significantly positively correlated with personal agentic goal endorsement,  $r(108) = .54, p = .00$ , and belongingness in science,  $r(108) = .28, p = .00$ . Also shown in Table 1, personal agentic goal endorsement was significantly positively correlated with belongingness in science,  $r(108) = .33, p = .00$ , and interest in scientific research,  $r(108) = .36, p = .00$ .

Furthermore, belongingness in science was significantly positively correlated with interest in scientific research,  $r(108) = .41, p = .00$ . Personal communal goal endorsement was not significantly correlated with interest in scientific research,  $r(108) = .17, p = .08$ .

Table 1. *Pearson Correlations among Personal Goal Endorsement and Measures of Science Experience*

	2	3	4
1. Communal Goal Endorsement	.54**	.28**	.17
2. Agentic Goal Endorsement		.33**	.36**
3. Belongingness in Science			.41**
4. Interest in Scientific Research			

Note: \*\* signifies  $p < .01$

### Overview of Regression Model

In order to better understand the data, exploratory multiple regression analyses were conducted. Gender, personal communal goal endorsement, personal agentic goal endorsement, and the interaction among them served as the predictor variables. Predictor variables were centered and then submitted to multiple regressions simultaneously.

### Belongingness in Science

Results of the regression indicated that the predictor variables explained 37.3% of the variance,  $F(7, 100) = 2.31, p < .05, R^2 = .37$ . As shown in Table 2, it was found that personal agentic goal endorsement positively predicted belongingness in science ( $\beta = .31, p < .05$ ). The more people personally endorsed agentic goals, the more belongingness in science they reported. Results also indicated that personal communal goal endorsement, gender, and their interactions did not significantly predict belongingness in science.

Table 2. *Predictors of Belongingness in Science.*

Predictor	B	SE(B)	$\beta$	t	Sig.(p)
Gender	-.04	.07	-.51	-.51	.62
Personal Communal Goal Endorsement	.10	.09	.17	1.15	.25
Personal Agentic Goal Endorsement	.20	.09	.31	2.23	.03*
Gender X Communal	-.01	.09	-.02	-.14	.89
Gender X Agentic	-.04	.09	-.52	-.38	.70
Communal X Agentic	.03	.04	.09	.76	.45
Gender X Communal X Agentic	.01	.04	.02	.18	.86

### Interest in Scientific Research

The results of the regression indicated that the predictor variables explained 13.9% of the variance,  $F(7, 100) = 3.46, p < .01, R^2 = .14$ . As shown in Table 3, an interaction between participant gender and personal agentic goal affordance significantly predicted interest in scientific research ( $\beta = .36, p < .01$ ). The interaction indicated that for women endorsement of personal agentic goals positively predicted interest in scientific research, whereas for men this relationship was not significant (see Table 3). Results also indicated that personal agentic goal endorsement alone, personal communal goal endorsement, gender, and all other interactions between predictors did not significantly predict belongingness in science.

Table 3. *Predictors of Interest in Scientific Research.*

Predictor	B	SE(B)	$\beta$	t	Sig.(p)
Gender	-.08	.13	-.06	-.64	.52
Personal Communal Goal Endorsement	.09	.16	.09	.61	.54
Personal Agentic Goal Endorsement	.30	.16	.24	1.85	.07
Gender X Communal	-.18	.16	-.17	-1.15	.25
Gender X Agentic	.43	.16	.35	2.67	.01*
Communal X Agentic	-.03	.07	-.05	-.38	.71
Gender X Communal X Agentic	.03	.07	.06	.49	.62



## EXPERIMENT 1 DISCUSSION

Based on analysis of the manipulation check, the manipulation of task frame was not effective. The use of a subtle manipulation likely made it difficult for on-line participants to take notice of what type of task they were reading about. Most participants had to be excluded because they did not pass the manipulation check. Due to the failed manipulation of task frame, the hypotheses of experiment 1 were not testable.

In order to better understand the data, exploratory analyses were conducted. Results indicated that personal endorsement of agentic goals predicted belongingness in science, and for women, agentic goal endorsement also positively predicted interest in scientific research. Not unexpectedly, science is more inviting and comfortable for those who personally endorse agentic goals (Abele, 2003)

## EXPERIMENT 2

Experiment 2 investigated how self-generating the communal and agentic value of a research task impacts people's research motivation. Issues encountered in experiment 1 were corrected in experiment 2. In experiment 2 a more obvious manipulation was employed. Additionally, experiment 2 was conducted in the laboratory rather than on-line to ensure that participants engaged with the material. The design employed was a 2(gender: men vs. women) x 2(communal value: self-generated vs. not self-generated) x 2(agentic value: self-generated vs. not self-generated) between subject design with research motivation serving as the primary dependent variable.

Hypotheses

## Main Effect of Communal Value

1. It was expected that people would report greater research motivation when communal value was self-generated compared to when communal value was not self-generated.

