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Closing the Communal Gap: The Importance of Communal Affordances in Science Career Motivation

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Abstract

To remain competitive in the global economy, the United States (and other countries) is trying to broaden participation in science, technology, engineering, and mathematics (STEM) by graduating an additional 1 million people in STEM fields by 2018. Although communion (working with, helping, and caring for others) is a basic human need, STEM careers are often (mis)perceived as being uncommunal. Across three naturalistic studies we found greater support for the communal affordance hypothesis, that perceiving STEM careers as affording greater communion is associated with greater STEM career interest, than two alternative hypotheses derived from goal congruity theory. Importantly, these findings held regardless of major (Study 1), college enrollment (Study 2), and gender (Studies 1–3). For undergraduate research assistants, mid-semester beliefs that STEM affords communion predicted end of the semester STEM motivation (Study 3). Our data highlight the importance of educational and workplace motivational interventions targeting communal affordances beliefs about STEM.

Keywords

goal congruity theory; communion; science, technology, engineering, and mathematics (STEM); motivation

“...scientific and technological innovations have become increasingly important as we face the benefits and challenges of both globalization and a knowledge-based economy. To succeed in this new ... society, all students need to develop their capabilities in STEM to levels much beyond what was considered acceptable in the past.”

National Science Board (2007, p. 2)

There is a national consensus that broadening participation in science, technology, engineering, and mathematics (STEM) is vital to the economic, health, and political future of the United States (U.S.) (U.S. Congress Joint Economic Committee, 2012). Despite growing numbers of college degrees awarded in the U.S. over the last 15 years, the proportion of degrees awarded in STEM is decreasing (President's Council of Advisors on Science and Technology (PCAST), 2012). By some forecasts, the U.S. must increase the quantity and quality of STEM workers by graduating an additional 1 million STEM undergraduate majors by 2018 (Carnevale, Smith, & Strohl, 2010; PCAST, 2012). The current project adds to the existing psychological literature (for a review see Yazilintas, Svensson, de Vries, & Saharson, 2013) on STEM motivation and provides an empirical, systematic study of the way in which people may be pushed or pulled toward science depending on how well STEM careers are viewed as meeting basic human needs for communion (i.e., working with, helping, and caring for others) (e.g., Diekman, Brown, Johnston, & Clark, 2010; Lips, 1992; Morgan, Isaac, & Sansone, 2001; Weisgram, Bigler, & Liben, 2010).

STEM careers have a bad reputation in the U.S. For example, from perceptions of “nerdy” and “masculine” to perceptions that STEM careers do not help others and involve working in isolation, STEM is associated with many different stereotypes which can negatively impact students' STEM motivation (e.g., Aronson, Fried, & Good, 2002; Cheryan, Plaut, Davies, & Steele, 2009; Diekman et al., 2010; Dweck, 2008; Nosek, et al., 2009). We focus here on the expectations that STEM does not allow for communal values such as interpersonal connections (e.g., “the lone scientist”) and directly or indirectly helping other people or society (e.g., Diekman et al., 2010; Lips, 1992; Morgan et al., 2001; Weisgram et al., 2010). This (mis)perception of STEM as uncommunal is problematic because communal values such as working with and helping others are psychological needs that many people highly value in vocational choices (Duffy & Sedlacek, 2007). Thus, this perceived gap between what someone values and what the career allows for may be deterring people from considering a career in STEM. Such a mis-match explanation can be seen in classic person-environmental fit theory (Lewin, 1951) and is updated in *Goal Congruity Theory* (e.g., Diekman, Weisgram, & Belanger, 2015; Diekman, Clark, Johnston, Brown, & Steinberg, 2011; Diekman & Steinberg, 2013). *Goal Congruity Theory* posits that people are motivated to pursue careers and tasks that are perceived to match personal values. From the perspective of goal congruity theory, two inputs determine positivity toward a career: the goals that an individual values and the opportunities that the individual perceives to fulfill those goals. These perceived goal affordances thus reflect beliefs about whether a career will offer opportunities to meet valued goals.

