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The Relationship of Undergraduate Research Participation to Graduate and Professional Education Pursuit: An Empirical Study

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In this study we investigate the relationship of undergraduate research participation to pursuit of graduate education and other activities. Data come from 291 survey respondents who provided information about their post-undergraduate education pursuits and activities. The findings indicate that undergraduate research participants were significantly more likely to pursue graduate education and additional research activity.

The recruitment of talented undergraduates into graduate and professional education has been an ongoing concern for higher education. A number of barriers exist to the pursuit of graduate education. Graduate education today is more expensive, and institutions are less likely to offer financial support in terms of tuition deferments and waivers, particularly for those who pursue medical, law, and business degrees (Bowen & Rudenstine, 1992). Though doctoral students are well supported, they often accumulate substantial financial debt (Schapiro, O'Malley, & Litten, 1991). In addition, doctoral students in the social sciences are aware of the difficulties they face securing employment after they complete their Ph.D. degrees (Schapiro et al.). Furthermore, the academic culture of some fields, in particular, the sciences, makes them less attrac-

tive to women and underrepresented students of color (African American, Latina/o American, Native American) (Seymour, 1995a, 1995b). There have been many efforts focused on preparing and attracting undergraduates to pursue further education. Especially important is recruiting and retaining underrepresented students of color and women in graduate and professional education for positions in fields that have been traditionally occupied by White men.

Despite the challenges inherent in pursuing postgraduate education, a large proportion of incoming first-year students indicate they expect to pursue postbaccalaureate degrees (Pascarella & Terenzini, 1991). Research shows that students' undergraduate experiences play a significant role in their pursuit of postbaccalaureate degrees (Astin, 1993; Ethington & Smart, 1986; Hearn, 1987; Pascarella & Terenzini). For instance, attending racial or ethnic workshops, taking interdisciplinary courses, participating on research projects, and interacting with faculty are all factors that appear to influence such educational aspirations (Astin; Pascarella & Terenzini; Tinto, 1993). Faculty-student interaction, in particular, appears to play a pivotal role not only in academic achievement, student retention, and institutional satisfaction, but also in

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students' decisions to pursue further education (Astin; Pascarella & Terenzini). Specifically, the number of hours per week students talked with faculty outside of class and worked on a professor's research project, and the number of their class papers critiqued by faculty influence graduate education degree aspirations (Astin). Furthermore, faculty-student interaction is also related to students' pursuit of academic careers as college faculty or research scientist (Astin). Several institutions have developed programs designed to facilitate and enhance faculty-student interaction (see Lenning & Ebbers, 1999; Shapiro & Levine, 1999 for a review of such programs).

Early research into graduate education identified characteristics of graduate students and reasons for attending graduate or professional school (Ethington & Smart, 1986; Hearn, 1987). Central literature on predictors influencing the pursuit of graduate education is based on the research and theory of undergraduate student retention and attrition (Ethington & Smart; Hearn; Malaney & Isaac, 1988). Researchers have applied Astin's theory of involvement (Astin, 1993) and Tinto's theory of student departure (1975, 1987, 1993) to their analyses of the factors influencing students' decisions to pursue graduate education. Astin's theory of involvement posits that students learn by becoming involved. The more involved, both qualitatively and quantitatively, the more likely the student is to become integrated into the undergraduate academic and social experience. This in turn leads to their persistence and academic success. In his model of undergraduate student persistence in postsecondary education, Tinto theorized that the degree of social and academic integration experienced by students influences persistence toward graduation (Tinto,

1975, 1987, 1993). By extending Tinto's theory, several researchers have found that the influences of social and academic integration are approximately equal, and that students with higher levels of overall integration are more likely to enroll in graduate programs (Ethington & Smart; Hearn).

