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From Bench to Bedside: A communal utility value intervention to enhance students' biomedical science motivation

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Abstract

Motivating students to pursue science careers is a top priority among many science educators. We add to the growing literature by examining the impact of a utility value intervention to enhance student's perceptions that biomedical science affords important utility work values. Using an expectancy-value perspective we identify and test two types of utility value: communal (other-oriented) and agentic (self-oriented). The culture of science is replete with examples emphasizing high levels of agentic value, but communal values are often (stereotyped as) absent from science. However, people in general want an occupation that has communal utility. We predicted and found that an intervention emphasizing the communal utility value of biomedical research increased students' motivation for biomedical science (Studies 1–3). We refined whether different types of communal utility value (working with, helping, and forming relationships with others) might be more or less important, demonstrating that helping others was an especially important predictor of student motivation (Study 2). Adding agentic utility value to biomedical research did not further increase student motivation (Study 3). Furthermore, the communal value intervention indirectly impacted students' motivation because students believed that biomedical research was communal and thus subsequently more important (Studies 1–3). This is key, because enhancing student communal value beliefs about biomedical research (Studies 1–3) and science (Study 4) was associated both with momentary increases in motivation in experimental settings (Studies 1–3) and increased motivation over time among students highly identified with biomedicine (Study 4). We discuss recommendations for science educators, practitioners, and faculty mentors who want to broaden participation in science.

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Keywords

STEM education; motivation; utility value; communion; psychological intervention

The United States needs more scientists, especially scientific researchers (National Science Board, 2008). From the White House, to granting agencies, to the U.S. Department of Education there remains a commitment to initiatives aimed at improving science education and increasing participation and interest in science fields (e.g., U.S. Department of Education, 2014). Students, at all levels of education, often have a hard time seeing value in what they are learning (Brophy, 1999); however one way to enhance student interest in science is by coaching students to find value or meaning in what they are learning (e.g., Atkinson, 1957; Eccles & Wigfield, 2002; Hidi & Harackiewicz, 2000; Hidi & Renninger, 2006; Husman & Lens, 1999; Malka & Covington, 2005; Wigfield & Eccles, 2002). For example, high school and college students who engage in guided activities that help them find their own value in science fields (e.g., writing about how consuming healthy food increases the body's ability to produce energy needed to pursue one's passions, such as hiking for long distances) demonstrate greater subsequent mathematical and science motivation than those who did not do the guided task (e.g., Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Hulleman & Harackiewicz, 2009). Such values interventions are gaining traction in educational and social psychology as researchers aim to close achievement gaps, increase sense of belonging, and increase student motivation for science, technology, engineering, and math (STEM) domains (e.g., Cook, Purdie-Vaughns, Garcia, & Cohen, 2012; Harackiewicz et al., 2013; Walton, 2014). Although activities with scaffolded opportunities for student-generated values are important to enhancing science motivation, it is important to explore opportunities which do not place the burden on the student to generate value. We focus here on biomedical science research in particular because of its importance in helping win the fight against ailments such as heart disease, cancer, influenza, and HIV/AIDS. Because biomedical science integrates bench science with medicine to address and resolve health and disease-related research questions, healthcare is dependent on the innovation of biomedical fields (e.g., National Institutes of Health, 1999). One way to increase innovation, and thus develop more healthcare breakthroughs, is to encourage more people to pursue biomedicine. In this research, we test whether incorporating important values into biomedical research can enhance students' positivity toward biomedical science and increase students' motivation for biomedical science. We focus on two core types of utility values (communal – helping others and agency – helping the self) to determine if one or both might best contribute to student's motivation. Toward this end, we review research on values, discuss why we focus on communal and agentic utility value, and test a values intervention in which beliefs that biomedicine has communal utility value (above and beyond agentic value) should contribute to student's increased motivation for biomedical science.

Expectancy-Value Theory: An Emphasis on Utility Value

Expectancy-value theory is a multiplicative function that identifies both expectations for success in combination with personal valuation of the domain as key predictors of

motivation (e.g., Eccles & Wigfield, 1995). Both expectancies and values are assumed to be positively related (e.g. Eccles & Wigfield, 2002), and as such, career and educational choices are dependent on whether or not people believe 1) they will do well in the field (expectancy) and 2) the field is valuable (value). Expectancies and values are part of a larger network of processes in that they are developed and shaped, in part, by life experiences including, but not limited to, feedback from socializing agents (including parents, teachers, and peers), experiences in the educational setting (which include observations of aptitudes for particular subjects), and observations of norms within society (including the distribution of similar others into particular roles/occupations) (e.g., Eccles, Barber, & Jozefowicz, 1999).

Although the theory has been around for decades, expectancy-value scholars (Eccles et al., 1983; Eccles, 2009) have largely focused more on the "expectancy" component (e.g., Eccles & Wigfield, 1995; Meece, Wigfield, & Eccles, 1990; Wigfield & Eccles, 1994), leaving room for theoretical growth in understanding the influence of values on student motivation. Indeed, because individuals are more or less likely to select a domain or task depending on the qualities (or values) of the domain or task (Eccles, 2009), research derived from many different theoretical perspectives has demonstrated that when a task is perceived as having "value" an individual should and does experience enhanced motivation. From classic theory of reasoned action research (Ajzen & Fishbein, 1980; Fishbein & Azjen, 1975), to the interest development literature (e.g., Durik & Harackiewicz, 2007; Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008), and the perceived instrumentality literature (e.g., Creten, Lens, & Simons, 2001; Miller, DeBacker, & Greene, 1999; Simons, Vansteenkiste, Lens, & Lancante, 2004) the convergent theme is that "values matter" for capturing and holding student motivation. Eccles' and colleagues' (1983; 2005; 2009) expectancy-value model of student motivation indicates: 1) values are situationally-based (Eccles & Wigfield, 1995) and thus amenable to intervention; and 2) different types of values help motivate students (i.e., attainment value, intrinsic value, utility value, and perceived cost; Eccles, 2005).

Because the research on the direct influence of values on student motivation suggests utility value is key for high school and college student populations (Wigfield, 1994), the current research examines utility value, which is the extent to which a domain or task is perceived as providing an opportunity to attain a long- or a short-term goal (i.e., helping other people). For example, in one study undergraduate students were randomly assigned to either write about the personal or general relevance of a new mathematical technique (i.e., how using this mathematical technique helps students solve two-digit multiplication problems) or a control task (i.e., writing about the objects seen in pictures). Students then used the mathematical technique they read about and rated their interest in using it in the future. Undergraduate students, especially those who were low on mathematical performance expectations at the start of the study, who wrote about the utility value of the mathematical technique expressed more interest in using the mathematical technique in the future and performed better on the mathematical task than students in the control condition (Hulleman et al., 2010). Likewise, when high school students participated in a guided activity that helped them connect the material that they were learning in a science class to their own lives (value intervention), as compared with writing about what they learned in science class

(control), they expressed more interest in science and received better science grades particularly if they began the class with low performance expectations (Hulleman & Harackiewicz, 2009).

Whether and how a domain or activity is relevant to a person's life is the basis of utility value. The presence or absence of such utility is important for motivation (e.g., Hulleman et al., 2010). In the few studies that have examined how utility value predicts motivation, tasks are described as having higher or lower utility value (e.g., Eccles, Barber, & Jozefowicz, 1999; Hulleman, Durik, Schweigert, & Harackiewicz, 2008) which is an important first step. More recently, scholars have investigated different types of utility. For example, Harackiewicz, Rosek, Hulleman, and Hyde (2012) found informing parents about a range of utility values of science (how math and science was relevant to everyday activities such as video games, driving, cell phone use, socializing with friends, shopping, housing-related choices, managing finances, recreational sports, medicine, biotechnology, clean water, and recycling) increased the science motivation of their high school sons and daughters. This was among the first utility value interventions to demonstrate that multiple utilities impact high school students' motivation (via their parents). Given the nature of the intervention, however, it was unclear which type of utility might be most influential, or if all types of utility value were necessary.

In looking at the types of utility emphasized in the intervention by Harackiewicz et al., it becomes clear that utility values can take on many forms, including other-focused (i.e., medicine and socializing) and self-focused (i.e., video games, cell phone use) (for similar distinctions see also Diekman, Brown, Johnston, & Clark, 2010; 2011; Dunteman, Wisenbaker, & Taylor, 1979; Eccles, Barber, & Jozefowicz, 1999; Smith, Brown, Thoman, & Deemer, in press; Su, Rounds, & Armstrong, 2009). An "other-focused" value is referred to as a "communal value" and is the extent that a domain or activity is perceived as involving working with others, helping others, and allowing for forming lasting bonds with others (Pohlmann, 2001). This concept of communion, and other related constructs such as warmth (e.g., Fiske, Cuddy, Glick, & Xu, 2002) and relatedness (e.g., Ryan & Deci, 2000), is said to stem from the universal human need to affiliate and belong to social groups (Baumeister & Leary, 1995; Deci & Ryan, 1987; Hill, 1987). A "self-focused" value is referred to as an "agentic value" and is the extent that a domain or activity is perceived as allowing for new experiences, involving power, and involving achievement (Pohlmann, 2001). This concept of agency, and other related constructs such as autonomy (e.g., Ryan & Deci, 2000) and competence (e.g., Fiske et al., 2002; Ryan & Deci, 2000), is said to stem from the universal human need for independence and achievement (Atkinson, 1958; Deci & Ryan, 1987; Markus & Conner, 2013; Maslow, 1954; Phillips & Gully, 1997). Agency and communion are independent utility values, and perceptions of these utility values toward a given educational activity may vary. For example, a person may see an activity as high on both utility values, high on one utility value and low on the other utility value, or low on both types of utility value. Further, even for the same activity, perceptions of communal and agentic utility value can change over time. Importantly, both communal and agentic utility values are malleable in school-aged populations (middle school, high school, and college) and thus amenable to intervention (e.g., Colvin, Lyden, & Leon de la Barra, 2013; Diekman, Clark, Johnston, Brown, & Steinberg, 2011).

The perceived uncommunal nature of science

Science educators and practitioners often recommend emphasizing the agentic aspects of science, such as self-directed laboratory experiences, to increase student science motivation in school-aged populations (Gunstone, 1991; Lunetta & Tamir, 1979; National Research Council, 1996). Likewise, interviews and anecdotal reports from scientists indicate that many successful scientists are motivated by agentic aspects of science such as curiosity, intrinsic motivation, and the thrill of discovery (Gibbs & Griffin, 2013; Hargittai, 2011; McGee & Keller, 2007). As a cause or consequence, the field of science is often perceived as relatively high in agentic utility value (Diekman et al., 2010; Smith, Cech, Metz, Huntoon, & Moyer, 2014; Smith, Deemer, Thoman, & Zazworsky, 2014). Coupling this with the unsocial stereotypes about scientists (e.g., Boswell, 1979; Finson, 2002) translates to students rating physical and mathematical sciences as providing few opportunities to work with and help others (Morgan, Isaac, & Sansone, 2001), and it is no surprise that science is assumed to be relatively high in agentic utility value and relatively low in communal utility value (Diekman et al., 2010; Diekman et al, 2011; Morgan et al., 2001; Smith et al., in press; Weisgram, Bigler, & Liben, 2010). As such, we predict that communal utility, a value that is just as important as agency to the human condition, might be a promising ingredient to add to science. Science is communal, albeit sometimes indirectly, and intervening to enhance the communal utility value of science might serve to positively influence student attitudes, motivation, and perceptions of the importance of science. We test this hypothesis using biomedical science as the context in the studies that follow. Because agency plays a central role in the scientific culture, we also examine the additive effect of incorporating communal and agentic utility value into biomedical research and compare motivational effects of agency and communal utility value interventions.

Our prediction that enhancing communal utility value will increase student motivation for biomedical science comes from research that shows the reverse: the perception that science is *un*communal decreases students' science motivation (Eccles et al., 1999; Lips, 1992; Weisgram & Bigler, 2006; Weisgram & Diekman, 2013). For instance, college students who believe that scientists are unsociable express less desire to pursue science fields (Lips, 1992), and adolescent boys and girls who believe that science does not help others express less interest in pursuing a science occupation (Weisgram & Bigler, 2006; Weisgram & Diekman, 2013). But let us be clear: science is a field that often has high impact and translational benefits to society and involves collaborations and teamwork (Waldman & Terzic, 2010; Woolf, 2008). In this way, science as a domain has received (however intentionally or not) a potentially harmful reputation as low in communal utility value (e.g., Diekman et al., 2010).

To the extent that scientific research is viewed as uncommunal, intervening to help students, in this case undergraduate students, see the communal utility value inherent within scientific research should result in students believing that science has communal value, which should be positively related to the perceived importance of science and subsequently students' motivation for science. That is, our intervention should affect positivity and motivation by increasing communal utility value beliefs and subsequently increasing the perceived importance of biomedical research. This novel prediction is akin to research on the

integration of stories into science (e.g., Eshach, 2009; Haven, 2007; McKinney & Michalovic, 2004). In a review of over 350 studies across various fields, findings demonstrated that stories shape students' beliefs about an academic field's values and increase students' motivation to pursue a field (Haven, 2007). Indeed, experimental evidence suggests that reading about a day in a scientist's life involving working with others (e.g., mentoring and team meetings), as opposed to alone, enhanced undergraduate students' beliefs that science had communal utility value, which in turn increased science positivity (Diekman et al., 2011; see also Colvin et al., 2013).