The literature on goal congruity theory is replete with examples testing two main types of affordances and personal values, communion (other-oriented) and agency (self-oriented); with the robust finding that both people's overall communal value orientation and people's assumptions about the communal opportunities within STEM are key to predicting STEM motivation and career pursuit (e.g., Diekman et al., 2010; Diekman et al., 2011; Smith, Cech, Metz, Huntoon, & Moyer, 2014; Thoman, Brown, Mason, Harmsen, & Smith, 2015). Although goal congruity theory posits that both a communal value orientation and perceived

communal affordances are critical in producing positivity toward STEM, there are a few key reasons that we believe it is essential for interventions to focus on communal affordances in particular. First, according to the theory, communal goal congruity might be enhanced by decreasing how much an individual values communion in general. In practice, of course, such decreases in communal value orientation would be highly undesirable, because these other-oriented attributes are key in smooth social functioning (e.g., Swap & Rubin, 1983; Diekman & Clark, in press). Second, in practice, decreasing communal value orientation may be difficult to do because communion is highly valued (Baumeister & Leary, 1995; Crocker, 2008; Crocker & Canevello, 2008; Fiske, Cuddy, & Glick, 2007). What is more, changing the person to fit the stereotypic uncommunal culture of STEM places the burden of change on the “victim” who is not assimilating to STEM fields and is believed to be “missing” some ingredient needed for STEM success (in this case, the individual values communion too much).

Instead, we adopt a cultural strengths approach (Gay, 2000; Ladson-Billings, 2002), which suggests that STEM careers and educational programs should work to remove these cultural barriers within STEM fields (i.e., that STEM is uncommunal) to enable individuals who value communion to flourish in STEM. For these reasons, we focus on and predict that applications of goal congruity theory are likely to be much better served by attempting to *increase* perceived communal affordances of the STEM domain. In this project, we propose the *Communal Affordance Hypothesis*; perceiving STEM careers as affording greater communion will be associated with greater STEM career interest. We also extend the goal congruity literature by providing a critical test examining which of these two variables (communal affordances or communal value orientation or the interaction between the two) is the relatively more important contributor to STEM motivation. Such information about the primary factors involved in STEM motivation is central to designing effective STEM education interventions (Walton, 2014). We first review the empirical evidence supporting the communal affordance hypothesis before reviewing literature supporting the two alternative hypotheses.

Support for the communal affordance hypothesis

Several randomized experimental studies have found that manipulating the salience of the communal nature inherent within STEM fields (the translational benefits and the collaborative and teamwork aspects already inherent in STEM, Waldman & Terzic, 2010; Woolf, 2008) enhances student's STEM motivation (Belanger, Diekman, & Steinberg, 2014; Brown, Smith, Thoman, Allen, & Muragishi, in press; Diekman et al., 2011; Weisgram & Bigler, 2006). For instance, students randomly assigned to read a science research abstract showcasing the interpersonal nature of the scientific work reported greater positivity toward and motivation for scientific research than those in the control condition because they perceived scientific research as affording more communion (Brown et al., in press).

Beyond the experimental data, correlational studies have measured naturally occurring levels of communal affordance perceptions of STEM (e.g., Diekman et al., 2010; Lips, 1992; Weisgram et al., 2010), with a few of these studies examining their relationships with STEM-related career interest or motivation (e.g., Lips, 1992; Morgan et al., 2001).

However, no published studies have examined the relative or combined contributions of communal personal values and affordances to subsequent motivation. The existing evidence does suggest that perceiving greater communal affordances in STEM is related to greater STEM career interest (e.g., Lips, 1992), even when controlling for effects of other important career goals (Morgan et al., 2001; Thoman et al., 2015). Without understanding the relative contributions of communal personal values and affordances to STEM interest in non-experimental settings, it is possible that interventions targeting only communal affordances could be ineffective. Our research extends and builds upon the existing work by testing whether naturally occurring beliefs that STEM offers communal opportunities predict STEM motivation even when accounting for communal value orientation and their interaction.

Support for alternative hypotheses

Although we argue that communal affordances are likely the most important contributor to career motivational outcomes, it is possible that STEM motivation might be predicted by a main effect of communal value orientation (alternative hypothesis 1) or the moderated congruity between communal affordances and communal value orientation (i.e., the interaction between the two) (alternative hypothesis 2).

Decreasing communal value orientation might not be advisable in practice, but it may be important in increasing communal goal congruity; thus a main effect of personal value orientation on STEM motivation might emerge, with greater personal valuing of communion being associated with decreased STEM career interest (alternative hypothesis 1). Indeed, experimental and cross-sectional goal congruity evidence suggests when communal values are situationally activated (Diekmann et al., 2011) or individuals highly value communion (Diekmann et al., 2010; Smith et al., 2014), STEM motivation is diminished. For instance, students who wrote about a time they failed to act communally experienced an unmet communal need; compared to students who wrote about a neutral topic, students who were led to temporarily desire communion expressed less interest in STEM careers (Diekmann et al., 2011, Study 2).