## Main effect of Agentic Value

1. It was expected that people would report greater research motivation when agentic value was self-generated compared to when agentic value was not self-generated.

## Interaction among Gender, Communal Value condition, and Agentic Value condition

1. If communal value was self-generated, women would report greater research motivation than men.

2. If agentic value was self-generated, men would report greater research motivation than women.
3. Both men and women would report the greatest research motivation when both the communal value and agentic value of the task was self-generated.
4. Both men and women would report the lowest research motivation when neither the communal value nor agentic value of the task was self-generated.

## EXPERIMENT 2 METHOD

### Participants

Participants were 105 undergraduate students (53.3% men, 88% White, 43.8% freshman, mean age=20.2 years) in science majors drawn from the Montana State University subject pool. Participants represented fifteen different science majors with the majority being from pre-medicine (18%). Participants received credit towards a course requirement as compensation for participating.

### Procedure

As in experiment 1, participants were recruited for a study ostensibly intended to research how to best train undergraduate research assistants. Participants were brought in the same laboratory depicted in experiment 1. Participants read a letter ostensibly from Dr. Lindeman briefly explaining his research. Next, participants were told that in an effort not to waste data, Dr. Lindeman planned to use the data collected for a project currently being conducted in his laboratory. Participants then signed a supposed consent form allowing their data to be used. Participants then received instructions for the chemistry task they would complete. The chemistry task used was the same Protein Quantification Task participants in experiment 1 read about. Participants then self-generated communal value, agentic value, or completed filler items according to their randomly conditions. Participants were then instructed to put on a lab coat, latex gloves, and safety glasses. They sat in front of a spectrometer with all of the materials they

needed in front of them clearly labeled according to the instructions. The materials in front of them were a pre-charted curve of protein quantifications, a data collection sheet, three unknowns, a pipette, a spectrometer cuvette, and a spectrometer. Participants then completed the research task independently according to the written instructions. In order to complete the research task, participants took each unknown serum (one at a time) and pipetted it into the spectrometer cuvette, inserted the cuvette into the spectrometer, read the spectrometer output, plotted the output on the pre-charted protein quantification curve, and wrote the correct value of the unknown in the appropriate place on the data collection sheet. Once finished with the research task, participants cleaned the area with a disinfecting wipe and disposed of any waste in the appropriate receptacle. Participants then completed survey measures of dependent variables in a counter balanced order.

### Independent Variables

Gender. Participant Gender served as the quasi-independent variable.

Communal Value Manipulation. Participants in the communal value self-generated condition were prompted to write down three probable communal goals of the research task. Specifically, participants were told, “Please write three ways this type of research could help people or serve your community. Of course, you would probably need more experience with the field to really appreciate its value, but for purposes of this writing assignment, please focus on how this type of research could ultimately be helpful to people such as your friends and family, members of your community, or people in general”. Participants generated items such as “help to find more effective drugs for

people with cancer or AIDS” and “could help prevent sickness/disease” and “this could help rid water of bacteria for drinking”. This manipulation was adapted from Harackiewicz, Durik, Barron, Linenbrink-Garcia, & Tauer (2008).

Agentic Value Manipulation. Participants in the agentic value self-generated condition were prompted to write down three probable agentic goals of the research task. Specifically participants were told, “please write three ways this type of research could be beneficial to you personally. Of course, you would probably need more experience with the field to really appreciate its value, but for purposes of this writing assignment, please focus on how this type of research could be beneficial to you or your future”. Participants generated items such as “research is a very reputable thing to mark on one's resume.” and “undergraduate research can be relatively lucrative, particularly during the summer”. This manipulation was also adapted from Harackiewicz et al. (2008).

Filler Measure. Participants who were in the communal value not self-generated or the agentic value not self-generated condition completed a filler measure. The filler measure prompted participants to either write down three things they noticed about the laboratory space or three steps they would take to complete the research task. Participants wrote items such as “I noticed how organized and clean the lab was” and “First, I'll pipet 2 ml of an unknown substance into the cuvettes”. Filler measures were counterbalanced across conditions.

## Dependent Variables

### Manipulation Check

Research Task Goal Affordances. Communal goal affordance for the research task and agentic goal affordance for the research task served to test the effectiveness of the manipulation. The same measures of research task goal affordances from experiment 1 were used in experiment 2. The communal and agentic value items participants self-generated also served as the manipulation check.

### Research Motivation

Survey measures of research motivation were adapted from Deemer, Martens, and Buboltz (2010). Research motivation was comprised of items measuring intrinsic motivation, extrinsic motivation, and failure avoidance motivation.

Intrinsic Motivation. Nine items measured intrinsic motivation. Example items included, “Conducting research provides me with feelings of satisfaction.” and “Research in and of itself is enjoyable to me.” Items were rated on a 7 point (1= *not at all* to 7=*very much*) Likert scale.