Exploring possible group differences in response to the communal utility value intervention

It is possible that perceptions about the communal utility value of biomedical science (or lack thereof) may be one reason that certain groups are less drawn to science fields. Communion as a trait, for example, is especially high in women and ethnic minorities (e.g., Latinos, African Americans, Native Americans) (Harper, 2005; Horgan & Smith, 2006; Fryberg & Markus, 2007; Markus & Conner, 2013; Torres, 2009) and likely partly contributes to why individuals from underrepresented groups express less interest in science (Diekman et al., 2010; Smith et al., 2014; Thoman, Brown, Mason, Harmsen, & Smith, 2015). Case in point, undergraduate women, versus men, who highly endorse communal values as a trait, express less interest in pursuing STEM careers (Diekman et al., 2010). These effects also emerge for racial minority groups with Native American undergraduate science majors who highly endorse communal values experiencing belonging uncertainty and expressing lower science persistence intentions over time (Smith et al., 2014).

However, alternate evidence suggests that communal values are important motivators for everyone, regardless of group membership (Diekman et al., 2011; Isaac, Sansone, & Smith, 1999; Morgan et al., 2001; Smith, Morgan, & Sansone, 2001). For instance, Diekman and colleagues (2011) experimentally manipulated communal values such that undergraduate college students were either prompted to think about their communal values (activation) or not (control). Regardless of gender, students endorsed more communal values and expressed less interest in pursuing STEM careers when their communal values were activated, as compared to control (Diekman et al., 2011). Thus there is mixed evidence about how group membership influences the relationship between communal values and STEM interest. We therefore examined whether situationally adding communal utility value helps certain groups more than others - or whether everyone benefits from an "other-focused" understanding of a task?

Project overview

Across four studies with mutually exclusive and diverse student samples, we examined whether intervening to explicitly add communal utility value to descriptions of biomedical research enhances students' motivation to pursue biomedical science by complementing, not replacing, the agentic value already present within the culture of science. In Studies 1–3 we examined our hypotheses with a general population of undergraduate students whereas

Study 4 tested our hypotheses with a highly invested (domain identified) sample of undergraduate biomedical research assistants.

In Study 1, we examined whether highlighting communal utility value (defined as helping others, which is a specific definition of communal value) increased students' science motivation, and whether this effect occurred indirectly by increasing participants' communal utility value beliefs about biomedical research. In Study 2, we examined whether highlighting certain types of communal utility value (working with, helping, or forming connections with others; Pohlmann, 2001) or combining multiple-communal utility values (a broader definition of communal value) best enhances students' motivation for biomedical science using between-subject comparisons. Because expectancy-value theory is silent as to whether certain types of utility should matter, we test the possibility that any type of communal value enhances student motivation versus a particular type of utility is most beneficial to motivation. We also wanted to test whether intervening to add agentic value to biomedical research descriptions benefits students' motivation for biomedical science, and more importantly, whether adding *both* agentic and communal value to research descriptions especially boosts students' motivation for biomedical science. Adding more utility, as proposed by Expectancy-Value Theory (e.g., Eccles, 2009), should result in more motivation. However, if communal utility value is important to student motivation but missing from the scientific research culture, it is possible that a communal utility value intervention would be beneficial whereas an agentic value utility intervention would not change student motivation given sufficient agentic value is already inherent in perceptions of scientific research.

Because in Studies 1–3 we use an experimental communal utility value intervention with a sample of undergraduate students at a single time point, in Study 4 we examine these relationships over time in a naturally occurring sample of advanced undergraduate science students. Specifically, in Study 4 we extend the previous work by documenting the association between believing that science is high in communal value and motivation for biomedical science (specifically) and science (broadly) several months later, among research assistants (RAs) working in biomedical science laboratories.

Analysis overview

In Studies 1–3 we examined the effects of random assignment to different types of communal value intervention conditions on our manipulation checks (communal and agentic utility value) and our variables of interest (positivity, motivation, perceived importance). For our manipulation checks, because all participants reported beliefs about the communal and agentic utility value of biomedical science, utility value scores were included in the Analysis of Variance (ANOVA) models as a within-subjects variable. Studies 1–2 had no other within-subjects factor and thus we utilized between-subjects ANOVAs for our other variables of interest (positivity, motivation, and, in Study 2, importance). However, because Study 3 was a completely within-subjects communal and agentic value intervention, intervention was also a within-subjects factor in the mixed ANOVA. Furthermore, in all models used in Studies 1–3 we tested for a possible interaction with student gender. We also tested for a possible interaction with student ethnicity (comparing ethnic majority to

minority students), but because no effects related ethnicity were found, we do not discuss this variable further.

In Study 4, we examined the long term effect of variability in initial beliefs about the utility value of science on our variables of interest at Times 2 and 3. First we conducted correlational analyses between the utility value beliefs at Time 1 and our motivational and importance variables at Times 2 and 3. To eliminate the possibility that our correlational results are due to the time points that the motivations were measured, we conducted partial correlational analyses between communal utility value beliefs at Time 1 and importance and motivational variables at Time 3 controlling for agentic utility value beliefs at Time 1 and our importance and motivational variables at Time 2.

For clarity, in all of our studies we discuss our predicted results before discussing other significant effects that emerged. We conclude by stating the main effects or interactions that did not emerge as significant.

Study 1: Testing a Communal Value Utility Intervention

Study 1 was an initial investigation aimed at integrating communal utility values into a description of biomedical research. We assessed students' beliefs that biomedical science had communal utility value and students' motivation for biomedicine (i.e., positivity toward biomedicine and future career motivation). We hypothesized that students randomly assigned to the high (vs. low) communal value intervention would be more likely to report that biomedical research had communal utility value. Importantly, we also hypothesized that students in the high (vs. low) communal value intervention would also report increased positivity toward biomedical science and increased motivation to pursue a biomedical research career in the future. In addition, we hypothesized that the effect of the communal value intervention on positivity toward and motivation to pursue a biomedical research career in the future would be indirectly explained by students' feelings that biomedical science had communal value. Study 1 employed a 2 (communal value intervention: high vs. low) × 2 (student gender) between-subjects design.

Method

Participants—Fifty five undergraduate students (67.27% female; 38.19% Hispanic/Latino, 27.28% Asian, 25.46% Caucasian; ages 18–25, median age = 18; academic majors were 20% nursing, 18.18% psychology, 12.73% undeclared, 12.7% kinesiology/exercise science, 9% biology, 4% business, 4% communication, 4% history, 4% human/child development) from the psychology participant pool at a West Coast (Hispanic serving) university participated for course credit. Two additional students were excluded because they reported being under the age of 18.[1]

Procedure—Undergraduate students volunteered for a study on "Learning about Science Research." At individual computer stations, they learned about a program of biomedical research. Students were randomly assigned to read one of two research descriptions: (a) one

[1]The exclusion of students under 18 did not change the results.

that described basic methods and findings with low levels of communal utility information (low communal value condition) versus (b) one that described the basic methods and findings with a clear emphasis on implications for helping others (high communal value intervention). Next students rated their beliefs that biomedical research has communal and agentic utility value (manipulation check), positivity toward biomedical research, and motivation to pursue a biomedical research career in the future using established measures. Demographic information was also collected. Finally, students were debriefed on the purpose of the study.

Intervention—All students read a paragraph detailing a biomedical program of research featured in a publication by the National Science Foundation (National Science Foundation, April 2011; see page 1 in http://www.nsf.gov/news/strategicplan/nsfstrategicplan_2011_2016.pdf) which highlighted the strategic plan of the NSF and findings of NSF funded research projects. The research paragraph used was about current research being conducted by "Psychologist Eugene Goldfield of the Center for Behavioral Science at Children's Hospital Boston, together with a team of engineers and scientists at the Wyss Institute" called the "Second Skin" project. Across both conditions, the project was presented as involving groups working together (the collaborative aspect of communion) and the purpose of the technology was described as improving "brain function." Both of these utility values were held constant across conditions. In this study, we only manipulated the helping others aspect of communion between conditions. For students randomly assigned to the *high communal value intervention condition*, the research was described as being "… in the early stages of a project that could help infants with early brain injury learn to move similar to other infants. Goldfield calls it "second skin"— smart clothing whose fabric would pick up attempts at motion and improve brain function." The high communal value intervention condition also included many details on the implications of the "second skin" product, describing how the smart clothing increases wearers' (particularly babies and injured soldiers) range of motion: "The work is being conducted with infants because "the infant brain, when injured, has a remarkable capability for restoration of function," Goldfield said. If it proves successful, the technology could also be applied to others with mobility impairments, including children and adults with brain injuries, the aging population, and soldiers who are injured in combat." For students randomly assigned to the *low communal value condition* the same description was provided, but no mention of helping others (particularly babies and injured soldiers) was made. Rather, the description included being "…in the early stages of a project. Goldfield calls it "second skin"— smart clothing whose fabric would pick up attempts at motion and improve brain function."

Measures

Manipulation check: Students' beliefs that biomedical research had communal utility value were assessed with five items ("How much does the research that you just read about fulfill the following goal:" serving the community; caring for others; connection with others; helping others; attending to others' needs) on 1(*not at all*) to 7(*extremely*) scales. Responses were averaged (α = .87). Students' beliefs that biomedical research had agentic utility value were assessed with five items ("How much does the research that you just read about fulfill the following goal:" power; achievement; status; financial rewards; self-promotion) on 1(*not*

at all) to 7(*extremely*) scales. Responses were averaged (α = .73). The communal and agentic utility value scales were modified from a communal value scale used in Diekman et al. (2010; 2011). These communal and agentic items were originally developed by Pohlmann (2001) and Bakan (1966) and were subsequently validated by Diekman et al. (2010).

Science Motivation Variables

Positivity toward biomedical research: Students' positivity toward the biomedical research they read about was assessed with four items ("What is your impression of the research that you read about?"; "What is your impression of a career that conducts research like what you read about?"; "How enjoyable do you believe you would find the research that you read about?"; "How enjoyable do you believe that a career that conducts the research that you read about would be?") on 1(*not at all positive/enjoyable*) to 7(*extremely positive/enjoyable*) scales. Responses were averaged (α = .80). These items were modified from a career positivity scale used in and validated by Diekman et al. (2011).

Future career motivation: Students' future career motivation for biomedical science was assessed with eight items. Three items ("How willing would you be to work in a laboratory conducting similar research in the future?"; "How willing would you be to look into joining a laboratory like the one that you read about?"; "How willing would you be to tell a friend about this research?") were rated on scales ranging from 1(*not at all willing*) to 7(*very willing*). Five items ("How likely would you be to apply for a job that required you to engage in research similar to the research you read about today?"; "How likely would you be to apply for a job that required you to engage in research similar to the research you read about today?"; "How interested are you in applying to graduate programs in this area of research?"; "How interested are you in learning more about graduate programs related to this area of research?"; "How interested are you in building a career in this area of research?") were rated on 1(*very slightly or not at all*) to 5(*extremely*) scales. Five-point scale items were linearly transformed into seven-point scales and responses were averaged (α = .90). These items were originally modeled after Harackiewicz and Elliot (1993) and were validated by Smith, Sansone, and White (2007).

Results

For all ANOVA models we tested the equality of variance assumption using a Levene's test. In Study 1, the Levene's tests were nonsignificant for all of our outcome variables, *ps*>.36, and thus the ANOVA assumptions were not violated. Effect sizes (Cohen's *d*) were coded with positive numbers indicating differences favoring the high communal value intervention, communal utility value beliefs, or men. Correlations across study variables are presented in Table 1. Means for all dependent variables by intervention condition are presented in Table 2.

Manipulation check—We conducted a 2(communal value intervention: high vs. low) × 2(student gender: men vs. women) × 2(utility value beliefs: communal vs. agentic) mixed ANOVA. Supporting our hypothesis that the high (vs. low) communal value intervention would enhance students' beliefs that biomedical research had communal but not agentic

utility value, the predicted Utility Value Beliefs × Communal Value Intervention interaction emerged, $F(1, 51) = 6.67$, $p = .013$. Students believed biomedical research had more communal value after reading the high (vs. low) communal value information, $p < .001$, $d = 1.64$ (see Table 2). There was no difference based on the intervention in students' beliefs about the agentic utility value of biomedical science, $p = .244$, $d = 0.17$.