The moderated congruity between communal affordance beliefs and communal value orientation might also be important in determining STEM motivation (an interaction might emerge between communal affordance beliefs and communal value orientation); perhaps communal affordance beliefs about STEM positively predict STEM motivation to the extent that an individual highly values communion (moderated congruity alternative hypothesis 2). Specifically, communal affordance beliefs might be particularly likely to predict greater STEM motivation amongst individuals who highly value communion. Some evidence supports this prediction, although most work has examined either affordances or communal value orientation separately. In an experimental study, Diekmann et al. (2011, Study 3) manipulated communal goal affordance beliefs by asking participants to read about a highly collaborative or independent day in the life of a scientist. Framing science as collaborative (versus independent) led to increased beliefs that science afforded communal goals. Supporting the interaction hypothesis, individuals who highly valued communion showed the strongest positive relationship between (the manipulated) STEM communal goal

affordances and science positivity. Similarly, an examination of the sources of communal affordance beliefs found that working with or helping others in STEM fostered communal beliefs about STEM, which in turn predicted positivity toward STEM; across three different samples, communal goal processes were more important for individuals who highly valued communal goals (Steinberg & Diekmann, 2014). We test for these alternative hypothesis possibilities in our naturalistic studies, where the ranges of both communal affordance beliefs and communal value orientation are free to vary.

Current research

The current research extends previous goal congruity work by testing the communal affordance hypothesis, as well as 2 alternative hypotheses, across 3 different naturalistic studies. We test these hypotheses in two survey studies and examine whether these relationships are broadly important with an undergraduate student sample of both STEM and non-STEM majors (Study 1) and a broader sample of college students and individuals not currently enrolled in college (Study 2). In both studies, we examine whether communal value orientation, STEM communal affordances, or their interaction predict STEM motivation. Study 3 uses a prospective naturalistic longitudinal field study with a sample of undergraduate biomedical research assistants to account for the possibility that examining the relationship between communal affordances and STEM motivation at a single time point contributes to those relationships.

Study 1

Method

Participants and Procedure—A total of 594 undergraduate students (23.74% STEM (in the colleges of engineering, math and science, and computing), 71.21% non-STEM, and 5.05% undecided majors) from a Midwestern University participated. Of those students, 545 undergraduate students (63.3% women; 86.42% Caucasian; ages 18–24; median age = 19; majority were freshman 58.82% and sophomores 31.62%) were recruited through the psychology participant pool in exchange for course credit, and 49 undergraduate students who were STEM majors (51.02% women; 73.47% Caucasian; ages 18–43; median age = 21; mostly evenly split between freshman 24.49%, juniors 30.61%, and seniors 26.55%) were recruited through campus fliers in exchange for payment. Data from an additional 34 participants were excluded because they were under the age of 18.¹ Some measures included in our analyses were included in a previous publication (Diekmann et al., 2010); however, the current study is novel in that we include communal affordances and communal orientation in the same analysis and we include additional participants.

As part of a larger survey, participants rated our variables of interest in a randomly presented order: beliefs that STEM careers afforded communal goals, communal value orientation, and interest in pursuing a STEM career. In this survey, participants rated their beliefs that male-dominated (e.g., dentist, lawyer) and female-dominated (e.g., social worker, preschool or kindergarten teacher) careers afforded communal goals as well as their

¹Excluding data from participants under 18 produced similar results.

interest in these careers. Although variables involving non-STEM careers are beyond the scope of our research questions, engaging in comparisons between STEM and other careers could increase variability in the affordance and interest measures (as is further discussed in the discussion of Study 1). Demographic information was collected.

Predictor Variables

Communal goal affordances: Participants rated how much they perceived four STEM careers (mechanical engineer, computer scientist, aerospace engineer, and environmental scientist) as affording “intimacy, affiliation, and altruism” on scales from 1 (*not at all*) to 7 (*extremely*) (items were averaged; $\alpha = .78$).

Communal value orientation: Participants rated their endorsement of nine communal values (i.e., caring for others; serving the community) on scales from 1 (*not at all*) to 7 (*extremely*) (items were averaged; $\alpha = .84$).

Motivational Outcome Variables

STEM career motivation: Participants rated their interest in eight STEM careers (e.g., mechanical engineer, computer scientist, environmental scientist) on scales from 1 (*not at all*) to 7 (*extremely*) (items were averaged; $\alpha = .91$).

Results

Means, standard deviations, and ranges are presented in Table 1. To test our communal affordance hypothesis and two alternative hypotheses, we regressed STEM interest onto a model including communal goal affordances, communal value orientation, whether or not participants were majoring in STEM, and their interactions. Because STEM interest failed the homoscedasticity assumption, $\chi^2(19) = 67.30, p < .001$, robust standard errors corrected for heteroscedasticity (Hayes & Cai, 2007). We report all significant or marginal effects. Furthermore, because gender differences sometimes emerge on communal value orientation (e.g., Diekmann et al., 2010), in Studies 1–3 we conducted subsequent analyses including gender and interactions between gender and our predictor variables; however, because no systematic gender differences emerged across studies we do not discuss these analyses.