Extrinsic Motivation. Five items measured extrinsic motivation. Example items included, “I want to leave my mark on my field.” and “I want to receive awards for my scientific accomplishments.” Items were rated on a 7 point (1= *not at all* to 7=*very much*) Likert scale.

Failure Avoidance Motivation. Six items measured failure avoidance motivation. Example, items included, “I sometimes want to avoid difficult research projects because I’m concerned that I may fail.” and “I want to avoid difficult research projects that might result in a negative outcome.” Items were rated on a 7 point (1= *not at all* to 7=*very much*) Likert scale.

### Task Experience

For experiment 2, perception of task difficulty, future motivation for the research task, belongingness in science, and interest in scientific research comprised task experience. With the exception of task difficulty, the same items used to measure prospective task experience in experiment 1 were used to measure task experience in experiment 2.

Perception of Task Difficulty. Two items adapted from Smith et al. (2007) measured task difficulty. Items included, “I think this research was difficult to conduct.” and “I think this was a hard research task.” Items were rated on a 7 point (1= *not at all* to 7=*very much*) Likert scale.



## EXPERIMENT 2 RESULTS

Manipulation CheckCommunal Goal Affordance Task

The mean response to the 2 items assessing communal goal affordance was calculated and submitted to an independent samples t-test with communal value self-generated vs. communal value not self-generated serving as the groups. Participants who generated communal value of the task perceived the chemistry task as affording fewer communal goals ( $M = 4.24, SD = 1.4$ ) than participants who did not self-generate communal value of the chemistry task ( $M = 4.41, SD = 1.6$ ), but this difference was not significant,  $t(102) = -.62, p = .54$ . Most unexpectedly, these results show communal goal affordance was not affected by the study manipulations. The manipulation of communal value evidence was not effective.

Agentic Goal Affordance of Task

The mean response to the 2 items assessing agentic goal affordance was calculated and submitted to an independent samples t-test with agentic value self-generated vs. agentic value not self-generated serving as the groups. Participants who generated agentic value of the task perceived the chemistry task as affording fewer agentic goals ( $M = 4.29, SD = 1.31$ ) than participants who did not self-generate agentic value of the chemistry task ( $M = 4.58, SD = 1.41$ ), but this difference was not significant,  $t(102) = -1.13, p = .26$ . Most unexpectedly, agentic goal affordance of the research task

was also not affected by the study manipulations. Similar to the findings for communal value, the manipulation of agentic value was not effective.

### Secondary Analyses of Manipulation Check

In order to better understand the results of the manipulation check, data were coded for what types of items participants generated for communal and agentic value of the chemistry task. Only participants who correctly self-generated items according to their assigned condition were included in secondary analysis of the manipulation check.

### Coded Communal Goal Affordance of Task

The data from 76 participants who correctly self-generated communal items were submitted to secondary analysis of the manipulation check. Again, the mean response to the 2 items assessing communal goal affordance was calculated and submitted to an independent samples t-test with communal value self-generated vs. communal value not self-generated serving as the groups. Participants who generated communal value of the task perceived the chemistry task as affording fewer communal goals ( $M = 4.25$ ,  $SD = 1.47$ ) than participants who did not self-generate communal value of the chemistry task ( $M = 4.41$ ,  $SD = 1.6$ ), but this difference was not significant,  $t(74) = -.41$ ,  $p = .68$ . Again, communal goal affordance was not affected by the study manipulations. Results suggest that the manipulation of communal value evidence was not effective, even among those who correctly self-generated condition appropriate items.

### Coded Agentic Goal Affordance of Task

The data from the 75 participants who self-generated appropriate agentic items were submitted to secondary of the manipulation check. The mean response to the 2 items assessing agentic goal affordance was calculated and submitted to an independent samples t-test with agentic value self-generated vs. agentic value not self-generated serving as the groups. Participants who generated agentic value of the task perceived the chemistry task as affording fewer agentic goals ( $M = 4.19, SD = 1.42$ ) than participants who did not self-generate agentic value of the chemistry task ( $M = 4.58, SD = 1.41$ ), but this difference was not significant,  $t(73) = -1.01, p = .32$ . Agentic goal affordance of the research task was not affected by the study manipulations. Similar to communal value, results suggest that the manipulation of agentic value was not effective even among those who correctly self-generated condition appropriate items.

Complete analysis of the manipulation check indicated that the manipulation of communal and agentic value evidence was unsuccessful <sup>1</sup>. Exploratory analyses were conducted to better understand the data. In order to analyze the data, 2(gender: men vs. women) x 2(communal value: self-generated vs. not self-generated) x 2 (agentic value: self-generated vs. not self-generated) analysis of variances were conducted for each dependent variable. A follow up simple effects analysis was conducted on any significant results.