In addition to our predicted effects, an unexpected Utility Value Beliefs × Communal Value Intervention × Student Gender interaction emerged, $F(1, 51) = 5.32$, $p = .025$. For agentic values, a significant Communal Value Intervention × Student Gender interaction emerged, $p = .039$. Men believed biomedical research had more agentic value after reading the high communal value information ($M = 4.58$, $SD = 0.74$) versus low communal value information ($M = 3.60$, $SD = 0.80$), $p = .018$, $d = 1.27$. No significant effect emerged for women, $p = .46$, $d = 0.25$. Furthermore, students believed biomedical research had more utility value (both communal and agentic) after exposure to the research description containing high communal utility value information ($M = 5.01$, $SD = 0.70$) compared to the low communal value information ($M = 4.20$, $SD = 0.73$), $F(1, 51) = 17.05$, $p < .001$, $d = 1.13$.[2] Regardless of whether the students read the high or low communal value information, students believed biomedical research had more communal than agentic value, $F(1, 51) = 6.11$, $p = .017$, $d = 0.46$.

There was no main effect of student gender ($F = 3.08$, $p = .085$, $d = 0.59$), Communal Value Intervention × Student Gender interaction ($F = 0.89$, $p = .351$), or Utility Value Beliefs × Student Gender interaction ($F = 0.31$, $p = .579$).

Effects of the communal value intervention on science motivation outcomes—We used a 2(communal value intervention: high vs. low) × 2(student gender: men vs. women) between-subjects ANOVA. Consistent with predictions, compared to the low communal value condition, students in the high communal value intervention reported more biomedical research positivity, $F(1, 51) = 4.06$, $p = .049$, $d = 0.57$, and future career motivation, $F(1, 51) = 3.86$, $p = .054$, $d = 0.52$ (see Table 2).

For biomedical research positivity and future career motivation there was no main effect of gender (positivity: $F = 0.00$, $p = .977$, $d = -0.06$; motivation: $F = 0.09$, $p = .772$, $d = 0.02$) or Utility Value Intervention × Student Gender interaction (positivity: $F = 0.05$, $p = .816$; motivation: $F = 0.29$, $p = .594$).

Finally, to examine if the relationship between the communal utility value intervention and science motivation variables (biomedical research positivity and future biomedical science career motivation) occurred indirectly, by increasing beliefs that biomedical research had communal utility value, we conducted path analysis with maximum likelihood estimation and indirect effects using bootstrapped standard errors (see Figure 1). The high (vs. low) communal values intervention significantly predicted beliefs that biomedical research had communal utility value ($R^2 = .40$), which in turn predicted both biomedical research

[2]By using beliefs that biomedical research had communal and agentic utlity values as a within-subjects factor, students' communal and agentic utility value beliefs about biomedical research were averaged together by the statistical program.

positivity (R^2 = .39) and future career motivation for biomedical science (R^2 = .11). Further, both indirect effects were statistically significant. The intervention indirectly affected biomedical research positivity and future career motivation via effects on beliefs about the communal utility value of biomedical research (biomedical research positivity: bootstrapped, 95% CI (unstandardized) 0.439 to 1.218; future biomedical science career motivation: bootstrapped, 95% CI (unstandardized) 0.116 to 0.904).

Discussion

Study 1 demonstrated that the high communal value intervention designed to help students believe that science had communal utility value was effective. Even though other utility values were present in both paragraphs (i.e., working with others), randomly assigning students to read a research description that highlighted the helping others component of communion enhanced students' beliefs that biomedical science had communal utility value, biomedical research positivity, and motivation to pursue a biomedical research career in the future, compared to students who read the same research description that did not highlight helping others (low communal utility value). Furthermore, increases in positivity and motivation for biomedical science occurred indirectly through students' feelings that biomedicine had communal utility value. In general, these results were true for everyone, as only a single effect of gender emerged, and this effect was unrelated to study hypotheses. Men and women responded to the intervention similarly with regard to communal utility value beliefs about science and science outcomes. Importantly, in adding communal utility value information to the research description, the intervention did not negatively affect participants' beliefs that biomedical science had agentic utility value, which is also critical in science.

Although communion is defined as working with, helping, and forming connections with others (Pohlmann, 2001), the intervention condition in Study 1 emphasized how biomedical science helped others. The other core-theoretical aspects of communal utility value (working with and forming connections with others) were held constant and thus not experimentally manipulated in Study 1. Because previous research from an expectancy-value perspective utilizes multiple types of utility value within the manipulations (e.g., Harackiewicz et al., 2012), it is unclear whether certain types of communal utility value should matter more than others. In Study 2 we examine this open question. Although our theoretical analysis suggests that highlighting all aspects of communal utility value should increase motivation, it is possible that only helping information matters or that interventions highlighting multiple aspects of communal utility value may produce diminishing returns (i.e., no difference compared to highlighting a single aspect). Furthermore we also included a no communal utility value (lacking any mention of helping, working with, or connections with others) condition to serve as a baseline of comparison for others.

Finally, in Study 2 we explore if the perceived "importance" of biomedical research is impacted by the utility value intervention; after all, some associate communal utility with a "feminine" norm which could result in people viewing biomedical science as less important because communal utility is present (e.g., Glick, Wilk, & Perreault, 1995; Horgan & Smith, 2006; Liben, Bigler, & Krogh, 2001; Smith, Lewis, Hawthorne, & Hodges, 2013; Touhey,

1974). We investigate this possibility, as it is paramount to know if intervening to improve student motivation for biomedical science by emphasizing communal utility value comes at the expense of people seeing biomedical research as less important.

Study 2: Testing Different Types of Communal Value Utility Interventions

Study 2 extends our analysis of communal utility values interventions by comparing effects of randomly assigning student participants to interventions that highlight one type of communal utility value (helping, working with, or forming connections with others) versus all types of communal utility value (multiple-communal utility value) on science outcomes. We hypothesized that students randomly assigned to learn about research that highlighted multiple aspects of communal utility value in biomedical research descriptions, compared to one type of communal utility value or no communal utility value, would believe that biomedical science had more communal utility value and would be more positive toward and express more future career motivation for biomedical science. Because of the possibility that interventions emphasizing the communal utility value of science might potentially come at the expense of perceiving science as less important, we also tested whether the multiple-communal value intervention influenced the importance of biomedical science. Furthermore, Study 2 tests whether our intervention influenced motivational variables sequentially through communal utility value beliefs and subsequently through the perceived importance of biomedicine. Study 2 employed a 5(research value intervention: control vs. multiple-communal utility vs. helping others vs. working with others vs. forming connections with others) × 2(student gender) between-subjects design.

Method

Participants—One hundred forty undergraduate students (69.29% women; 1 did not indicate gender; ages 18–43; median age = 19; 34.76% Hispanic/Latino, 26.96% Asian, 24.12% Caucasian; academic majors were 19.38% nursing, 12.86% kinesiology/exercise science, 11.43% psychology, 8.57% biology, 5.63% undeclared, 5% human/child development, 2.5% business, 2.5% communication disorder) from the psychology participant pool at a West Coast university (Hispanic Serving Institution) and a Mountain West university who had not participated in Study 1 participated in exchange for course credit.

Procedure—Procedures were identical to Study 1 with the following exceptions. Students were randomly assigned to read one of five research descriptions: (a) multiple-communal utility, (b) helping others, (c) working with others, (d) forming connections with others, or (e) no communal utility value. Next, students rated their beliefs that biomedical research had communal and agentic value, biomedical research importance, positivity toward biomedical research, and motivation to pursue a biomedical research career in the future.

Intervention—Students read about the same NSF biomedical research as in Study 1. After consulting the actual published research on the second skin project, we created new descriptions that included multiple-communal applications or a specific communal application (helping others, working with others, or forming connections with others), or did not mention communal application (control). The helping others description only focused on

how this work might help individuals with mobility problems (including children, soldiers, the elderly, and adults). The working with others description only focused on how this project involved a team of scientists and engineers who are working collaboratively together. The forming connections with others description only focused on how this project involved a close knit group of friends. The multiple-communal utility value included all three of these components (helping people with mobility impairments; working with a collaborative team; involving a close knit group of friends); while all three of these components were completely absent from the control.

Materials—Beliefs that biomedical research had communal utility value (manipulation check; α = .90), beliefs that biomedical research had agentic utility value (α = .82), positivity toward biomedical research (α = .87), and motivation to pursue a biomedical research career in the future (α = .93) were assessed as in Study 1.

Importance: Students' beliefs about the importance of biomedical research were assessed with five items ("I think this is valuable research"; "This is useful research"; "I think this research is a waste of time" (reverse-coded); "I think this is prestigious research"; "I think this research is important") on 1(*strongly disagree*) to 7(*strongly agree*) scales. Responses were averaged (α = .90). The majority of these items (except for the prestigious item, which we added) were used in and validated by Smith et al. (2013) to test importance and value of a given task. The importance items were originally developed from Smith et al. (2007) and the value items were originally developed by Harackiewicz, Manderlink, and Sansone (1984).

Results

Significant main effects with more than two levels were further analyzed using pairwise *t*-tests; we present all significant and nonsignificant pairwise t-tests. For all ANOVA's in Study 2 we tested the equality of variance assumption using a Levene's test. The Levene's tests were nonsignificant for most outcome variables, *ps* > .06. Because the importance variable had a significant Levene's test, $F(9,130) = 2.11$, $p = .033$, we corrected for the nonnormality of the distribution by squaring the importance variable, resulting in a nonsignificant Levene's test, $p = .22$. Thus all ANOVA assumptions were met in Study 2. Effect sizes (Cohen's *d*) were coded with positive numbers indicating differences favoring the multiple-communal value intervention, beliefs about the communal utility value of biomedical research, or men. Correlations across study variables are presented in Table 1. Means for all dependent variables by intervention condition are presented in Table 2.

Manipulation check—As in Study 1, we conducted a 5(research value intervention: control vs. multiple-communal utility vs. helping others vs. working with others vs. forming connections with others) × 2(student gender: men vs. women) × 2(utility value beliefs: communal vs. agentic) mixed ANOVA. Supporting our hypothesis that highlighting all aspects of communion (vs. a single aspect or control) would enhance students' beliefs that biomedical research had communal and not agentic utility value, the predicted significant Utility Value Beliefs × Communal Value Intervention interaction emerged, $F(4, 130) = 5.71$, $p < .001$. Consistent with predictions, for communal utility values, a main effect of

communal value intervention type emerged, $F(4, 130) = 7.36$, $p < .001$. Students believed that biomedical research had more communal utility value after reading the multiple-communal value intervention compared to the forming connections with others intervention, working with others intervention, or control, $ps < .050$, $ds > 0.94$. However, the difference between the multiple-communal value intervention and the helping others intervention was not statically significant ($p > .050$, $d = 0.69$). Furthermore, students believed that biomedical research had more communal utility value after reading the helping others and forming connections with others interventions (vs. control), $ps < .050$, $ds > 0.57$. Other condition differences were nonsignificant (all $ps > .05$, $ds < 0.43$). For agentic values, no effect of communal value intervention type emerged, $p = .095$. Thus, highlighting multiple-communal values of biomedical research enhanced students' beliefs that biomedical research had communal value more than highlighting working with others or forming connections with others. Highlighting multiple-communal value did not enhance communal utility value beliefs significantly more than the helping others intervention.

In addition to the predicted effects, other significant yet not predicted effects emerged. A main effect of value intervention emerged, $F(4, 130) = 4.12$, $p = .004$. Students who read the multiple-communal ($M = 5.23$, $SD = 1.06$), working with others ($M = 4.77$, $SD = 1.01$), forming connections with others ($M = 4.74$, $SD = 0.91$), and helping others ($M = 4.72$, $SD = 0.79$) utility value information believed that biomedical research had more communal and agentic value than students who read the control research ($M = 4.07$, $SD = 1.29$), $ps < .050$, $ds > 0.50$. Other condition differences were nonsignificant (all $ps > .05$, $ds < 0.55$). Furthermore, students believed biomedical research had more communal (vs. agentic) value after reading the research description, $F(1, 30) = 34.86$, $p < .001$, $d = 0.52$ (see Table 2).

There was no main effect of student gender ($F = 1.28$, $p = .259$, $d = 0.12$), Research Value Intervention × Student Gender interaction ($F = 0.42$, $p = .795$), Utility Value Beliefs × Student Gender interaction ($F = 0.03$, $p = .870$), or Research Value Intervention × Utility Value Beliefs × Student Gender interaction ($F = 0.06$, $p = .992$).

Importance—We used a 5(research value intervention: control vs. multiple-communal utility vs. helping others vs. working with others vs. forming connections with others) × 2(student gender: men vs. women) between-subjects ANOVA. As predicted, a main effect of communal value intervention emerged, $F(4, 130) = 4.46$, $p = .002$. The multiple-communal and helping others value intervention were perceived as more important than the forming connections with others intervention, working with others intervention, or control, $ps < .050$, $ds > 0.75$ (see Table 2). Again, the difference between the multiple-communal value intervention and the helping others intervention was not statistically significant ($p > .05$, $d = 0.37$). Other condition differences were nonsignificant (all $ps > .05$, $ds < 0.02$).

In addition to the predicted effects, men ($M = 5.81$, $SD = 0.75$) believed that the research was more important than women ($M = 5.42$, $SD = 0.96$), $F(1, 130) = 5.49$, $p = .021$, $d = 0.45$. No significant Utility Value Intervention × Student Gender interaction emerged, $F(4, 130)=1.17$, $p=.326$.