What predicts STEM motivation?—Overall, the model significantly predicted STEM motivation, $F(7, 563) = 36.49, p < .001, R^2 = .31$. Consistent with the communal affordance hypothesis, students expressed greater STEM motivation to the extent they believed STEM careers fulfilled communal goals. Consistent with alternative hypothesis 1, students also expressed diminished STEM motivation to the extent they highly endorsed communal values. Furthermore, as expected, STEM majors expressed more STEM interest than non-STEM majors (see Table 2). No other marginal or significant effects emerged, $bs < .12, \beta s < .06, ps > .36$; no support was found for the moderated congruity alternative hypothesis 2.

Discussion

Consistent with the communal affordance hypothesis, communal goal affordances emerged as the strongest psychological predictor of STEM motivation, with students expressing more STEM motivation to the extent they believed STEM careers fulfilled communal goals.

Consistent with alternative hypothesis 1, students who highly valued communion expressed less interest in STEM careers. Most importantly, this relationship was not moderated by STEM or nonSTEM major; communion was an important predictor of STEM motivation regardless of identification as a STEM major. However, STEM majors expressed overall more STEM motivation than non-STEM majors. Finding that communal affordances were a considerably stronger naturalistic predictor of STEM interest than communal value orientation provides initial support for our cultural strengths approach, suggesting that STEM careers and educational programs should focus on increasing communal affordances within STEM to broaden participation.

Because participants in Study 1 considered STEM in the context of other careers, it is possible that these comparisons influenced the results. When individuals consider STEM fields in their daily lives, they might not think about STEM in comparison to other careers (although other approaches argue that these comparisons are critical to understanding choices because students always have alternatives that they are considering; e.g., Wang, Eccles, & Kenny, 2013). Nonetheless, it is possible that thinking about STEM in reference to other fields created more variability in the affordance and interest variables, causing the relationships to be artificially stronger or weaker than they would be naturalistically. To address this potential confound, in Study 2, participants in an online study completed our measures within an applied scientific context. We also broadened the sample in Study 2, to examine whether the communal affordance hypothesis is supported in naturally occurring data from both college students and individuals not currently enrolled in college.

Study 2

Method

Participants and Procedure—We recruited 256 participants (53.13% women; 64.09% Caucasian; ages 18–55; median age = 23) online through Amazon’s Mechanical TURK for payment. Of these, 203 of the participants were college students (17.82% freshman, 32.67% sophomores, 21.29% juniors, 28.22% seniors; majors in the following fields: 20.20% social science, 17.24% natural/physical science, 14.29% engineering/computer science, 13.79% business, 8.87% unknown/undeclared, 7.39% health-related, 6.90% arts and humanities, 3.94% education, 3.45% law/criminal justice, 2.46% mathematics, 0.99% science, and 0.49% culinary), and 53 of the participants were not currently enrolled in college (54.72% were missing data about whether or not they attended college; 20.75% attended a 4 year college or graduate institution; 7.55% attended a 2 year college or community college; 7.55% did not attend college; 3.77% attended an online college; 1.89% attended a technical college; college degree information was not collected; occupations in the following fields: 26.42% business, 13.21% humanities, 13.21% service industry, 13.21% unknown/unemployed, 7.55% analysts, 5.66% health-related, 5.66% researcher/laboratory assistant, 3.77% homemaker, 3.77% law/criminal justice, 1.89% engineering, 1.89% education, 1.89% retired, and 1.89% student).

Participants were shown a picture of a research laboratory and read about a protein quantification task used in that laboratory (illustrating the work involved). Next, participants rated the following items in the order provided: their beliefs that science careers afforded

communal goals, positivity towards the science research task, motivation to pursue a science research career, and communal value orientation. Demographic information was collected.

Predictor Variables

Communal goal affordance beliefs: Participants rated how much they perceived the research task as affording six communal values (i.e., caring for others; serving the community; adapted from Diekmann et al.'s (2010) communal value orientation items) on scales from 1 (*not at all*) to 7 (*extremely*) (items were averaged; $\alpha = .94$).

Communal value orientation: Communal value orientation was rated the same way as in Study 1 (Diekmann et al., 2010; items were averaged; $\alpha = .90$).

Motivational Outcome Variables

Research task positivity: Participants rated three items assessing how much they anticipated interest in working on the research task (adapted from Smith, Sansone, & White, 2007) (e.g. "I think that I would enjoy doing this research task very much") on scales from 1 (*strongly disagree*) to 7 (*strongly agree*) (items were averaged; $\alpha = .88$).