### Dependent Variables

The data from the original 105 participants were submitted to analyses based on assigned condition, rather than the data from participants coded for appropriate items because the patterns were the same regardless. Participants who did not answer items for certain dependent variables were excluded only from analyses of the variables to which they failed to respond. Although the manipulation check failed, exploratory analyses were conducted to better understand the data and to investigate possible reasons that the manipulation was unsuccessful.

### Research Motivation

Intrinsic Motivation. The mean response of the 9 items assessing intrinsic research motivation was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA. A main effect of communal goal condition emerged,  $F(1, 93) = 4.22, p = .04, R^2 = .18$ . As seen in Table 4, when communal value was self-generated people showed less intrinsic research motivation regardless of participant gender and agentic goal condition. An interaction between communal value condition and agentic value condition also emerged,  $F(1, 93) = 10.87, p = .001, R^2 = .18$ . As seen in Table 4, follow-up simple effect analysis showed that when both communal and agentic value were self-generated, intrinsic motivation was lowest compared to all other conditions, which were equal to each other. That is, generating both communal and agentic value resulted in significantly lower intrinsic research

motivation compared to when only communal value was self-generated, when only agentic value was self-generated, and when neither communal or agentic value was self-generated<sup>2</sup>. No main effect of gender emerged,  $F(1, 93) = .56, p = .46, R^2 = .18$ . No main effect of agentic value condition emerged,  $F(1, 93) = .78, p = .38, R^2 = .18$ . No interaction between gender and agentic value condition emerged,  $F(1, 93) = 10.87, p = .001, R^2 = .18$ . Additionally, no interaction between gender and communal value emerged,  $F(1, 93) = 2.09, p = .15, R^2 = .18$ . Similarly, no interaction among gender, communal value condition, and agentic value condition emerged,  $F(1, 93) = .03, p = .87, R^2 = .18$ .

Extrinsic Motivation. The mean response of the 5 items assessing extrinsic research motivation was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA. No main effect of gender emerged,  $F(1, 93) = .21, p = .64, R^2 = .07$ . No main effect of communal value condition emerged,  $F(1, 93) = .14, p = .71, R^2 = .07$ . No main effect of agentic value condition emerged,  $F(1, 93) = 1.5, p = .22, R^2 = .07$ . Further, no interaction between gender and communal value condition emerged,  $F(1, 93) = .09, p = .76, R^2 = .07$ . No interaction between gender and agentic value condition emerged,  $F(1, 93) = 1.1, p = .30, R^2 = .07$ . Also, no interaction between communal value condition with agentic value condition emerged,  $F(1, 93) = 1.7, p = .19, R^2 = .07$ . No interaction among gender, communal value condition, and agentic value condition emerged,  $F(1, 93) = 2.06, p = .16, R^2 = .07$ . Extrinsic motivation was not affected by the experiment manipulations.

Failure Avoidance Motivation. The mean response of the 6 items assessing motivation to avoid failure was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA. A main effect of gender emerged,  $F(1, 93) = 4.25, p = .04, R^2 = .1$ . As seen in Table 4, women showed more failure avoidance motivation than men regardless of communal value condition and agentic value condition. No main effect of communal value condition emerged,  $F(1, 93) = 1.33, p = .25, R^2 = .1$ . No main effect of agentic value condition emerged,  $F(1, 93) = 3.35, p = .07, R^2 = .1$ . No interaction between gender and communal value condition emerged,  $F(1, 93) = .03, p = .86, R^2 = .1$ . No interaction between gender and agentic value condition emerged,  $F(1, 93) = .09, p = .76, R^2 = .1$ . No interaction between communal value condition and agentic value condition emerged,  $F(1, 93) = .00, p = .98, R^2 = .1$ . No interaction among gender, communal value condition, and agentic value condition emerged,  $F(1, 93) = 1.29, p = .26, R^2 = .1$ .

### Task Experience

Perception of Task Difficulty. The mean response of the 2 items assessing perception of task difficulty was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA.

Table 4. *Descriptive Statistics for Research Motivation Dependent Measures as a Function of Communal Value Condition, Agentic Value Condition, and Gender*

<i>Agentic Value Condition and Gender</i>	Communal Value Condition	
	Self-generated <i>M (SE)</i>	Not Self-generated <i>M (SE)</i>
<b>Intrinsic Research Motivation</b>		
Women		
Agentic Value Self-generated	4.86 (1.30)	5.69 (1.01)
Agentic Value Not Self-generated	5.42 (1.13)	5.06 (1.14)
Men		
Agentic Value Self-generated	4.15 (1.15)	5.68 (.65)
Agentic Value Not Self-generated	5.27 (.95)	5.15 (1.46)
<b>Extrinsic Research Motivation</b>		
Women		
Agentic Value Self-generated	4.60 (1.58)	4.40 (1.27)
Agentic Value Not Self-generated	4.62 (1.24)	4.48 (1.09)
Men		
Agentic Value Self-generated	3.77 (1.33)	4.46 (1.07)
Agentic Value Not Self-generated	5.05 (.51)	4.34 (1.64)
<b>Failure Avoidance Motivation</b>		
Women		
Agentic Value Self-generated	3.38 (1.43)	2.90(1.34)
Agentic Value Not Self-generated	3.62 (.86)	3.65 (1.32)
Men		
Agentic Value Self-generated	2.76 (.91)	2.71 (1.02)
Agentic Value Not Self-generated	3.38 (1.43)	2.80 (.82)