Effects of the communal value intervention on science motivation outcomes—We used a 5(research value intervention: control vs. multiple-communal utility vs. helping others vs. working with others vs. forming connections with others) × 2(student gender: men vs. women) between-subjects ANOVA. As predicted, a main effect of communal value intervention emerged for biomedical research positivity, $F(4, 130) = 4.67$, $p = .002$, and motivation to pursue a biomedical research career in the future, $F(4, 130) = 3.07$, $p = .019$. The research description highlighting multiple-communal values was perceived more positively than the forming connections with others intervention, working with others intervention, and control, *ps* < .050, *ds* > 0.76. Again, the difference between the multiple-communal value intervention and the helping others intervention was not statically significant (*ps* > .050, *ds* < 0.38). The helping others intervention was also perceived more positively than the working with others intervention, $p = .050$, $d = 0.71$. Furthermore the multiple-communal and forming connections with others interventions were more motivating than the working with others intervention, *ps* < .050, *ds* > 0.67 (see Table 2). Other condition differences were nonsignificant (all *ps* > .05, *ds* < 0.13).

For biomedical research positivity and motivation to pursue a biomedical research career in the future, there was no main effect of student gender (positivity: $F = 0.87$, $p = .352$, $d = 0.20$; motivation: $F = 3.31$, $p = .071$, $d = 0.35$) or Research Value Intervention × Student Gender interaction (positivity: $F = 1.65$, $p = .165$; motivation: $F = 1.44$, $p = .225$).

Indirect Effect Analysis: As in Study 1, we next examined potential indirect effects that might explain how the intervention led to increases in biomedical research motivation. Specifically, we examined whether our intervention (multiple-communal vs. control) influenced biomedical research positivity and motivation sequentially through communal utility value beliefs about biomedical research and subsequently through the perceived importance of biomedical research, using path analyses with maximum likelihood estimation and indirect effects using bootstrapped standard errors. As drawn in Figure 1, the indirect effect variables were tested as operating in sequence, rather than in parallel. The multiple-communal utility value intervention (vs. control) significantly predicted beliefs that biomedical research had communal utility value ($R^2 = .32$), which in turn predicted perceptions of the importance of biomedical research ($R^2 = .36$). Perceptions of the importance of biomedical research also predicted both biomedical research positivity ($R^2 = .41$) and future biomedical research career motivation ($R^2 = .11$). Further, both indirect effects were statistically significant. The intervention indirectly affected biomedical research positivity and motivation to pursue a biomedical research career in the future via effects on communal utility value beliefs about biomedicine and subsequently effects on the perceived importance of biomedicine (biomedical research positivity ($R^2 = .41$): bootstrapped, 95% CI (unstandardized) 0.272 to 0.989; motivation to pursue a biomedical research career in the future ($R^2 = .11$): bootstrapped, 95% CI (unstandardized) 0.107 to 0.61; see Figure 1).

Discussion

For interventions designed to add communal value to scientific research, results of Study 2 suggest that adding all three communal components and especially adding the helping others component more strongly enhances biomedical research positivity and motivation than

focusing on the working with others or forming relationships with others aspects of communion (as the multiple-communal intervention did not differ from the helping others intervention). Importantly, the means of all study variables were highest for the multiple-communal intervention condition as compared with all other conditions, including the helping others intervention. This suggests that among the individual aspects of communal utility value, helping others may be most important for increasing science motivation. However, when interventions such as these are implemented in settings such as education, the means indicate that the multiple-communal intervention will be the most likely to enhance motivation. As in Study 1, believing that biomedical research had communal utility value accounted for positive intervention effects, and further process analyses in Study 2 demonstrated that greater perceived importance of science also explains why communal utility value beliefs about science predict greater biomedical research positivity and motivation. Again, only a single effect of gender (unrelated to study hypotheses) emerged in Study 2, with men believing that the research was more important than women. Motivational benefits of our multiple communal utility value intervention were thus the same for women and men.

Results from Studies 1 and 2 demonstrate the effectiveness of communal utility value interventions, but did not directly examine whether adding communal information to research descriptions that contain agentic utility values information is helpful. Research on the communal value of science is often met with skepticism from scientists who believe that agentic values (e.g., achievement) are the only important scientific values (for work on the importance of agentic values in science, see Gibbs & Griffin, 2013; Hargittai, 2011; McGee & Keller, 2007). These attitudes about science are often reflected in science writing with agentic information being present. What is unclear is how the addition of communal information in science writing with agentic information already present might help students' biomedical science motivation. If communion is highly valued by students but perceived as absent from biomedical research, it is likely that adding communal utility value to biomedical science would increase students' motivation while adding agentic utility value would not influence students' motivation. However, it also could be that the more utility value added should boost students' motivation (a prediction consistent with Expectancy-Value theory; Eccles, 2009). Finally, to rule out the possibility that the effects found in Studies 1 and 2 were idiosyncratic to the research description used, in Study 3 four new biomedical research descriptions were generated from actual biomedical faculty working at the authors' institutions. We also moved from a between-participants design in Studies 1 and 2 to a within-subjects design in Study 3 to examine how viewing multiple project descriptions impacts the relative influence of each of the values interventions on biomedical science motivation.

Study 3: Testing the Addition of an Agentic Utility Value Intervention

New to Study 3, we directly compared the motivational effects of adding communal versus agentic utility value. Specifically, Study 3 extends our analysis by randomly assigning students to read research project descriptions that varied in the communal and/or agentic utility value. We were primarily interested in whether or not communion boosts student motivation and importance of biomedical research more than agency alone. In addition to

replicating Studies 1 and 2, we predicted that highlighting the multiple-agentic utility value of biomedicine would be unrelated to student biomedical research motivation, compared to a control description, because we expected that even without explicit agentic connections, research is generally perceived as high in agentic utility value. However, there may be an additive effect of highlighting multiple-agentic and communal utility values (referred to as the combined multiple-agentic and multiple-communal utility values condition). Furthermore, as in Study 2, we also examined how research importance indirectly influenced the relationship between the values interventions and positivity toward and motivation to pursue biomedical research. Study 3 employed a 4(research value intervention: control vs. multiple-communal vs. multiple-agentic vs. combined) × 2(student gender) mixed design, with research value intervention as the within-subjects variable.

Method

Participants—One hundred sixty undergraduate students (58.75% female; 89.43% Caucasian; ages 18–36; median age = 19; academic majors were 17.5% nursing, 14.38% kinesiology/exercise science/health, 5% business, 5% psychology, 5% undeclared, 4.38% biology, 4.38% engineering, 4.38% general/liberal studies, 3.13% biomedical science, 2.5% community health, 1.88% premed, 1.25% education) from the psychology participant pool at a Mountain West university who had not participated in Studies 1 and 2 were recruited for course credit.

Procedure—Each student read four research project descriptions from actual biomedical faculty with varying amounts of utility value information: multiple-communal-only, multiple-agentic-only, combined (both multiple-communal and multiple-agentic), or no communal or agentic value in a within-subject design. These intervention statements were counterbalanced and randomly determined using a Latin Square Design. Thus in Study 3, research value intervention type was a completely within-subjects variable. For each research statement, students rated their beliefs about the communal and agentic value of biomedical research (manipulation check), importance of biomedical research, positivity toward biomedical research, and motivation to pursue a biomedical research career in the future. Demographic information was also collected. At the end of the study, students were debriefed on the purpose of the research.

Intervention—Biomedical faculty at a Mountain West and a West Coast university provided descriptions of their research, from which four different research statements (one from a man and woman at each university) were selected (research described lysosomal events, Staphylococcus Aureus, nanomaterials, or Group A Streptococcus). These research statements were selected because each contained a large amount of information about the research project. For each research description, we generated four different utility value versions: (a) *only the program of research* (with no communal or agentic value applications); (b) *the program of research with multiple types of communal utility values* (involving others, helping others, and forming connections with others); (c) *the program of research with multiple-agentic utility values* (involving seeking new experiences, power, and achievement); (d) *the program of research with combined values* (multiple-communal and multiple-agentic applications). Thus, 16 possible research descriptions with similar

word counts were created. Random assignment took place at the level of research description, as each participant read one (of four) randomly assigned research descriptions for each condition. For illustrative purposes, one of the faculty research descriptions is provided in Appendix A as an example of the four utility value conditions created (values information is bolded).

Measures—Importance of biomedical research (α = .91), positivity toward biomedical research (α = .83), and motivation to pursue a biomedical research career in the future (α = .97) were assessed as in Study 2.

Manipulation check: Because the computer program used to run and collect data for Study 3 allowed for a limited number of questions to be asked (a newer version of this program has since eliminated this issue), we were forced to include a shortened version of our manipulation check. Therefore, we assessed students' beliefs about the communal utility value of biomedical research with two questions ("How much do you believe that this research [career] fulfills goals such as working with people, helping others, and serving the community?") on 1(*not at all*) to 7(*extremely*) scales. Responses were averaged (α = .82). Furthermore, we assessed students' beliefs about the agentic utility value of biomedical research with two questions (instead of the 5 questions used in Studies 1–2) ("How much do you believe that this research [career] fulfills goals such as power, achievement, and seeking new experiences?") on 1(*not at all*) to 7(*extremely*) scales. Responses were averaged (α = .86). These shortened items were originally inspired by the work of Pohlmann (2001) and Bakan (1966), validated by Diekman et al. (2010), used in Diekman et al. (2010; 2011), and have produced similar effects to the measures used in Studies 1 and 2 (Brown, Thoman, Smith, & Diekman, 2014).

Results

Significant main effects with more than 2 levels were further analyzed using pairwise *t*-tests; all significant and marginal pairwise *t*-tests are presented. For all ANOVAs we tested the equality of variance assumption using a Levene's test. The Levene's tests were nonsignificant for the majority of outcome variables, *ps* > .13, with the importance variable in the control condition being the only variable to emerge as significant, $F(1, 157) = 4.15$, $p = .043$. To correct for distribution nonnormality and to ensure all within-subjects variables were on the same scale, we squared the importance variables for all conditions, the resulting Levene's tests were no longer significant, *ps* > .09. Thus the ANOVA assumptions were met in Study 3. Effect sizes (Cohen's *d*) were coded with positive numbers indicating differences favoring the multiple-communal value intervention, communal values, or men. Correlations across study variables are presented in Table 1. Means for all dependent variables by intervention condition are presented in Table 2.

Manipulation check—We conducted a 4(research value intervention: control vs. multiple-communal vs. multiple-agentic vs. combined) × 2(student gender: men vs. women) × 2(utility value beliefs: communal vs. agentic) mixed ANOVA. Supporting our hypothesis that highlighting all aspects of communion (vs. agency or control) would enhance students' beliefs that biomedical research had communal utility value, the predicted significant

Research Value Intervention × Utility Value Beliefs interaction emerged, $F(3, 471) = 17.65$, $p < .001$ (see Table 2). Consistent with hypotheses, a significant effect of research value intervention type emerged for communal utility value, $ps < .001$. The multiple-communal-only value intervention and combined communal and agentic intervention enhanced beliefs that biomedical research had communal utility value compared to the multiple-agentic-only value intervention or control condition, $ps < .050$, $ds > 0.59$. Other condition differences were nonsignificant (all), $ps > .15$, $ds < 0.11$.

Furthermore, consistent with the prediction that highlighting all aspects of agency (vs. control) would enhance students' beliefs that biomedical research has agentic utility value, the predicted significant effect of research value intervention type also emerged for agentic utility value, $p < .001$. Students believed biomedical research had more agentic utility value when they read the multiple-agentic-only value intervention research compared to the control, $p = .037$, $d = 0.17$, and when they read the combined value intervention research compared to the multiple-agentic-only, $p = .006$, $d = 0.25$, multiple-communal-only, $p = .057$, $d = 0.13$, or control, $p < .001$, $d = 0.43$. Students also believed that biomedical research had more agentic utility value after reading the multiple-communal-only value intervention research compared to control, $p = .002$, $d = 0.31$ (see Table 2). These results suggest that communal information does not undermine agentic utility value but rather bolsters both types of utility value for biomedical research. Interestingly, the multiple-agentic-only utility value intervention did not differ from the multiple-communal-only utility value intervention, $p = .36$, $d = 0.12$. Thus it is unclear whether our agentic utility value intervention was completely effective at bolstering agentic utility value beliefs about biomedical research.

In addition to our predicted effects, other effects also emerged. A significant effect of research value intervention emerged, $F(3, 471) = 28.11$, $p < .001$, with students believing that biomedical research had more utility values (communal and agentic combined) after reading the multiple-communal-only value intervention research ($M = 4.67$, $SD = 1.38$) as compared to the multiple-agentic-only ($M = 4.08$, $SD = 1.41$) or control ($M = 4.06$, $SD = 1.34$), $ps \leq .047$, $ds > 0.42$. Furthermore, students believed that biomedical research had more communal and agentic values after reading the combined value intervention research description ($M = 4.83$, $SD = 1.38$) compared to the multiple-communal-only, multiple-agentic-only, or control, $ps \leq .048$, $ds > 0.11$. For all research descriptions, students believed that biomedical research had more communal as opposed to agentic value, $F(1, 157) = 45.76$, $p < .001$, $d = 0.31$. Other condition differences were nonsignificant (p=.79, d=.02).