Future career motivation: Participants completed nine items (adapted from Smith et al., 2007) assessing their future motivation to pursue either science research (e.g.: "How willing would you be to complete a research task similar to the one described in the future?") or a scientific research career (e.g.: "How likely would you be to apply to a job that required you to complete many tasks similar to the one you read about today?") on scales from 1 (*not at all/very slightly or not at all*) to 7 (*very willing/extremely*) (items were averaged; $\alpha = .95$).

Results

Means, standard deviations, and ranges are presented in Table 1. As in Study 1, to examine the communal affordance hypothesis and our two alternative hypotheses we regressed research task positivity and future career motivation onto a model including communal goal affordances, communal value orientation, current enrollment in college (college student versus not currently enrolled in college), and their interactions. Because future career motivation failed the homoscedasticity assumption, $\chi^2(20) = 31.43$, $p = .05$, robust standard errors were used in the regression to correct for heteroscedasticity (Hayes & Cai, 2007). We report all significant or marginal effects.

What predicts STEM motivation?—The overall model significantly predicted both research task positivity, $F(7,245) = 12.13$, $p < .001$, $R^2 = .26$, and future career motivation, $F(7,245) = 7.31$, $p < .001$, $R^2 = .17$. Replicating findings from Study 1 and supporting the communal affordance hypothesis, when participants believed that science fulfilled communal goals they expressed more positivity towards the research task and expressed enhanced motivation to pursue a science career in the future (see Table 2). No support was found for alternative hypothesis 1 (the main effect of communal value orientation) or the moderated congruity alternative hypothesis 2 in Study 2.

College students also expressed more future science career motivation than individuals not currently enrolled in college. Unexpectedly, a significant Communal Affordances $\times$ College student interaction also emerged (see Table 2). Simple slopes revealed that that communal goal affordances more strongly predicted future science career motivation for individuals not currently enrolled in college ($b = .68, \beta = .64, p < .001$) as opposed to college students ($b = .37, \beta = .33, p < .001$). This pattern suggests that communal goal affordances were important in attracting both college students and individuals not enrolled in college alike to STEM careers. Unlike Study 1, no other marginal or significant effects emerged, $bs < .07, \beta s < .08, ps > .15$.

Discussion

Within an applied scientific context, communal affordance beliefs about science were the best predictor of STEM motivation. Furthermore, although college students were more likely to express future science career motivation than individuals not currently enrolled in college, communal affordance beliefs contributed to future science career motivation for both individuals not currently enrolled in college and college students alike. Thus, within an applied scientific context, communal affordance beliefs about science played an especially important role in STEM motivation; interventions that focus on communal affordance beliefs within this applied scientific context would be most effective in enhancing STEM motivation at a single point in time.

It is especially important that the effect of communal affordances on STEM motivation occurred particularly for individuals not currently enrolled in college as opposed to college students. Currently in the U.S. although many people are underemployed or are searching for employment (Gallup, 2014) many high paying jobs within STEM (even low levels ones) remain unfilled (PCAST, 2012) and predictions are that 1 million new jobs in the U.S. will be STEM-related by 2018 (PCAST, 2012; STEMconnector, 2012). Our data suggests one additional way that workforce retraining interventions could promote STEM interest and encourage more workers to train for STEM careers.

Although Studies 1 and 2 provide promising results for how communal affordance beliefs about STEM are particularly important for STEM career motivation at a single point in time, it is also important to determine how communion influences STEM motivation at a future point in time. Using a prospective longitudinal field study, Study 3 allows us to rule out the possibility that completing the affordance, communal value orientation, and motivation measures at a single time point is inflating the observed relationship between communal affordances and communal value orientation and STEM motivation. We also examined these relationships for actual undergraduate student biomedical research assistants, allowing for the most stringent test of whether communal affordances powerfully predicts STEM motivation amongst individuals who are highly involved in a STEM field.

Study 3

Method

Participants and Procedure—We recruited 452 undergraduate research assistants (RAs) in biomedical STEM fields (62.83% women; 56.13% Caucasian, 20.22% Asian,

10.97% Latino, 8.82% Native American; ages 18–55; median age= 21; 46.48% seniors, 23.67% juniors, 18.12% sophomores) at Mountain West Universities and a West Coast University. These RAs were recruited through their faculty research mentors and/or student training programs (i.e., McNair) during the middle of the semester (Time 1) in exchange for payment. At the end of the semester (Time 2), all participants were invited to complete a follow-up survey in exchange for additional payment; 335 undergraduate research assistants (63% retention) completed the follow-up survey (60.60% women; 56.59% Caucasian, 23.65% Asian, 11.98% Latino, 3.89% Native American; ages 18 – 55; median age= 21). Students who opted out of participating in the Time 2 survey were not statistically different on important demographic variables such as gender, ethnicity, or age, $p > .13$, than students who participated in the Time 2 survey.