No main effect of gender emerged,  $F(1, 92)=2.96, p = .09, R^2 = .06$ . No main effect of communal value condition emerged,  $F(1, 92)=.02, p=.90, R^2 = .06$ . No main effect of agentic value condition emerged,  $F(1, 92)=.01, p=.93, R^2 = .06$ . No interaction between gender and communal value condition emerged,  $F(1, 92)=.00, p = .98, R^2 = .06$ . No interaction between gender and agentic value condition emerged,  $F(1, 92)=.54, p = .46, R^2 = .06$ . No interaction between communal value condition and agentic value condition emerged,  $F(1, 92)=2.46, p = .12, R^2 = .06$ . No interaction among gender,

communal value condition, and agentic value condition emerged,  $F(1, 92) = .06, p = .81, R^2 = .06$ . Perception of task difficulty was not affected by the experiment manipulations.

Future Motivation for the Task. The mean response of the 3 items assessing future motivation for the research task was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA. An interaction between communal value condition and agentic value condition emerged,  $F(1, 95) = 4.61, p = .03, R^2 = .08$ . As seen in Table 5, follow-up simple effect analysis showed that when both communal and agentic value was self-generated, future motivation for the research task was significantly lower than all other conditions, which were equal to each other. Self-generating both communal and agentic value resulted in significantly lower future motivation compared to when only communal value was self-generated, when only agentic value was self-generated, and when neither communal or agentic value was self-generated. No main effect of gender emerged,  $F(1, 95) = 1.17, p = .28, R^2 = .08$ . No main effect of communal value condition emerged,  $F(1, 95) = .94, p = .34, R^2 = .08$ . No main effect of agentic value condition emerged,  $F(1, 95) = .72, p = .4, R^2 = .08$ . No interaction between gender and communal value condition emerged,  $F(1, 95) = .03, p = .86, R^2 = .08$ . No interaction between gender and agentic value condition emerged,  $F(1, 95) = .05, p = .82, R^2 = .08$ . No interaction among gender, communal value condition, and agentic value condition emerged,  $F(1, 95) = .48, p = .49, R^2 = .08$ .



Belongingness in Science. The mean response of the 8 items assessing belongingness in science was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA. An interaction between communal value condition and agentic value condition emerged,  $F(1, 91) = 4.28, p = .04, R^2 = .12$ . As seen in Table 5, follow-up simple effect analysis showed that when both communal and agentic value were self-generated, reported belongingness in science was the lower than all other conditions, which were equal. Generating both communal and agentic value resulted in reporting significantly less belongingness in science compared to when only communal value was generated, when only agentic value was generated, and when neither communal nor agentic value was self-generated. No main effect of gender emerged,  $F(1, 91) = .37, p = .54, R^2 = .12$ . No main effect of communal value condition emerged,  $F(1, 91) = 3.55, p = .06, R^2 = .12$ . No main effect of agentic value condition emerged,  $F(1, 91) = .02, p = .9, R^2 = .12$ . No interaction between gender and communal value condition emerged,  $F(1, 91) = .71, p = .41, R^2 = .12$ . No interaction between gender and agentic value condition emerged,  $F(1, 91) = 2.55, p = .11, R^2 = .12$ . No interaction among gender, communal value condition, and agentic value condition emerged,  $F(1, 91) = .24, p = .62, R^2 = .12$ .

Interest in Scientific Research. The mean response of the 6 items assessing interest in scientific research was calculated and submitted to a 2 (men vs. women) x 2 (communal value self-generated vs. communal value not self-generated) x 2 (agentic value self-generated vs. agentic value not self-generated) ANOVA. An interaction

between communal value condition and agentic value condition emerged,  $F(1, 93) = 4.69, p = .03, R^2 = .10$ . As seen in Table 5, follow-up simple effect analysis showed that when both communal and agentic value were self-generated, interest in scientific research was the lowest. That is, generating both communal and agentic value resulted in a significantly less interest in scientific research compared to when only communal value was generated, when only agentic value was generated, and when neither communal nor agentic value was self-generated. No main effect of gender emerged,  $F(1, 93) = .43, p = .51, R^2 = .10$ . No main effect of communal value condition emerged,  $F(1, 93) = 3.14, p = .08, R^2 = .10$ . No main effect of agentic value condition emerged,  $F(1, 93) = .33, p = .57, R^2 = .10$ . No interaction between gender and communal value condition emerged,  $F(1, 93) = .00, p = .99, R^2 = .10$ . No interaction between gender and agentic value condition emerged,  $F(1, 93) = .69, p = .41, R^2 = .10$ . No interaction among gender, communal value condition, and agentic value condition emerged,  $F(1, 93) = .12, p = .73, R^2 = .1$ .