No main effect of student gender ($F = 0.06$, $p = .810$, $d = -0.04$), Utility Value Beliefs × Student Gender interaction ($F = 2.98$, $p = .086$), Research Value Intervention × Student Gender ($F = 1.35$, $p = .256$), or Research Value Intervention × Utility Value Beliefs × Student Gender interaction ($F = 0.46$, $p = .708$) emerged.

Importance—We used 4(research value intervention: control vs. multiple-communal vs. multiple-agentic vs. combined) × 2(student gender: men vs. women) mixed ANOVAs. Supporting our hypothesis that highlighting the multiple-communal utility value (vs. multiple-agentic or control) would increase the perceived importance of biomedical research, the predicted effect of value intervention emerged on importance, $F(3, 471) =$

36.91, $p < .001$ (see Table 2). The multiple-communal-only value description and the combined value description were perceived as more important than the multiple-agentic-only or control, $ps < .001$, $ds > 0.46$. Furthermore, the combined value intervention was perceived as more important than the multiple-communal-only intervention, $p = .012$, $d = 0.05$. Other condition differences were nonsignificant ($p = .10$, $d = 0.17$).

No main effect of student gender ($F = .45$, $p = .503$, $d = 0.08$) or Research Value Intervention × Student Gender interaction ($F = .27$, $p = .843$) emerged.

Effects of the communal value intervention on science motivation outcomes—We used 4(research value intervention: control vs. multiple-communal vs. multiple-agentic vs. combined) × 2(student gender: men vs. women) mixed ANOVAs. Supporting our hypothesis that highlighting the multiple-communal utility value (vs. multiple-agentic or control) would increase students' biomedical research motivation, the predicted effect of research value intervention emerged for biomedical research positivity, $F(3, 471) = 20.19$, $p < .001$, and motivation to pursue a biomedical research career in the future, $F(3, 471) = 8.75$, $p < .001$. The multiple-communal-only and combined value interventions were perceived more positively and increased students' motivation more than the multiple-agentic-only and control research, $ps \leq .005$, $ds > 0.22$ (see Table 2). For positivity and motivation, other condition differences were nonsignificant (all $ps > .46$, $ds < .04$).

For biomedical research positivity and motivation to pursue a biomedical research career in the future, no main effect of student gender (positivity: $F = 1.11$, $p = .294$, $d = 0.17$; motivation: $F = 2.29$, $p = .132$, $d = 0.24$) or Research Value Intervention × Student Gender interaction (positivity: $F = 1.47$, p=222; motivation: $F = 1.18$, $p = .318$) emerged.

Summary of main effects results—Across outcome measures, results of main effect analyses indicate that there was no additive effect of highlighting the multiple-communal and agentic values of biomedical research, as it did not increase the perceived importance of, positivity toward, or motivation to pursue a biomedical research career in the future compared with the multiple-communal-only value condition.

Indirect Effect Analyses: Next, we compared the downstream motivational effects of the multiple-communal vs. multiple-agentic value interventions. Specifically, we examined the role of research importance in understanding the relationship between the values interventions and positivity toward and motivation to pursue biomedical science, again employing path analyses with maximum likelihood estimation and indirect effects using bootstrapped standard errors. For within-subjects designs, an indirect effect occurs when a parallel difference emerges for the computed difference variables and the difference for the dependent measure is predicted by the difference for the indirect effect variable (Judd, Kenny, & McClelland, 2001). Thus, we examined if the difference between conditions for students' beliefs that biomedical science had communal utility value predicted the difference between conditions for research importance, and subsequently if the difference between conditions for research importance predicted the difference between conditions for biomedical research positivity and motivation to pursue a biomedical research career in the future (see Figure 1).

The difference between the multiple-communal and multiple-agentic utility value intervention for students' beliefs about the communal value of biomedical science predicted perceptions of the importance of biomedicine (R^2 = .07), which in turn predicted both biomedical research positivity (R^2 = .38) and biomedical research career motivation in the future (R^2 = .20). Further, both indirect effects were statistically significant. The multiple-communal (vs. multiple-agentic) research description indirectly affected biomedical research positivity and motivation to pursue a biomedical research career in the future via effects on beliefs that biomedicine had communal utility value and the perceived importance of biomedicine (biomedical research positivity: bootstrapped, 95% CI (unstandardized) 0.039 to 0.287; motivation to pursue a biomedical research career in the future: bootstrapped, 95% CI (unstandardized) 0.019 to 0.180; see Figure 1). Beliefs that biomedicine had agentic value did not have any statistically meaningful effects and thus were not included in the indirect effect analyses.

Discussion

Results of Study 3 suggest that communion is a particularly powerful component of students' science motivation, regardless of whether it is presented alone or in conjunction with agentic information. This is important because most real scientific research writing contains agentic information; thus we demonstrated that the addition of communal information in scientific writing increased students' motivation. Highlighting agentic utility value alone did not impact the study outcomes, and there were no differences on any measured outcomes between the multiple-communal utility value description and the combined communal-agentic description. Thus, the key ingredient in successful intervention conditions for increasing importance, positivity toward, and motivation for biomedical research was highlighting the communal value of biomedical research. Demonstrating the generalizability of our intervention, no gender or ethnicity differences in perceptions of biomedical research emerged in Study 3.

Although results have been consistent in support of study hypotheses across three experimental studies, a key limitation is that these designs only allowed us to examine immediate effects of communal utility value at a single point in time with a general population of students. Thus, the long-term effect of these interventions for students relatively committed to biomedicine is unclear and we address this in Study 4. Importantly, Study 4 also extends Studies 1–3 by examining communal and agentic utility value beliefs about science and future science career motivation, which allows for us to test the generalizability of our findings beyond biomedical research.

Study 4: Testing the Association of Communal Values with Motivation Longitudinally

In a prospective longitudinal field study, using a naturally occurring sample of science students we examined whether undergraduate biomedical research assistants' beliefs that science had communal and agentic utility values were associated with research importance, positivity toward biomedicine, and motivation to pursue a science career in the future 7–8 months later. We hypothesized that the extent to which students perceive science as having

high communal utility value would be associated with perceiving biomedical research as more important, endorsing more positive attitudes toward biomedicine, and reporting greater future science career motivation across two semesters.

Method

Participants—Three hundred thirty seven undergraduate students working in biomedical faculty research laboratories as research assistants (58.75% women; 2 students did not indicate gender; ages 18–48; 1 student did not indicate age; median age = 21; 47.6% Caucasian, 20.8% Asian, 17.3% Hispanic/Latino, 12.4 % Native American) from West Coast (Hispanic Serving Institution) and Mountain West universities and Tribal Colleges were recruited to participate in a longitudinal study. None of the students who participated in Study 4 participated in Studies 1–3. One additional student was excluded from analyses because they indicated they were under the age of 17 at the initial recruitment period.[3]

Attrition analyses: Three hundred thirty seven students participated in the initial survey at the middle of the semester (Time 1). These students were invited to participate in a follow-up survey at the end of the semester (Time 2); 234 students participated in this survey. At the end of the subsequent semester, all students who participated in the initial study were again invited to participate in a follow-up survey (Time 3); 167 students participated in this survey. Attrition reasons include incomplete data, leaving the lab, graduation, loss of interest in the project, and inability to contact the participant. Analyses were conducted to examine the likelihood that attrition biased results. For all study variables (including gender, age, ethnicity, communal utility values, agentic utility values, biomedical research importance, biomedical research positivity, and motivation to pursue a science career in the future), students in Time 1 did not differ from students in Time 2 or Time 3, and students in Time 2 did not differ from Time 3, all *ps* > .059. Based on these results, it is unlikely that attrition among this sample significantly impacts results of Study 4.

Procedure—Study 4 was a prospective longitudinal field study with undergraduate biomedical research assistants. Undergraduate research assistants were invited to participate in a longitudinal survey approximately 5–6 weeks into the first semester. These undergraduate research assistants were sent an email invitation through their (randomly selected) faculty research mentors to complete a larger online survey, which included ratings of beliefs that science had communal and agentic utility value. Demographic information was also collected. Participants were also asked to complete a follow-up online survey at the end of the same semester (Time 2; approximately 10–12 weeks after the initial survey) as well as at the end of the subsequent semester (Time 3; approximately 30 weeks after the initial survey). The follow-up surveys at Times 2 and 3 were identical, and included measures of biomedical research importance, positivity toward biomedical research, and motivation to pursue a science career in the future.

[3]The exclusion of data from this student did not change results.

Measures

Beliefs that science had communal and agentic utility value at Time 1: Students' beliefs that science had communal ("How much does a science career fulfill goals such as working with people, helping others, and serving the community?") or agentic ("How much does a science career fulfill goals such as power, achievement, and seeking new experiences or excitement?") values were assessed on 1(*not at all*) to 7(*extremely*) scales. These scales were originally inspired by Pohlmann (2001) and Bakan (1966) and were used in this exact form in Diekman et al. (2011). Although the use of a single item measure to assess communal and agentic utility value beliefs about science might not be ideal and caution is warranted, these are robust and validated measures that have been used in the literature (e.g., Diekman et al., 2011). Indeed, in the literature these single item scales have been used interchangeably with multiple item scales (like the ones used in Studies 1–3) and have yielded the same results regardless of whether the scales contain a single item or multiple items (Diekman et al., 2011).

Importance at Times 2 and 3: The importance of biomedical research was assessed with six items ("I think what we are learning in this lab is important;" "I think what we are studying in this lab is useful for me to know;" "I think the field of biomedical research is an important discipline;" "I find the content of the research done in this lab personally meaningful;" "I see how I can apply what we are learning in this lab to real life;" "This lab work has been a waste of my time (reverse-coded)") on 1(*strongly disagree*) to 7(*strongly agree*) scales. Items were averaged at Times 2 (α = .81) and 3 (α = .84). This scale was adapted from a validated scale by Linnenbrink-Garcia (2010) who developed their scale based on Hidi and Renninger (2006), Krapp (2002), Mitchell (1993), and Schiefele (1991; 2001).

Science Motivation Variables

Positivity toward biomedical research at Times 2 and 3: Students' positivity toward biomedical research was assessed with six items ("I would describe my research lab as very interesting"; "I enjoy doing work in my research lab very much"; "Work in my research lab is fun to do"; "I think my research lab is boring" (reverse-scored); "I become very absorbed with work in my research lab while I am doing it"; "I would describe work in my research lab as very enjoyable"; "I think about how learning the science can help my career") on 1(*strongly disagree*) to 7(*strongly agree*) scales. Items were averaged at Times 2 (α = .93) and 3 (α = .92). These scale items were modified from a validated scale by Smith, Sansone, and White (2007) and were originally modeled after Harackiewicz and Elliot (1993).

Future science career motivation at Times 2 and 3: Students' science career motivation was assessed with two items ("I think about how learning the science can help my career;" "I think about how learning the science can help me get a good job") using scales ranging from 1(*never*) to 5(*always*). Items were averaged at Times 2 (α = .76) and 3 (α = .85). This measure was created and validated by Glynn and Koballa (2006) and has been used in other research studies (e.g., Glynn, Taasoobshirazi, & Brickman, 2007; 2009; Taasoobshirazi & Car, 2009; Taasoobshiazi & Glynn, 2009).

Results

In addition to the results presented below, we used regression to test for a possible interaction with participant gender (which did not consistently emerge in Studies 1–3) and ethnicity (comparing ethnic majority to minority students); because no consistent effects were found we do not discuss these variables further in Study 4. Means and correlations among study variables are presented in Table 3.

Correlational analyses—To examine the long term effects of variability in beliefs about utility values of science on the importance and motivational variables, we first conducted correlational analyses between our utility value variables at the initial time point and motivational variables at Times 2 and 3. Consistent with predictions that students who report higher beliefs that science had communal utility value should perceive biomedical research as more important and experience more motivational benefits than those with lower communal beliefs, beliefs that science had communal utility value (at Time 1) were significantly positively related to biomedical research importance (at Times 2 and 3), as well as biomedical research positivity and future science career motivation (at Times 2 and 3).

Significant correlations also emerged for agentic utility value. Beliefs that science had agentic utility value (at Time 1) were positively related to biomedical research positivity and future science career motivation at Time 2. However, no additional relationships emerged between agentic utility value and these motivational variables at the later time point (Time 3) or importance at either time (see Table 3).

Partial correlational analyses—To rule out the possibility that the correlational results cannot be separated from the unique time points at which the importance and motivational variables were measured, we also conducted partial correlational analyses between beliefs that science had communal utility value at Time 1 and motivation and importance variables at Time 3, controlling for beliefs that science has agentic utility value at Time 1 and the motivation and importance variables at Time 2. Because we did not measure outcome variables at Time 1, to examine the lasting relationships for these variables it is especially important to control for Time 2 outcomes when predicting Time 3 motivational and importance outcomes. Furthermore, because agentic utility value beliefs about science at Time 1 were related to our motivational variables at Time 2, we also control for the influence of agentic utility value beliefs about science.