Approximately 6 weeks into the semester (Time 1), participants rated their beliefs that science/biomedicine fulfilled communal goals and their communal value orientation. Demographic information was collected. At the end of the semester (approximately 10–12 weeks later; Time 2), participants rated their intrinsic science motivation and their motivation to pursue graduate school and a career in biomedicine. The intrinsic motivation measure included two items and the biomedical graduate school and career interest measure included one item analyzed in a previously published manuscript (Thoman et al., 2015); however, the current study is novel in that we include additional participants and examine both communal value orientation and communal affordance perceptions.

Predictor Variables- Time 1

STEM careers afford communion: Participants rated two items on their beliefs that science and biomedical careers fulfilled goals such as working with people, helping others, and serving the community (adapted from Diekman et al., 2010; 2011) on scales from 1 (*not at all*) to 4 (*neutral*) to 7 (*extremely*) (items were averaged; $\alpha = .78$).

Communal value orientation: Participants' endorsement of communal values was measured in the same way as Studies 1 and 2 (Diekman et al., 2010; items were averaged; $\alpha = .82$).

Motivational Outcome Variables (Time 2)

Intrinsic science motivation: Participants rated 8 intrinsic science motivation items (e.g.: “I would describe my research lab as very interesting.” “I think it was a waste of time to do work in my research lab.” (reverse-scored)) on scales ranging from 1 (*strongly disagree*) to 4 (*neutral*) to 7 (*strongly agree*) (items modified from Smith et al., 2007; items were averaged; $\alpha = .92$).

Biomedical graduate school and career interest: Participants rated 5 biomedical graduate school and career interest items (e.g.: “Do you intend to apply to a graduate program for biomedical research?”) on scales from 1 (*definitely not/not at all interested*) to 7 (*definitely/extremely interested*) (items modified from Carroll, Sheppard, & Arkin, 2009; items were averaged; $\alpha = .97$).

Results

Means, standard deviations, and ranges are presented in Table 1; we report all significant or marginal effects. To test our communal affordance hypothesis and our alternative hypotheses, we regressed intrinsic science motivation and biomedical graduate school and career interest onto a model including communal goal affordances, communal value orientation, and their interaction.

What predicts STEM motivation?—The overall model significantly predicted both intrinsic science motivation, $F(3,251) = 7.55, p < .001, R^2 = .08$, and biomedical graduate school and career interest, $F(3,276) = 5.07, p = .002, R^2 = .05$. Consistent with the goal affordance hypothesis, undergraduate research assistants expressed enhanced STEM motivation at the end of the semester when they believed that science afforded communal goals mid-semester (see Table 3). No support was found for the main effect alternative hypothesis 1.

For the first time in this series of studies, evidence was at least partially supportive of alternative hypothesis 2; a marginal Communal Goal Affordances $\times$ Communal Value Orientation interaction emerged for intrinsic science motivation only (see Table 3). Simple slope analyses suggest that on this one outcome, communal goal affordances mid-semester at least marginally predicted intrinsic science motivation at the end of the semester for everyone, but this effect was stronger and significant for individuals who had higher ($b = .37, \beta = .36, p < .001$) versus lower ($b = .14, \beta = .15, p = .09$) communal value orientation mid-semester. Thus, although the decomposed statistical interaction was in the right direction, consistent with alternative hypothesis 2, the omnibus test was not statistically significant suggesting a cautious interpretation. What is more, communal affordances at least marginally predicted science motivation for everyone (not just those high in communal values), providing support for the communal affordance hypothesis.

No other significant or marginal effects emerged for intrinsic science motivation and biomedical graduate school and career interest, $bs < .15, \beta s < .09, ps > .14$.

General Discussion

In order to design effective STEM interventions, it is critical to identify the important contributors to STEM interest (Walton, 2014). Goal congruity theory identifies both communal value orientation and uncommunal stereotypes about STEM fields as reasons why people are not motivated to pursue STEM careers (Diekmann et al., 2010; 2011; Diekmann & Steinberg, 2013). When applying goal congruity interventions, it is essential to consider which of these aspects offer the best opportunity for targeted interventions. We tested the *Communal Affordance Hypothesis* across 3 naturalistic studies. Results showed converging evidence that communal affordance beliefs about STEM fields especially bolstered STEM motivation. Regardless of whether STEM was contrasted against other fields (Study 1), or whether individuals only focused on an applied scientific context at a single time point (Study 2) or over time (Study 3), STEM motivation was enhanced to the extent that STEM fields were perceived as affording communal opportunities. Most importantly, these effects occurred for everyone regardless of gender, major, or current

enrollment in college. Consistent with past research that identifies the importance of communal affordance beliefs in career motivation (e.g., Grant, 2008; Grant et al., 2007; Harackiewicz, Rosek, Hulleman, & Hyde, 2012; Isaac, Sansone, & Smith, 1999; Patterson, Campbell, Busch-Vischniac, & Guillaume, 2011), communal affordances were an especially robust predictor of STEM motivation.