Table 5. *Descriptive Statistics for Task Experience Dependent Measures as a Function of Communal Value Condition, Agentic Value Condition, and Gender*

<i>Agentic Value Condition and Gender</i>	Communal Value Condition	
	Self-generated <i>M (SE)</i>	Not Self-generated <i>M (SE)</i>
<b>Task experience</b>		
Perception of Task Difficulty		
Women		
Agentic Value Self-generated	4.66 (2.19)	4.0 (2.45)
Agentic Value Not Self-generated	3.64 (1.43)	4.38 (2.02)
Men		
Agentic Value Self-generated	3.6 (1.76)	3.14 (1.79)
Agentic Value Not Self-generated	3.33 (1.43)	3.92 (2.31)
Future Motivation for the Task		
Women		
Agentic Value Self-generated	4.46 (.96)	5.45 (1.1)
Agentic Value Not Self-generated	4.94 (1.45)	4.39 (1.25)
Men		
Agentic Value Self-generated	4.24 (1.40)	4.96 (1.68)
Agentic Value Not Self-generated	4.47 (1.24)	4.39 (1.70)
Belongingness in Science		
Women		
Agentic Value Self-generated	5.10 (.61)	5.62 (.80)
Agentic Value Not Self-generated	5.07 (1.23)	4.96 (.93)
Men		
Agentic Value Self-generated	4.63 (1.34)	5.69 (.72)
Agentic Value Not Self-generated	5.44 (.90)	5.47 (1.03)
Interest in Scientific Research		
Women		
Agentic Value Self-generated	5.47 (.63)	6.21 (.85)
Agentic Value Not Self-generated	5.56 (.87)	5.56 (.87)
Men		
Agentic Value Self-generated	5.1 (1.02)	5.98 (.90)
Agentic Value Not Self-generated	5.67 (1.04)	5.51 (1.72)

## EXPERIMENT 2 DISCUSSION

The manipulations employed in Experiment 2 were not effective. Self-generating the communal value of the research task did not influence participants' ratings of communal affordances of the task. Self-generating the agentic value of the research task did not influence participant ratings of agentic affordances of the task. It was intended that participants who self-generated the communal value of the task would perceive the task as affording more communal goals. Based on the results of the manipulation check, the study hypotheses could not be evaluated. Exploratory analyses did yield some interesting results. Based on exploratory results, the manipulation influenced impressions of the task, but not in the intended direction. Because the manipulation check indicated that communal and agentic affordances of the task were not influenced by study manipulations, we consider an alternative explanation for the current results.

A main effect of communal value was expected, such that people would report greater research motivation when communal value was self-generated compared to when communal value was not self-generated (hypothesis 1). However results yielded a main effect in the opposite direction for intrinsic research motivation such that participants who self-generated communal value reported less intrinsic motivation than participants who did not self-generate communal value. There was no significant main effect of self-generating communal value condition on extrinsic research motivation or failure avoidance. In total, the predicted effect of communal value on research motivation was not present. A main effect of communal value was also expected, such that people would report a more positive task experience when communal value was self-generated

compared to when communal value was not self-generated. Specifically, it was predicted that people would report more future motivation for related tasks, more belongingness in science, and more interest in scientific research. Significant main effects were not present for the variables measuring task experience. These results suggest that self-generating communal value did not increase research motivation or task experience. It is possible that self-generating communal value of the research task actually activated communal goals rather than made the communal value more obvious. As past research has shown, activating communal goals inhibits interest and motivation for STEM fields (Diekman et al., 2011). This is one plausible explanation for why a main effect of communal value did not emerge.

A main effect of agentic value was expected, such that people would report greater research motivation when agentic value was self-generated compared to when agentic value was not self-generated (hypothesis 2). However, there was no effect of agentic value on intrinsic or extrinsic motivation for the research task. Results did show that when the agentic value of the task was self-generated, people reported greater failure avoidance motivation than when agentic value was not self-generated. Because avoidance goals are associated with less intrinsic motivation and less positive experiences (Elliot & Murayama, 2008), we interpret this result as opposing our predictions as it was predicted that self-generating agentic value would positively influence research motivation. A main effect of agentic value was also predicted such that people would report a more positive task experience when agentic value was self-generated compared to when agentic value was not self-generated. However results indicated that the

predicted main effect of agentic value was not present for any of the variables measuring task experience. In total, the predicted effect of agentic value on research motivation and task experience was not present.