Even when controlling for ratings of biomedical research importance, positivity toward biomedical research, and future science career motivation at Time 2 and agentic utility value at Time 1, beliefs that science had communal utility value Time 1 were still positively related to biomedical research importance ($r(90) = .24$, $p = .018$), biomedical research positivity ($r(90) = .28$, $p = .007$), and future science career motivation ($r(106) = .23$, $p = .016$), at Time 3. These significant partial correlations provide greater confidence that higher beliefs that science had communal value were significantly associated with greater biomedical research and science motivation two academic semesters later.

Discussion

Study 4 demonstrates that students who internalize the communal utility value of science also experience lasting motivation to pursue science and biomedical research. When undergraduate RAs perceived science as having communal utility value at the initial survey time point, they reported increased biomedical research importance, positivity towards biomedicine, and future science motivation 30 weeks later. Importantly, this relationship holds even when controlling for the perceived agentic utility value of science at the initial survey time point and importance, positivity, and future motivation 10–12 weeks after the initial survey. Furthermore, among the descriptive statistics it is noteworthy that the overall means for both communal utility value and agentic utility value of science were quite high (above the scale midpoint) for this sample of undergraduate biomedical RAs; thus it seems that undergraduate biomedical research assistants perceive science as having both communal and agentic utility value.

General Discussion

Utility value interventions have shown great promise as relatively simple and effective means to promote student motivation in specific educational tasks or classes. However, results from our series of studies on communal utility value interventions in biomedical research suggest that not all utility values are equal in their motivational benefits. Understanding the educational context where the intervention occurs is key to identifying which value(s) should be highlighted in relevant educational activities or materials.

We identified two fundamental utility values which are typically motivating for most people: an “other-oriented” value (communion) and a “self-oriented” value (agency). We demonstrated that interventions adding communal utility value are particularly effective for increasing undergraduate students’ motivation for biomedicine, a domain typically seen as highly agentic. By identifying a commonly important utility value that is often (mis)perceived as missing from students’ understanding of the nature and purpose of scientific research, we tested our communal utility value intervention and found that adding communal information to biomedical research descriptions experimentally boosts motivation for biomedical science by increasing beliefs that biomedicine had communal utility value (Study 1; also Studies 2–3). When testing the association of communal values with motivation longitudinally, we demonstrate that these concepts also apply to science in general. Specifically, we found long lasting motivational benefits associated with strong beliefs that science had communal utility value, even for undergraduate students highly interested in biomedical research (Study 4). Further, when testing different types of communal utility value interventions, results suggest that research descriptions highlighting multiple aspects of communal utility value are more effective than highlighting single aspects, although helping others emerged as the most beneficial single aspect (Study 2). Also when testing the addition of communal and agentic utility value interventions by directly comparing effects of communal utility value with agentic utility value interventions, results suggest that not all added values facilitate biomedical research motivation similarly (Study 3). Counter to typical Expectancy-Value theory predictions, adding more value did not result in greater motivation, as the combination of agentic and communal information

added to biomedical research descriptions did not lead to greater motivation than adding communal information alone (Study 3). Thus across four studies, we extend Expectancy-Value theory by demonstrating that the communal utility value of biomedical research and science, in general, is particularly effective for increasing students' positivity toward and motivation to pursue biomedical research in the future. Our findings are also consistent with other data showing that emphasizing important values (e.g., helping society) in STEM classrooms increases students' valuation of (Patterson, Campbell, Busch-Vischniac, & Guillaume, 2011) and attraction toward STEM careers (Colvin et al., 2013).

We also set out to explore how these interventions might influence the perceived prestige of biomedicine; how might these interventions impact individuals from groups that traditionally highly value communion? First, because communion and agency are often linked with femininity and masculinity, respectively (e.g., Bem, 1974; Eagly, Wood, & Diekman, 2000; Spence, Helmreich, & Stapp, 1975), and that feminine fields are generally perceived as being less important (e.g., Glick et al.,1995; Liben et al., 2001; Smith et al., 2013; Touhey, 1974), it was worthwhile to test whether emphasizing the communal utility value of biomedical science might undermine the perceived importance of biomedical research. Fortunately, our results demonstrate that making these communal aspects of biomedical research salient did not decrease the perceived importance of biomedical research and instead increased the perceived importance of biomedical research (Studies 2–3). Moreover, results demonstrate that there were no reliable or consistent gender or ethnicity differences associated with the communal value intervention (similar to Diekman et al., 2011; Isaac et al., 1999; Morgan et al., 2001; Smith et al., 2001). This is good news because it suggests that utilizing communal utility value interventions will make biomedical research and science, in general, more attractive to all undergraduate students, regardless of their group membership, and thus broaden participation in science research and the STEM workforce (e.g., National Science Board, 2008; U.S. Department of Education, 2014). Indeed our effects are robust in that they are replicated across four studies conducted at different institutions (a doctoral level research institution and a Masters level, Hispanic serving institution) with mutually exclusive and diverse samples of students (including men, women, underrepresented minorities, and individuals from highly represented groups in science).

Importantly, although in our studies we primarily focused on biomedical research, it is important to remember that biomedical research is part of the broader field of science. Indeed, biomedicine includes fields such as bioengineering, microbiology, immunology, neuroscience, and biochemistry (all of which are classified as science fields). Furthermore, four studies demonstrated that regardless of whether communal utility value beliefs were about biomedical research or science, these utility value beliefs were robust predictors of positivity toward biomedical research (Studies 1–3), perceived importance of biomedical research (Studies 2–3), and future career motivation (Studies 1–4). Based on the consistency between our findings pertaining to both biomedical research and science, we argue that our findings are not limited to biomedical research in particular, but instead have broader implications for science as a whole.

Limitations and future directions

Our research has several limitations and future directions. First, because we examined effects of our communal utility value interventions in controlled experimental settings, results from these studies cannot verify that the same interventions would be effective if integrated into science classes. However, findings from Study 4 suggest that the mechanism through which the intervention produces motivational effects (beliefs that science had communal utility value) was associated with more biomedical research and science motivation across two semesters. In addition, previous utility value interventions research suggests that interventions developed in laboratory settings can be effective in classrooms (e.g., Hulleman et al. 2010; Hulleman & Harackiewicz, 2009). Thus, integrating these types of communal utility value interventions into science classes is an important next step. Doing so also opens possibilities for testing whether these interventions might also affect students' science learning, performance, or other motivational outcomes such as effort.

Second, we focused on undergraduate students' biomedical research motivation in all studies. Our data cannot address whether or not these interventions are effective in K-12 students, whose interests may potentially be sparked or captured by other values. However, previous utility values intervention research has demonstrated relatively robust effects across a number of students in high school (e.g., Hulleman et al., 2010) and college (e.g., Hulleman and Harackiewicz, 2009), and science is typically perceived as missing communal utility value across educational levels (e.g., Diekman et al., 2010; Weisgram et al., 2010). Thus, although not yet tested, we would expect these interventions to be similarly effective for high school students.

Third, although our research examined one medium for communicating the communal utility value of biomedical research (reading about biomedical research), there are multitudes of ways that students can come to believe that biomedicine and science have communal utility value. Previous research has examined how reading about the collaborative day in the life of a scientist (Diekman et al., 2011) or engaging in engineering activities that highlight how engineering impacts society (Colvin et al., 2013) increases science motivation. In classroom interventions, students may benefit from the integration of communal utility values throughout diverse science curricula: engaging in group-related science activities, science educators discussing how science benefits society, or communal utility value of science being integrated into science textbooks.

Fourth, our work points to communal utility value as being especially transformative in motivational processes. Yet, more research is needed to completely understand the role of agentic utility value (or its combination with communal utility value), as manipulation check analyses in Study 3 demonstrated that multiple-agentic value may be interpreted in different ways. For example, describing the independent nature of one's research (e.g., taking ownership with I or my) and using achievement-oriented language (e.g., master, achieve) may not increase perceptions of agentic value in the same way as discussing achievement-driven actions (e.g., publishing an award-winning manuscript on pathogens; being appointed to a National Advisory Board as a result of one's burgeoning research program). Future work should thus test whether manipulating agentic utility value in more specific ways would produce similar findings to the results reported here, or if the motivational benefits of

communal utility value would be amplified relative to agentic (or multiple agentic) utility values.

Fifth, in this research we focused only on communal and agentic utility value. However, there are many different types of utility value, as illustrated by Harackiewicz et al. (2012) who utilized a broad range of everyday utility values related to math and science (such as video games, driving, cell phone use, socializing with friends, shopping, housing-related choices, managing finances, recreational sports, medicine, biotechnology, clean water, and recycling). Although many of these utility values might fall under the broad categories of communion and agency, some do not. Our theoretical interest was in comparing communal and agentic utility values in the science research context, specifically, so our data does not address whether other utility values play important roles in students' biomedical research motivation or whether other values have different theoretical implications for Expectancy-Value theory.

Sixth, although we focused on Expectancy-Value as our theoretical framework, our findings also have implications for Goal Congruity Theory (GCT; Diekman et al., 2010; 2011; Diekman & Steinberg, 2013). GCT states that people are motivated to pursue STEM careers and tasks that are perceived to match their personally valued communal goals, and that this preference should be especially strong among members of groups (i.e., women, ethnic minorities) who, on average, highly value communion (e.g., Diekman et al., 2011; Smith et al., 2014). Our studies extend the GCT research by demonstrating that communal utility values, in and of themselves, are important predictors of motivation for *all* students even when not accounting for personal communal values. Furthermore, although research on GCT often measures agentic utility value, we are the first to manipulate agentic utility value and examine the impact of agentic utility value beliefs on student motivation.

Seventh, as is the case with much psychological research, our research used self-report measures. Although self-report measures are useful in understanding various psychological constructs (e.g., Diekman et al., 2010; Diekman et al., 2011; Harackiewicz et al., 2008; Morgan et al., 2001; Smith et al., 2013; Smith et al., 2014; Weisgram & Bigler, 2006), they rely on the participant being accurate about their perceptions. Future research should examine behavioral and other non-self-report measures in order to replicate our findings. Previous research indicates that science is implicitly (or nonconsciously) perceived as lacking communion (Diekman et al., 2011), but has not examined how the implicit perceptions of science might change in response to interventions and influence students' science-related behaviors and motivations.

Finally, our research only examined the perceived importance of biomedical research as an explanatory factor for the relationship between beliefs that biomedical research has communal utility value and biomedical research motivation. Other factors likely play a role in explaining this relationship too. For instance, especially over time, goal orientation (e.g., interest or approach goals) and identity as a scientist may additionally explain how beliefs that science has communal utility value increase future science motivation (e.g., Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013). Examining these and other explanatory

factors will enable researchers to better understand the processes by which beliefs about the communal value of science increases science motivation.

Conclusion

In closing, we applaud ongoing efforts to broaden participation in science and set forth a call for future researchers, educators, and faculty mentors to further consider the translational benefits of a communal utility value intervention to motivate students to pursue science careers. In doing so, individuals occupying these leadership roles may capitalize on a unique opportunity to bridge the gap between the bench and bedside.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Ajzen, I.; Fishbein, M. Understanding attitudes and predicting social behavior. Englewood Cliffs, NJ: Prentice Hall; 1980.

Atkinson JW. Motivational determinants of risk-taking behavior. Psychological Review. 1957; 64:359–372. [PubMed: 13505972]

Atkinson, JW. Motives in fantasy, action, and society. Princeton, NJ: Van Nostrand; 1958.

Bakan, D. The duality of human existence: An essay on psychology and religion. Chicago: Rand McNally; 1966.

Baumeister RF, Leary MR. The need to belong: Desire for interpersonal attachments as a fundamental human motivation. Psychological Bulletin. 1995; 117:497–529. [PubMed: 7777651]

Bem SL. The measurement of psychological androgyny. Journal of Consulting and Clinical Psychology. 1974; 42:155–162. [PubMed: 4823550]

Boswell, SL. Nice girls don’t study mathematics: The perspective from elementary school. Paper presented at the annual meeting of the American Educational Research Association; San Francisco. 1979.

Brophy J. Toward a model of the value aspects of motivation in education: Developing appreciation for particular learning domains and activities. Educational Psychologist. 1999; 34:75–85.

Brown ER, Thoman DB, Smith JL, Diekman AB. Closing the Communal Gap: The Importance of Communal Affordance in Science Career Motivation. 2014 Unpublished manuscript.

Colvin WM, Lyden SL, Leon de la Barra BA. Attracting girls to civil engineering through hands-on activities that reveal the communal goals and values of the profession. Journal of Leadership and Management in Engineering. 2013; 13:35–41.