Although two alternative hypotheses were included for comparison (a main effect hypothesis of communal value orientation and an interaction hypothesis) in our analyses, no consistent evidence emerged for the alternative hypotheses. Across studies, communal value orientation was not reliably associated with STEM interest, and because communion is highly valued (e.g., Diekmann et al., 2011), it was likely difficult to uncover an interaction between communal affordances and communal value orientation

What Can We Do To Get 1 Million More People Into STEM?

Governmental agencies (i.e., PCAST, 2012; U.S. Congress Joint Economic Committee, 2012) and psychologists (for a review see Yazilintas et al., 2013) alike are concerned with meeting the growing need for STEM workers in the U.S. We examined one way to meet this need: enhancing individuals' motivation to pursue STEM fields through communal beliefs about science. Despite the correlational nature of our studies, a particularly important implication of our work is that our results can inform the design of effective communal affordance interventions.

A key way to both recruit and retain individuals in STEM fields is by designing interventions that target communal affordance beliefs about STEM. This strategy might be especially beneficial because communal goal processes predict interest in STEM above and beyond self-efficacy in science and math (Diekmann et al., 2010). Including collaborative and altruistic elements in the practice of scientific and mathematical skills can thus provide a unique opportunity to increase STEM engagement. Communal affordance beliefs about STEM fields are based, at least in part, on individuals' own communal and uncommunal experiences within STEM (Diekmann & Steinberg, 2014). In practice, STEM fields often involve collaboration and teamwork and have translational benefits to society (Waldman & Terzic, 2010; Woolf, 2008). One way to enhance STEM motivation to both recruit and retain the 1 million more STEM workers needed by 2018 (Carnevale et al., 2010; PCAST, 2012) is by changing the uncommunal perception of STEM and changing the audiences of messages about the communality of STEM.

Teachers, career counselors, STEM practitioners, and workforce retraining programs can also help change the uncommunal perception of STEM (for a review of policy implications, see Diekmann et al., 2015). For instance, teachers can utilize communion in the classroom by not only having students work with each other on STEM projects but also highlighting how STEM fields allow individuals to give back to the community and help others. STEM practitioners can communicate to the general public about how what they are doing not only involves others but also how it broadly impacts society. Preliminary evidence from our own and other's labs suggest that this type of communal communication is effective and can be integrated into the classroom and practices of both STEM teachers and practitioners

(Belanger et al., 2014; Brown et al., in press; Colvin, Lyden, & de la Barra, 2013; Diekman et al., 2011; Yeager et al., 2014).

Career counselors can both highlight how STEM careers will enable students to meet their communal values and connect students with STEM practitioners whom they can shadow within the STEM career for a day. Shadowing experiences will enable students to see how STEM careers are practiced and how STEM careers are communal. Programs that expose students to the day in the life of a scientist provide evidence consistent with the communal affordance hypothesis. Students' drawings of a scientist changed to include more collaboration after they spent the day with a scientist as compared with before (Fermilab, 2007).

STEM practitioners can also ensure the communality of STEM is highlighted within the workplace and that workplace relationships facilitate communion. If companies restrict or undervalue communal activities, students who chose STEM fields because of their communal applications will eventually opt out of STEM careers and choose other paths that do fulfill their communal values.

Currently, there is a need for accessible STEM retraining programs such as those offered by community colleges (e.g., Hagedorn & Purnamasari, 2012). These programs could advertise how STEM fields allow for helping society and working with others, involve group-based training, and focus on the communal implications of STEM. If retraining programs emphasize the communal applications of STEM, more of the workforce might seek out and complete these STEM retraining programs, increasing the number of qualified STEM workers in the U.S.

Another way to change the cultural stereotype of STEM fields is through marketing campaigns. Because STEM does have communal applications, targeted marketing campaigns for individuals who might excel in STEM fields but might not see how STEM fields meet their communal values might be helpful in STEM career recruitment. For instance, marketing campaigns targeted at school-aged children could highlight how STEM fields give back to the community or help others in an age-appropriate way. These types of campaigns might not only attract individuals to STEM fields, but they also might help to inform the public about the many different communal applications of STEM work.