It was also predicted that an interaction among gender, communal value condition, and agentic value condition would emerge (hypothesis 3). Results indicated that the predicted interaction was not present for any of the variables measuring research motivation. It was also predicted that a similar interaction among gender, communal value condition, and agentic value condition would emerge for task experience; however results indicated that the predicted interaction was not present for any of the variables measuring task experience. These results can be taken to suggest that the interaction between gender and communal value and agentic value did not affect research motivation or task experience.

Results indicated that gender influenced failure avoidance motivation. Namely, women reported more failure avoidance motivation than men regardless of communal value or agentic value condition. This suggests that in a chemistry research setting women were more motivated to avoid failure than their male counter-parts. Failure avoidance is associated with less positive experience and less intrinsic motivation (Elliot & Murayama, 2008). Past research has indicated that women self-generate more avoidance goals when working on a task in a stereotyped domain (computer science) (Smith et al., 2007). Like chemistry, computer science is stereotyped as a masculine domain, which undermines women's interest and motivation (Smith et al., 2007).

An interaction between communal value and agentic value emerged for intrinsic research motivation, such that people reported the lowest intrinsic research motivation when both communal value and agentic value was self-generated. Additionally people reported the lowest future motivation for similar tasks when communal value and agentic value was self-generated. Likewise, reported belongingness in science was lowest when both communal value and agentic value was self-generated. Results also indicated that people reported less interest in scientific research when both the communal value and agentic value of the research task was self-generated. One possible interpretation of the given results is that generating both communal and agentic goals is harmful, such that people report less intrinsic research motivation and a less positive task experience when generating both types of values. Although this explanation is possible, it is unlikely given past research has shown that making the communal value and agentic value of a field evident is helpful (Diekmann et al., 2010).

The type of value participants' self-generated in the current research was unique. In past research, participants have not self-generated the communal or agentic value of a field or research task. The current project drew from past research indicating that self-generating the utility value of a field was an effective way to increase interest in and motivation for that field (Hulleman, Godes, Hendricks, & Harackiewicz, 2010). Specifically, the current manipulation was developed from a study where participants self-generated ways a novel math task was useful to them personally (Hulleman et al., 2010). Past research on the importance of communal value or agentic value has provided participants with the value (Diekmann et al., 2011), rather than guided them to come up

with it on their own as in this project. Furthermore, this research project required participants to self-generate communal value and agentic value of chemistry task with which the participants were unfamiliar; resulting in what is likely a difficult task. Perhaps participants struggled to self-generate the communal value and agentic value of the research task, and they used this struggle as a cue that the research task did not have communal value or agentic value. This explanation accounts for why people who self-generated both communal and agentic value reported lower intrinsic research motivation and less positive task experience compared to people whom neither communal value nor agentic value was self-generated or only one type of value was self-generated. Along these lines, past research has shown that people use ease of retrieval to evaluate people (Wilson, Kraft, & Dunn, 1989) and tasks (Song & Schwarz, 2008). For example, in one study participants who self-generated more reasons they were in their current romantic relationship, reported less positive attitudes towards their partners (Wilson et al., 1989). Researchers interpreted the results as evidence that people use ease of retrieval as a cue to introspection. Similarly, one study found that participants who listed six reasons they were assertive rated themselves as more assertive than participants who listed twelve reasons they were assertive (Schwarz et al., 1991). Thinking of twelve reasons was more difficult than thinking of six reasons, therefore participants rated themselves as less assertive. This is a possible reason the current results show that people who generated both agentic and communal values reported less research motivation and a less positive task experience when compared to all other conditions.



## GENERAL DISCUSSION

Past research has suggested that chemistry is perceived as unlikely to afford communal goals, which are especially important to women (Diekmann et al., 2010). The current project aimed to extend the literature by investigating if some science fields are stereotyped as less likely to afford communal goals than others. Additionally, the current study aimed to test if self-generating communal and agentic value of a science task would result in increased research motivation and a more positive experience for all people, and especially women. However, study manipulations did not have the intended effect and the hypotheses could not be tested.

Experiment 2 analyses did highlight a potential concern that should be addressed when employing interventions that include self-generating values or goals. Although it is unclear what instructions to self-generate communal and agentic value created, there is some suggestion that the process was associated with lower research motivation and a less positive task experience. This result was unexpected given past research has shown self-generating value of a field is helpful (e.g. Harackiewicz et al., 2008). Unintended consequences such as the ones described in the current research should be considered when developing interventions.

Although the current study designs failed to address the intended questions, the current research did employ a science research task that may be used in future research to better understand how to make science a positive environment for all people. Indeed, the task used in Experiment 2 was interesting and valuable. Specifically, participants rated the task as more interesting than the midpoint of the scale,  $t(105) = 2.38, p = .02$ , and

more valuable than the midpoint of the scale,  $t(104) = 4.55, p = .00$ . Although the intended hypotheses were not testable using the current design, the task developed in this research may contribute to future research.