Cook JE, Purdie-Vaughns V, Garcia J, Cohen GL. Chronic threat and contingent belonging: Protective benefits of values-affirmation on identity development. Journal of Personality and Social Psychology. 2012; 102:479–496. [PubMed: 22082058]

Creten, H.; Lens, W.; Simons, J. The role of perceived instrumentality in student motivation. In: Efklides, A.; Khul, J.; Sorrentino, RM., editors. Trends and Prospects in Motivation Research. Netherlands: Springer; 2001. p. 37-45.

Deci EL, Ryan RM. The support of autonomy and the control of behavior. Journal of Personality and Social Psychology. 1987; 53:1024–1037. [PubMed: 3320334]

Diekman AB, Brown ER, Johnston AM, Clark EK. Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. Psychological Science. 2010; 21:1051–1057. [PubMed: 20631322]

Diekman AB, Clark EK, Johnston AM, Brown ER, Steinberg M. Malleability in communal goals and beliefs influence attraction to STEM careers: Evidence for a goal congruity perspective. Journal of Personality and Social Psychology. 2011; 101:902–918. [PubMed: 21859224]

Diekman AB, Steinberg M. Navigating social roles in pursuit of important goals: A communal goal congruity account of STEM pursuits. Social and Personality Psychology Compass. 2013; 7:487–501.

Dunteman, G.; Wisenbaker, J.; Taylor, ME. Race and sex differences in college science program participation. Research Triangle Park, NC: Research Triangle Institute; 1979.

Durik AM, Harackiewicz JM. Different strokes for different folks: How individual interest moderates the effects of situational factors on task interest. Journal of Educational Psychology. 2007; 99:597–610.

Eagly, AH.; Wood, W.; Diekman, AB. Social role theory of sex differences and similarities: A current appraisal. In: Eckes, T.; Trautner, HM., editors. The developmental social psychology of gender. Mahwah: Erlbaum; 2000. p. 123-174.

Eccles, JS.; Adler, TF.; Futterman, R.; Goff, SB.; Kaczala, CM.; Meece, JL.; Midgley, C. Expectancies, values, and academic behavior. In: Spencer, JT., editor. Achievement and achievement motivation. San Francisco: W.H. Freeman; 1983. p. 75-146.

Eccles, JS. Subjective task value and the Eccles et al. model of achievement-related choices. In: Elliot, AJ.; Dweck, CS., editors. Handbook of Competence and Motivation. New York, NY: The Guilford Press; 2005. p. 105-121.

Eccles JS. Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. Educational Psychologist. 2009; 44:78–89.

Eccles, JS.; Barber, B.; Jozefowicz, D. Linking gender to educational, occupational, and recreational choices: Applying the Eccles et al. model of achievement-related choices. In: Swann, WB.; Langlois, JH.; Gilbert, LA., editors. Sexism and stereotypes in modern society: The gender science of Janet Taylor Spence. Washington, DC: American Psychological Association; 1999. p. 153-192.

Eccles JS, Wigfield A. In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. Personality and Social Psychology Bulletin. 1995; 21:215–225.

Eccles JS, Wigfield A. Motivational beliefs, values, and goals. Annual Review of Psychology. 2002; 53:109–132.

Eshach H. The Nobel Prize in the physics class: Science, history, and glamour. Science & Education. 2009; 18:1377–1393.

Finson KD. Drawing a scientist: What we do and do not know after fifty years of drawings. School Science and Mathematics. 2002; 102:335–345.

Fishbein, M.; Azjen, I. Belief, attitude intention and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley; 1975.

Fiske ST, Cuddy AJC, Glick P, Xu J. A model of (often mixed) stereotype content: Competence and warmth respectively follow from perceived status and competition. Journal of Personality and Social Psychology. 2002; 82:878–902. [PubMed: 12051578]

Fryberg SA, Markus HR. Cultural models of education in American Indian, Asian American and European contexts. Social Psychology of Education. 2007; 10:213–246.

Gibbs KD, Griffin KA. What do I want to be with my PhD? The roles of personal values and structural dynamics in shaping the career interests of recent biomedical science PhD graduates. CBE- Life Sciences Education. 2013; 12:711–723. [PubMed: 24297297]

Glick P, Wilk K, Perreault M. Images of occupations: Components of gender status in occupational stereotypes. Sex Roles. 1995; 32:565–582.

Glynn, SM.; Koballa, TR. Motivation to learn in college science. In: Mintzes, J.; Leonard, WH., editors. Handbook of college science teaching. Arlington, VA: National Science Teachers Association Press; 2006. p. 25-32.

Glynn SM, Taasoobshirazi G, Brickman P. Nonscience majors learning science: A theoretical model of motivation. Journal of Research in Science Teaching. 2007; 44:1088–1107.

Glynn SM, Taasoobshirazi G, Brickman P. Science Motivation Questionnaire: Construct validation with nonscience majors. Journal of Research in Science Teaching. 2009; 46:127–146.

Gunstone, RF. Reconstructing theory from practical experience. In: Woolnough, BE., editor. Practical Science. Milton Ketenes: Open University Press; 1991. p. 67-77.

Harackiewicz JM, Canning EA, Tibbetts Y, Giffen CJ, Blair SS, Rouse DI, Hyde JS. Closing the social class achievement gap for first-generation students in undergraduate biology. Journal of Educational Psychology. 2013 Advance online publication.

Harackiewicz JM, Durik AM, Barron KE, Linnenbrink-Garcia L, Tauer JM. The role of achievement goals in the development of interest: Reciprocal relations between achievement goals, interest, and performance. Journal of Educational Psychology. 2008; 100:105–122.

Harackiewicz JM, Elliot AJ. Achievement goals and intrinsic motivation. Journal of Personality and Social Psychology. 1993; 65:904–915.

Harackiewicz JM, Manderlink G, Sansone C. Rewarding pinball wizardry: Effects of evaluation and cue value on intrinsic interest. Journal of Personality and Social Psychology. 1984; 47:287–300.

Harackiewicz JM, Rosek CS, Hulleman CS, Hyde JS. Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. Psychological Science. 2012; 23:899–906. [PubMed: 22760887]

Hargittai, I. Drive and Curiosity: What Fuels the Passion for Science. New York, NY: Prometheus Books; 2011.

Harper SR. Leading the way: Inside the experiences of high-achieving African American male students. About Campus. 2005; 10:8.

Haven, K. Story Proof: The Science Behind the Startling Power of Story. Westport, CT: Libraries Unlimited; 2007.

Hernandez PR, Schultz PW, Estrada M, Woodcock A, Chance RC. Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. Journal of Educational Psychology. 2013; 105:89–107.

Hidi S, Harackiewicz JM. Motivating the academically unmotivated: A critical issues for the 21st century. Review of Educational Research. 2000; 70:151–179.

Hidi S, Renninger KA. The four-phase model of interest development. Educational Psychologist. 2006; 41:111–127.

Hill CA. Affiliation motivation: People who need people… but in different ways. Journal of Personality and Social Psychology. 1987; 52:1008–1018. [PubMed: 3585697]

Horgan TG, Smith JL. Interpersonal reasons for interpersonal perceptions: Gender-incongruent purpose goals and nonverbal judgment accuracy. Journal of Nonverbal Behavior. 2006; 30:127–140.

Hulleman CS, Durik AM, Schwigert SB, Harackiewicz JM. Task values, achievement goals, and interest: An integrative analysis. Journal of Educational Psychology. 2008; 100:398–416.

Hulleman CS, Godes O, Hendricks BL, Harackiewicz JM. Enhancing interest and performance with a utility value intervention. Journal of Educational Psychology. 2010; 102:880–895.

Hulleman CS, Harackiewicz JM. Promoting interest and performance in high school science classes. Science. 2009; 326:1410–1412. [PubMed: 19965759]

Husman J, Lens W. The role of the future in student motivation. Educational Psychologist. 1999; 34:113–125.

Isaac JD, Sansone C, Smith JL. Other people as sources of interest in an activity. Journal of Experimental Social Psychology. 1999; 35:239–265.

Judd CM, Kenny DA, McClelland GH. Estimating and testing mediation and moderation in within-subjects designs. Psychological Methods. 2001; 6:115–134. [PubMed: 11411437]

Krapp, A. An educational-psychological theory of interest and its relation to SDT. In: Deci, EL.; Ryan, RM., editors. The handbook of self-determination research. Rochester, NY: Rochester University Press; 2002. p. 405-427.

Liben LS, Bigler RS, Krogh HR. Pink and blue collar jobs: Children's judgments of job status and job aspirations in relation to sex of worker. Journal of Experimental Child Psychology. 2001; 79:346–363. [PubMed: 11511128]

Linnenbrink-Garcia L, Durik AM, Conley AM, Barron KE, Tauer JM, Karabenick SA, Harackiewicz JM. Measuring situational interest in academic domains. Educational and Psychological Measurement. 2010; 70:647–671.

Lips HM. Gender- and science-related attitudes as predictors of college students' academic choices. Journal of Vocational Behavior. 1992; 40:62–81.

Lunetta VN, Tamir P. Matching lab activities with teaching goals. The Science Teacher. 1979; 46:22–24.

Malka A, Covington MV. Perceiving school performance as instrumental to future attainment: Effects on graded performance. Contemporary Educational Psychology. 2005; 30:60–80.

Markus, H.; Conner, A. Clash: 8 cultural conflicts that make us who we are. New York, NY: Hudson Street Press; 2013.

Maslow, AH. Motivation and Personality. New York: Harper; 1954.

McGee R, Keller JL. Identifying future scientists: Predicting persistence into research training. CBE Life Sciences Education. 2007; 6:316–331. [PubMed: 18056303]

McKinney D, Michalovic M. Teaching the stories of scientists and their discoveries. Science Teacher. 2004; 71:46–51.

Meece JL, Wigfield A, Eccles JS. Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. Journal of Educational Psychology. 1990; 82:60–70.

Miller RB, DeBacker TK, Greene BA. Perceived instrumentality and academics: The link to task valuing. Journal of Instructional Psychology. 1999; 26:250–260.

Mitchell M. Situational interest: Its multifaceted structure in the secondary school mathematics classroom. Journal of Educational Psychology. 1993; 85:424–436.

Morgan C, Isaac JD, Sansone C. The role of interest in understanding the career choices of female and male college students. Sex Roles. 2001; 44:295–320.

National Institutes of Health. The Biomedical Information Science and Technology Initiative. 1999. http://acd.od.nih.gov/agendas/060399_Biomed_Computing_WG_RPT.htm

National Science Board. Research and Development: Essential Foundations for U.S. Competitiveness in a Global Economy. Arlington, VA: 2008. (NSB 08-03).

National Science Foundation. Empowering the Nation through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011–2016. 2011 Apr.:1.

National Research Council. National science education standards. Washington, DC: National Academy Press; 1996.

Patterson EA, Campbell PB, Busch-Vischniac I, Guillaume DW. The effect of context on student engagement in engineering. European Journal of Engineering Education. 2011; 36:211–224.

Phillips JM, Gully SM. Role of goal orientation, ability, need for achievement, and locus of control in the self-efficacy and goal-setting process. Journal of Applied Psychology. 1997; 82:792–802.

Pohlmann, K. Agency- and communion-orientation in life goals: Impacts on goal pursuit strategies and psychological well-being. In: Schmuck, P.; Sheldon, KM., editors. Life goals and well-being: Towards a positive psychology of human striving. Seattle, WA: Hogrefe and Huber; 2001. p. 68-84.

Ryan RM, Deci EL. Intrinsic and extrinsic motivation: Classic definitions and new directions. Contemporary Educational Psychology. 2000; 25:54–67. [PubMed: 10620381]

Schiefele U. Interest, learning and motivation. Educational Psychologist. 1991; 26:299–323.

Schiefele, U. The role of interest in motivation and learning. In: Collis, J.; Messick, S., editors. Intelligence and personality: Bridging the gap in theory and measurement. Mahwah, NJ: Lawrence Erlbaum; 2001. p. 163-194.

Simons J, Vansteenkiste M, Lens W, Lacante M. Placing motivation and future time perspective theory in temporal perspective. Educational Psychology Review. 2004; 16:121–139.

Smith JL, Brown ER, Thoman DB, Deemer E. Losing its expected communal value: How stereotype threat undermines women's identity as research scientists. Social Psychology of Education: An International Journal. (in press).

Smith JL, Cech E, Metz A, Huntoon M, Moyer C. Giving back or giving up: Native American student experiences in science and engineering. Cultural Diversity and Ethnic Minority Psychology. 2014; 20:413–429. [PubMed: 25045952]

Smith JL, Deemer ED, Thoman DB, Zazworsky L. Motivation under the microscope: Understanding undergraduate science students' multiple motivations for research. Motivation and Emotion. 2014; 38:496–512.

Smith JL, Lewis KL, Hawthorne L, Hodges SD. When trying hard isn't natural: Women's belonging with and motivation for male-dominated STEM fields as a function of effort expenditure concerns. Personality and Social Psychology Bulletin. 2013; 39:131–143. [PubMed: 23187722]

Smith, JL.; Morgan, C.; Sansone, C. Getting (inter) personal: The role of other people in self-regulation of interest. In: Columbus, F., editor. Advances in Psychology Research. Vol. 5. Huntington, NY: Nova Science Publishers; 2001. p. 153-186.