Common to these theoretical models is the assumption that enrollment in graduate education is the culmination of a series of decisions made by the student concerning the extent of commitment to their education (Ethington & Smart, 1986; Hearn, 1987). Students' initial decisions involve the choice of undergraduate institution. Once at the institution, the student makes a series of decisions about their degree of engagement with the institution and their own academic progress. Student background characteristics such as family education level, family income, high school grades, academic self-confidence, and social self-confidence significantly predict student engagement with the institution (Ethington & Smart; Pascarella & Terenzini, 1991). However, student background characteristics only influence graduate education pursuit indirectly through their effects on students' type and quality of institutional involvement (Ethington & Smart; Hearn; Pascarella & Terenzini). That is, the interactions and experiences students have at an institution have a stronger influence on their pursuit of graduate education than do their incoming background characteristics (Ethington & Smart; Hearn). Environmental factors are considered to have a more direct influence on students' involvement. The focus of our study lay in understanding the role of the environmental factors as the students make decisions about their degree and quality of their engagement with the institution.

Environmental Factors

Central to Tinto's theory is the notion that the greater the student's social and academic involvement, the more likely the student is to persist to degree completion. Academic and social integration is influenced by various factors, including, but not limited to, faculty-student interaction, overall levels of faculty supportiveness of students, departmental grading practices, and departmental size (Astin, 1993; Ethington & Smart, 1986; Hearn, 1987; Pascarella & Terenzini, 1991). Such integration leads to higher levels of academic achievement, which in turn, influences the pursuit of graduate education (Astin; Ethington & Smart; Hearn; Pascarella & Terenzini).

The environment of students' primary academic department has the strongest effects on enrollment in graduate school. Students who major in science, premedicine, or prelaw are more likely to attend graduate school, whereas students who major in engineering, business, or nursing are less likely to attend graduate school (Astin, 1993). Research suggests that due to the large salaries and job opportunities in the engineering and business fields, students in those fields have less reason to acquire advanced degrees (Astin; Hauptman, 1986). A student-oriented faculty also positively affects graduate school attendance, as does the receipt of financial aid based on academic merit (Ethington & Smart, 1986; Hearn, 1987). Attending a public university, attending a large institution, and percentage of students majoring in engineering, have a negative effect on graduate school attendance (Astin). Undergraduate GPA is the involvement or intermediate outcome variable that shows the strongest correlation with enrollment in graduate school. Other involvement measures showing positive

associations with enrollment in graduate school include working on a professor's research project, student-faculty out-of-class contact, honors programs enrollment, and number of science courses taken (Ethington & Smart; Hearn; Malaney & Isaac, 1988).

Faculty-student interaction, one measure of academic integration, has been shown to play a positive role in affecting undergraduate students' decision to apply to graduate school (Hearn, 1987). However, research suggests that educational aspirations and plans are more affected by personalized interactions with individual professors than by the supportiveness of the overall department climate (Astin, 1993; Ethington & Smart, 1986; Hearn). In this study, we focused on the impact of faculty-student research partnerships on several key outcomes, most importantly, undergraduate student pursuit of graduate education and continued involvement in research activity after graduation. Such partnerships are construed as mentoring relationships in which undergraduates—first-year students and sophomores—work under faculty guidance on ongoing faculty research projects. In effect, such faculty-student interactions are at least qualitatively different than those interactions in classroom-related settings or advising situations. Moreover, these partnerships are not simply student initiated as other faculty-student interactions may be, but part of an institutionalized program on undergraduate research.

The Undergraduate Research Opportunity Program (UROP)

UROP was originally developed in 1988 to increase the retention and improve the academic performance of underrepresented students of color at a large Midwestern research university. UROP was developed to

engage first-year and sophomore undergraduates at the university more directly with faculty so that they could benefit from the wealth of research activity taking place at the university and acquire an interest in research-related or academic careers, thus promoting integration into the academic milieu. Today, the program is open to all undergraduate students, and continues to facilitate academic achievement and retention. The program has been successfully meeting its goals. Research indicates that UROP students show higher retention rates and academic achievement than do non-UROP students (Nagda, Gregerman, Jonides, von Hippel & Lerner, 1998). UROP remains committed to the academic achievement and retention of underrepresented students of color and has an emergent focus on retaining women in science and engineering fields. Other goals of UROP include increasing the participation of underrepresented students of color in the sciences and facilitating these students' graduate education pursuit and postgraduate research involvement.