The current study did not bridge the intended gaps in the literature, yet the topic at hand is an important one. Increasing the representation of women in chemistry is important as there are many known benefits of diversity. For example, diversity is associated with positive organization functioning and increased economic functioning (Herring, 2009). Research also suggests people exposed to greater diversity demonstrate increased critical thinking, greater open-mindedness, and higher levels of intellectual engagement than those exposed to less diversity (Wildes, 2000). Further, diverse small groups produce better quality ideas than groups lacking diversity, indicating that diversity provides groups with a competitive advantage (McLeod et al., 1996). Increased diversity also fosters divergent thinking, which is associated with decisions and performance of higher quality (Nemeth, 1995). Some other research does show that diverse groups might have initial interpersonal difficulties as they work through differences (McLeod et al., 1996). For example, some research indicates that people working in diverse groups indicate more negative affective reactions to their group than individuals working in less diverse small groups (McLeod et al., 1996). Although increasing diversity is not without blemishes, overall the positive effects are beneficial in the United States (Herring, 2009; Howard, & Brakefield, 2001; McLeod et al., 1996; Nemeth, 1995; Wildes, 2000) and globally (Vries & Pettigrew, 1998; Zhang & Hou, 2012).

### Limitations

Limitations of the current research are numerous. Experiment 1 was conducted with an on-line participant pool and overall participants did not carefully review the study material. Although there are obvious benefits to employing on-line participant collection techniques (e.g., efficient data collection, allows for national sampling), in the present study it was not effective. The subtle manipulation employed in experiment 1 was not effective. Experiment 1 hypotheses could not be evaluated using the given design.

In experiment 2 the manipulation of communal and agentic value was not effective. Results of the manipulation check indicated that participants did not see the chemistry task as affording more communal goals after self-generating the communal value of the task. Furthermore, participants did not see the task as affording more agentic goals after self-generating the agentic value of the task. The manipulation was shown to be unsuccessful even when participants who generated inappropriate items were excluded. One possible reason the current manipulation of communal and agentic value failed is that participants were not familiar with the chemistry task, and therefore self-generating the communal and agentic nature of the task was difficult. Because study manipulations were not effective, all analyses were exploratory and must be interpreted with extreme caution. In total, the current hypotheses cannot be effectively evaluated given the failure of the present study design.

### Future Directions

In order to better understand the hypotheses, experiment 1 is currently being rerun in a laboratory setting where it is possible to control for outside influences. Study manipulations will be more salient in a laboratory setting, which is important given the subtle manipulation employed. The same materials will be used as were used in experiment 1; however they will not be presented on the computer. If the results of the laboratory version of study one indicate that some science fields are stereotyped as less likely to afford communal goals, future research should address what factors are perpetuating such stereotypes. For example, future research should investigate how experts, such as professors, in science fields might suggest science does not afford communal goals. Furthermore, research might investigate how the image of chemistry can be adapted to highlight the communal potential within this field.

Future research is needed in order to better understand the hypotheses of experiment 2. Although the manipulation used was derived from past research, it proved to be ineffective in the present design. Future research might work to understand why this manipulation was not effective. Self-generating values of a field has been used as a successful intervention in past research (Hulleman & Harackiewicz, 2009), which suggests that there is something uniquely problematic with the current study design. Although the design of the present study was flawed, this project addresses important questions that when answered can inform future research and possible interventions. It is possible that this study design failed because the setting and task was contrived, rather than natural. Although great measures were taken to avoid the problem of artificiality, it

is plausible that this served as a problem in the current design. In a classroom setting, participants might be more familiar with the value of chemistry research, and therefore self-generating the communal and agentic value of the research may be easier.

Exploratory analyses of the present research indicated that difficulty in self-generation might deter motivation for the research task therefore such research designs should be employed with caution.

In order answer the research questions from experiment 2 future research might provide participants with the communal and agentic value of the chemistry task, and then measure research motivation to understand the impact of these types of values. Perhaps the current research skipped this logical step when adopting the present design. Some past research has indicated that providing participants with the communal value of a field increases motivation and interest in that science field, especially for women (Diekman et al., 2011). Therefore, future research might provide participants with the communal and agentic value of the research task in order to effectively test the impact these values have on research motivation and task experience. Although the present research alone is unable to answer the research questions brought forth, they are important and should be addressed. By understanding how the perceptions of science influence who pursues these fields we can better understand how to make science a more welcoming environment to all people.

## NOTES

1. A chi-square test was performed to test for a gender difference in correctly self-generating communal and agentic items. No relationship between gender and correctly generating communal items emerged,  $\chi^2(1, N = 57) = .74, p = .28$ . No relationship between gender and correctly generated agentic items emerged,  $\chi^2(1, N = 56) = 2.55, p = .09$ .
2. The pattern of results was the same when participants who self-generated both communal and agentic value were excluded.

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