Extending the Current Research Into Other Fields and For Other Goals

Although we focused on STEM fields in our studies, future research could use a goal congruity perspective within other career domains (i.e., military, nursing, police officers, teaching) and/or for other values (i.e., agentic, extrinsic). The affordance hypothesis broadly states that to the extent a career is stereotyped as missing an important value, highlighting how that value is actually present in a career should promote motivation for that career. For example, an investigation applying the goal congruity perspective to the gender gap in political leadership found that the political leader role was believed to involve high levels of conflict and few opportunities to serve the broader good; when the communal aspects of political leadership were emphasized experimentally, women were more interested in the political role (Schneider, Holman, Diekman, & McAndrew, 2014). Future research should

especially investigate the affordance hypothesis in career fields with projected or actual shortages of workers. For instance, there is a projected increasing shortage of registered nurses in the United States from 2009 to 2030 (e.g., Juraschek, Zhang, Ranganathan, & Lin, 2012). Nursing is stereotyped as being highly communal but affording few opportunities for leadership and independence (i.e., agentic values; e.g., Jinks & Bradley, 2004). Using an affordance hypothesis perspective, individuals who highly value agency should be especially motivated to pursue nursing if the independent and leadership opportunities that are already present in nursing are emphasized. Examining how beliefs about the agentic affordances (and their interaction) impact motivation to pursue nursing in a naturalistic study should yield results that provide vital information for how to create and design interventions that might increase the number of individuals who choose to pursue a nursing career.

Conclusions

Despite the uncommunal stereotype of STEM (Diekmann et al., 2010; Lips, 1992; Morgan et al., 2001; Weisgram et al., 2010), STEM fields involve many communal aspects (Waldman & Terzic, 2010; Woolf, 2008). Expanding upon the goal congruity literature by refining the communal affordance hypothesis, our studies provide clear evidence that communal affordance beliefs about STEM are particularly important for educational and workplace interventions to target. To meet the emerging challenges and opportunities of the 21st century and to graduate an additional 1 million people in STEM fields by 2018, it is important to understand that communal aspects in STEM environments should be emphasized both in reality and in perception.

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Table 1

Means, standard deviations, and ranges for all measures.

	<i>M</i>	<i>SD</i>	Range
Study 1			
Communal value orientation	5.46	0.88	1.67–7
Communal goal affordances	2.78	1.07	1–7
STEM career interest	2.16	1.20	1–6.63
Study 2			
Communal value orientation	4.81	1.16	1–7
Communal goal affordances	3.60	1.43	1–7
Research positivity	4.07	1.54	1–7
Future research motivation	3.68	1.57	1–7
Study 3			
Communal value orientation at Time 1	5.67	0.89	1.33–7
Communal goal affordances at Time 1	6.02	0.94	2–7
Intrinsic science motivation at Time 2	5.79	0.90	2.13–7
Biomedical graduate school and career interest at Time 2	4.67	1.84	1–7

Table 2

Communal goal affordances, communal value orientation, and their interaction predicting STEM motivation:
Studies 1–2

Study 1			
Predictor Variables	STEM career Interest		
	b	B	
Communal value orientation	-.18**	-.13	
Communal goal affordances	.29***	.26	
STEM major (0=non-STEM, 1=STEM)	1.04***	.37	
Communal value orientation × Communal goal affordances	-.02	-.02	
Communal value orientation × STEM major	-.09	-.03	
Communal goal affordances × STEM major	.12	.06	
Communal value orientation × Communal goal affordances × STEM major	-.09	-.05	

Study 2				
Predictor Variables	Research positivity		Future career Motivation	
	b	B	b	β
Communal value orientation	-.04	-.03	.05	.03
Communal goal affordances	.69***	.64	.68***	.62
Current enrollment in college (0=not enrolled in college, 1=enrolled in college)	.17	.05	.46*	.12
Communal value orientation × Communal goal affordances	.09	.11	.15	.18
Communal value orientation × Current enrollment in college	.04	.03	-.13	-.09
Communal goal affordances × Current enrollment in college	-.21	-.17	-.31*	-.26
Communal value orientation × Communal goal affordances × Current enrollment in college	-.03	-.03	-.14	-.14

*
p < .05,

**
p < .01,

p < .001

Table 3

Communal goal affordances, communal value orientation, and their interaction at Time 1 predicting STEM motivation at Time 2: Study 3

<i>Time 1 Predictor Variables</i>	Intrinsic Science motivation at Time 2		Biomedical Graduate school and career interest at Time 2	
	<i>b</i>	<i>B</i>	<i>b</i>	β
Communal value orientation at Time 1	.02	.02	.09	.04
Communal goal affordances at Time 1	.26***	.28	.42***	.21
Communal value orientation $\times$ Communal goal Affordances	.09 [†]	.11	.15	.09

[†]
 $p < .10$,

*
 $p < .05$,

**
 $p < .01$,

 $p < .001$