Smith JL, Sansone C, White PH. The Stereotyped task engagement process: the role if interest and achievement in motivation. Journal of Educational Psychology. 2007; 99:99–114.

Spence JT, Helmreich R, Stapp J. Ratings of self and peers on sex role attributes and their relation to self-esteem and conceptions of masculinity and femininity. Journal of Personality and Social Psychology. 1975; 32:29–39. [PubMed: 1206468]

Su R, Rounds J, Armstrong PI. Men and things, women and people: A meta-analysis of sex differences in interests. Psychological Bulletin. 2009; 135:859–884. [PubMed: 19883140]

Taasoobshirazi G, Carr M. A structural equation model of expertise in college physics. Journal of Educational Psychology. 2009; 101:630–643.

Taasoobshirazi G, Glynn SM. College students solving chemistry problems: A theoretical model of expertise. Journal of Research in Science Teaching. 2009; 46:1070–1089.

Thoman DB, Brown ER, Mason AZ, Harmsen AG, Smith JL. Seeing how science can help: A motivational factor in enhancing the participation of underrepresented minority students as biomedical researchers. BioScience. 2015; 65:186–188.

Torres L. Latino definitions of success: A cultural model of intercultural competence. Hispanic Journal of Behavioral Science. 2009; 31:576–593.

Touhey JC. Effects of additional women professionals on ratings of occupational prestige and desirability. Journal of Personality and Social Psychology. 1974; 29:86–89.

U.S. Department of Education. Science, Technology, Engineering and Math: Education for Global Leadership. 2014. http://www.ed.gov/stem

Waldman SA, Terzic A. Clinical and translational science: From bench-bedside to global village. Clinical and Translational Science. 2010; 3:254–257. [PubMed: 20973923]

Walton GM. The new science of wise psychological interventions. Current Directions in Psychological Science. 2014; 23:73–82.

Weisgram ES, Bigler R. Girls and science careers: The role of altruistic values and attitudes about scientific tasks. Journal of Applied Developmental Psychology. 2006; 27:326–348.

Weisgram ES, Bigler RS, Liben LS. Gender, values, and occupational interests among children, adolescents, and adults. Child Development. 2010; 81:778–796. [PubMed: 20573104]

Weisgram, ES.; Diekman, AB. Role Congruity, Values, and Adolescents' Interest in STEM Careers: The Importance of Beliefs that Science Helps People; Paper presented at the biannual meeting of the Society for Research in Child Development; Seattle WA. 2013 Apr.

Wigfield A. Expectancy-value theory of achievement motivation: A developmental perspective. Educational Psychology Review. 1994; 6:49–78.

Wigfield A, Eccles JS. Children's competence beliefs, achievement values, and general self-esteem: Change across elementary and middle school. Journal of Early Adolescence. 1994; 14:107–138.

Wigfield, A.; Eccles, JS. The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In: Wigfield, A.; Eccles, JS., editors. Development of Achievement Motivation. San Diego, CA: Academic Press; 2002. p. 91-120.

Woolf SH. The meaning of translational research and why it matters. Journal of the American Medical Association. 2008; 299:211–213. [PubMed: 18182604]

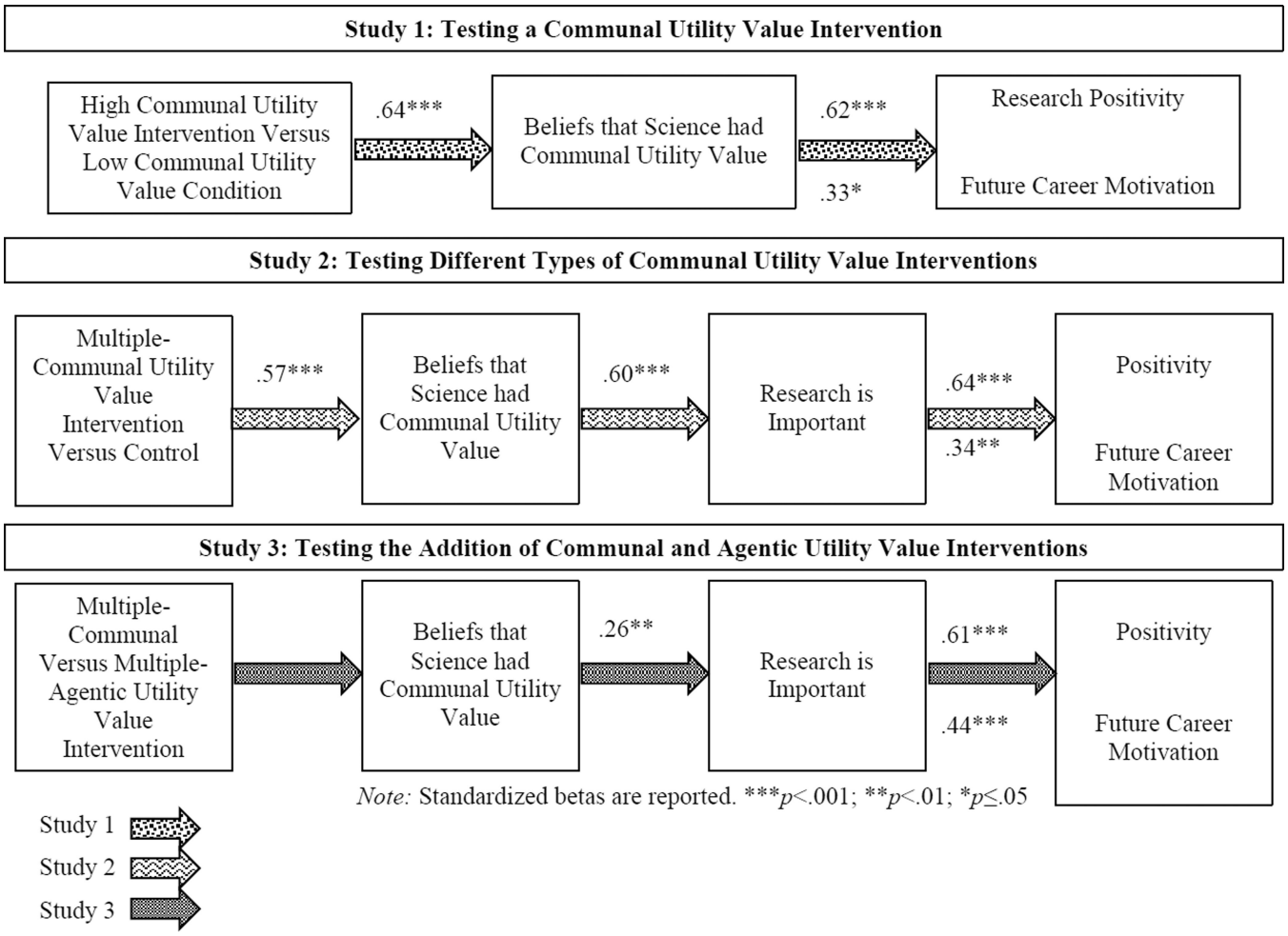

Fig. 1.

Indirect effect analyses for Studies 1–3.

Table 1

Correlations, Means, and Standard Deviations for Self-Report Items Used in Studies 1–3.

Variable	1	2	3	4	5
Study 1: Testing a Communal Utility value Intervention					
1. Beliefs that biomedical research had communal utility value	--	--	--	--	--
2. Beliefs that biomedical research had agentic utility value	.10	--	--	--	--
3. Biomedical research positivity	.62***	−.04	--	--	--
4. Future career motivation	.33*	.14	.68***	--	--
M	4.88	4.37	4.60	3.13	--
SD	(1.14)	(1.06)	(1.07)	(1.18)	--
Study 2: Testing Different Types of Communal Utility Value Interventions					
1. Beliefs that biomedical research had communal utility value	--	--	--	--	--
2. Beliefs that biomedical research had agentic utility value	.41***	--	--	--	--
3. Biomedical research positivity	.48***	.27**	--	--	--
4. Future career motivation	.27***	.20*	.66***	--	--
5. Importance of biomedical research	.45**	.28***	.60***	.25**	--
M	5.02	4.35	4.68	3.24	5.54
SD	(1.32)	(1.26)	(1.27)	(1.35)	(0.91)
Study 3: Testing the Addition of Communal and Agentic Utility Value Interventions					
1. Beliefs that biomedical research had communal utility value	--	--	--	--	--
2. Beliefs that biomedical research had agentic utility value	.64***	--	--	--	--
3. Biomedical research positivity	.59***	.45***	--	--	--
4. Future career motivation	.47***	.42***	.81***	--	--
5. Importance of biomedical research	.62***	.40***	.59***	.41***	--

Variable		1	2	3	4	5
	M	4.63	4.19	3.85	2.73	5.32
	SD	(1.43)	(1.37)	(1.09)	(1.33)	(0.71)

Note.

*** $p<.001$;

** $p<.01$;

* $p\leq.050$

Table 2

Descriptive Statistics by Intervention Condition for Studies 1–3

Study 1: Testing a Communal Utility Value Intervention (intervention is between-subjects)								
Research Value Intervention Condition	Beliefs that biomedical research had communal utility value		Beliefs that biomedical research had agentic utility value		Biomedical research positivity		Future career motivation	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
High communion	5.56_{a}	0.99	4.46_{a}	1.08	4.88_{a}	1.14	3.41_{a}	1.28
Low communion	4.12_{b}	0.75	4.27_{a}	1.06	4.29_{b}	0.90	2.82_{b}	0.99

Study 2: Testing Different Types of Communal Utility Value Interventions (intervention is between-subjects)										
Research Value Intervention Condition	Beliefs that biomedical research had communal utility value		Beliefs that biomedical research had agentic utility value		Biomedical research positivity		Future career motivation		Importance of biomedical research	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Multiple-communal	5.98_{a}	1.00	4.48_{a}	1.50	5.50_{a}	1.21	3.57_{a}	1.38	6.12_{a}	0.63
Helping others	$5.36_{a, b}$	0.85	$4.08_{a, b}$	1.09	$4.87_{a, b}$	1.13	$3.32_{a, b}$	1.07	5.88_{a}	0.66
Working with others	$4.79_{b, c}$	1.24	$4.74_{a, b}$	1.25	4.04_{c}	1.21	2.70_{b}	1.20	5.25_{b}	0.93
Forming Connections with others	4.97_{b}	1.14	$4.52_{a, b}$	0.92	$4.62_{b, c}$	1.08	3.64_{a}	1.53	5.27_{b}	0.95
Control	4.19_{c}	1.53	3.95_{b}	1.35	$4.46_{b, c}$	1.33	$2.99_{a, b}$	1.40	5.25_{b}	0.98

Study 3: Testing the Addition of Communal and Agentic Utility Value Interventions (intervention is within-subjects)						
Research Value Intervention Condition	Beliefs that biomedical research had communal utility value	Beliefs that biomedical research had agentic utility value	Biomedical research positivity	Future career motivation	Importance of biomedical research	

	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Multiple-communal	5.04_{a}	1.33	4.29_{a}	1.33	4.21_{a}	1.45	2.88_{a}	1.64	5.60	1.04
Multiple-agentic	$4.05_{a, b}$	1.40	4.12_{a}	1.42	3.52_{b}	1.39	2.52_{b}	1.50	4.93_{a}	1.04
Multiple-communal and agentic	5.18	1.26	4.47	1.39	4.15_{a}	1.40	2.95_{a}	1.54	5.64	0.91
Control	4.23_{b}	1.37	3.89	1.29	3.48_{b}	1.41	2.51_{b}	1.51	5.11_{a}	1.06

Note. For each study and within each dependent variable, means with different subscripts (or no subscripts) differ from each other, $p \leq .050$. For simplicity and clarity, all means and standard deviations are presented for the raw data, not the transformed data.

Table 3

Correlation Matrix and Descriptive Statistics for Study 4.

Variable	1	2	3	4	5	6	7	8
Study 4: Testing the Association of Communal Values with Motivation Longitudinally								
1. Beliefs that science had communal utility value at Time 1	--	--	--	--	--	--	--	--
2. Beliefs that science had agentic utility value at Time 1	.44***	--	--	--	--	--	--	--
3. Biomedical research positivity at Time 2	.19**	.17*	--	--	--	--	--	--
4. Biomedical research positivity at Time 3	.31**	.11	.69***	--	--	--	--	--
5. Future science career motivation at Time 2	.18**	.14*	.22**	.32**	--	--	--	--
6. Future science career motivation at Time 3	.24**	.02	.24*	.33***	.64***	--	--	--
7. Importance of biomedical research at Time 2	.22**	.13	.68***	.52***	.21**	.26**	--	--
8. Importance of biomedical research at Time 3	.34***	.17	.53***	.76***	.21*	.28**	.58***	--
M	5.75	5.99	5.74	5.81	4.17	4.25	6.03	6.08
SD	(1.08)	(1.05)	(0.92)	(0.95)	(0.78)	(0.83)	(0.76)	(0.75)

Note.

*** $p<.001$;

** $p<.01$;

* $p\leq.050$