UROP focuses on faculty-student collaboration in research. Students participate in a faculty research project for 10 to 12 hours per week, either for academic credit or as a work-study position. These partnerships are also supplemented by a program support system. Students attend an orientation week program to become familiar with UROP and with the job of working on faculty research projects. Students attend biweekly peer group meetings in which they can share their experiences with other students participating in research in similar academic disciplines. All UROP students are assigned a peer advisor with whom they meet on a monthly basis. Students must apply to the research projects in which they have an interest,

develop a resume, and interview with faculty and staff for those research projects. At the conclusion of their research experiences, students have the opportunity to present a poster session of their research during a campus-wide seminar (see Nagda et al., 1998, for a description of the program components).

In this paper, we report on a research study that investigated the impact of participation in an undergraduate research program on students' pursuit of graduate and professional education. We surveyed two groups of alumni of the University of Michigan: those who had participated in the program between 1989 and 1994 and those who had applied to participate but were not admitted to the program during those years. The research was guided by three questions: (a) Do participants in undergraduate research projects differ from nonparticipants in their pursuit of graduate education and involvement in postundergraduate research activity?; (b) Do participants in undergraduate research differ from nonresearch participants in the use of faculty for job recommendations and contact with faculty after graduation?; and (c) Does undergraduate research confer different benefits by race or ethnicity, that is, do students of color involved in research differ from their White counterparts in pursuit of graduate education and involvement in postundergraduate research activity?

METHODS

Participants and Design

Given the limited number of spaces in UROP and the large number of applicants, we used a stratified random sampling method for selecting students to participate in the UROP program. We sent all applicants a letter

stating that there had been more applicants than positions, so admission was determined by lottery. Thus, all the students—those in UROP and those rejected—understood that their status had been determined by chance. In this way, we avoided making the students in the control group feel that rejection of their application for the UROP program was based on their credentials, as indeed it was not. The sample consisted of 1 UROP student matched to 1 to 3 non-UROP students. UROP and non-UROP students were matched on major field of study (e.g., English, biology), race or ethnicity (African American, White, Asian American, Latino/a American, Native American), graduation date, and cumulative university GPA. Each UROP student was matched to 1 to 3 non-UROP students to insure that each UROP student would have at least one non-UROP student return a completed survey. This match allowed comparison between two groups of students who should have the same incoming motivations to participate in undergraduate research and allowed for analysis of the impact of undergraduate research above and beyond differences on incoming background characteristics.

Although the alumni survey sample consisted of 521 graduates, due to the unavailability of accurate mailing addresses, we sent surveys to 497 students from the original list. The alumni received a small piece of University of Michigan memorabilia in the mailing as an incentive, and those students who returned surveys were entered into a lottery to win a University of Michigan embroidered sweatshirt. We received 291 completed surveys, for a 58.55% return rate. This sample consisted of 183 research graduates (62.9%) and 108 nonresearch graduates (37.1%). The sample consisted of 33.3% African American, 21.9% White,

30.9% Asian American, 12.5% Latina/o American, and 1.4% Native American. The sample, therefore, consisted of 47.2% underrepresented students of color—African American, Native American, and Latina/o. Students of color comprised 49.5% of the no research, 41.0% of the other research, and 51.9% of the UROP groups. At the time of the survey, 30.9% of the respondents indicated that they were in school and 78.6% indicated that they were currently working. Of the respondents, 37.2% had not participated in any form of undergraduate research, 28.1% participated in UROP, and 34.7% participated in non-UROP undergraduate research.

Our original sample was developed by matching 1 UROP student to 1 to 3 non-UROP students, who, presumably, did not participate in any undergraduate research experiences. However, this assumption proved incorrect. Many of the non-UROP students in the sample did participate in some other form of undergraduate research. A question on the survey asked students to indicate whether they participated in undergraduate research. Therefore, we identified students three ways: students who participated in UROP, students who participated in other undergraduate research, and students who did not participate in any undergraduate research.

Measures

The survey consisted of questions asking respondents about their graduate educational and work or career experiences. We used UROP participation and other research participation as indicators of personalized faculty/student interaction. Students were categorized into one of three groups: (a) students who participated in UROP (hereafter referred to as the UROP group),

TABLE 1.
Chi-Square Analyses by Research Participation on Key Outcome Variables
($n = 288$) [Should this be $N = 288$?]

Variable	Group			Chi-Square
	UROP ($n = 81$) %	Other Research ($n = 100$) %	No Research ($n = 107$) %	
Graduate Education	81.5	82.0	65.4	9.77**
Professional Education	71.2	58.5	41.4	12.43**
Research Activity	51.9	56.6	30.1	16.04***
Faculty Recommendation	43.9	48.2	22.1	14.70***
Faculty Contact	18.5	36.7	19.2	10.83**

** $p < .01$. *** $p < .001$.

(b) students who participated in other undergraduate research (other research), and (c) students who did not participate in undergraduate research (no research). See Appendix for variable descriptions.

RESULTS

Of the respondents, 36.6% indicated that they used a faculty member for a job recommendation. Of those respondents that used faculty for job recommendations, 59.1% used more than one faculty member for a recommendation. 25.1% of respondents still kept in contact with University of Michigan faculty. Of the alumni who responded to the question about postgraduate research, 45.6% indicated that they were currently involved in some type of research activity. Three fourths (75.6%) of the respondents went on to further education beyond their undergraduate degree. Of the respondents who went on to pursue or

complete a graduate degree, 56.8% received a medical, law, or Ph.D. degree, and 43.2% acquired an MA or other degree.

Subsequent analyses compared the effect of undergraduate research participation on the outcomes identified.

Effect of Undergraduate Research Participation

Table 1 shows Chi-square results comparing UROP, other research, and no research students on outcomes of using faculty for job recommendations, remaining in contact with faculty, engaging in graduate research, pursuing graduate education, and pursuing professional education degrees. The chi-square statistic for all five outcomes was significant, indicating a difference by UROP, other research, and no research participation.

Pursuit of graduate education and involvement in postundergraduate research. The chi-square for graduate education (whether students pursued some form of

graduate or professional education) was significant, $\chi^2(2, N = 288) = 9.77, p < .01$. Looking at pursuit of graduate education by group, 81.5% of the UROP, 82.0% of the other research, and 65.4% of the no research students pursued some form of graduate education. UROP and other research students were significantly more likely to pursue postgraduate education than the no research students.

The three groups also differed on professional education, $\chi^2(2, N = 288) = 12.43, p < .01$. Of those who pursued a graduate education, 71.2% of the UROP, 58.5% of the other research, and 41.4% of the no research students pursued a professional degree. The main effect for research activity—whether students continue to engage in research after graduation—was significant, $\chi^2(2, N = 288) = 16.04, p < .001$. Broken down by group, 51.9% of the UROP students, 56.6% of the other research students, and 30.1% of the no research students participated in some form of research activity. Students who parti-

cipated in UROP or other research were significantly more likely to be engaged in research activity after graduation than their counterparts who did not participate in any undergraduate research.

Use of Faculty Recommendations and Contact With Faculty. The chi-square for faculty recommendation indicated a significant difference among the three groups, $\chi^2(2, N = 288) = 14.70, p < .001$. Table 1 indicates that 43.9% of the UROP students, 48.2% of the other research students, and 22.1% of the no research participants indicated that they used faculty for job recommendations. These results indicate that undergraduate research participants were significantly more likely to use faculty for job recommendations than their nonresearch counterparts.

On faculty contact, the chi-square was significant, $\chi^2(2, N = 288) = 10.83, p < .01$, indicating that the three groups differed on the degree to which they remain in contact with faculty after graduation. Broken down

TABLE 2.
Chi-Square Analyses by Research Participation on Key Outcome Variables—
Underrepresented Students of Color ($n = 136$)

Variable	Group			Chi-Square
	UROP ($n = 42$) %	Other Research ($n = 41$) %	No Research ($n = 53$) %	
Graduate Education	78.6	82.9	56.6	9.39**
Professional Education	66.7	38.2	36.7	7.44*
Research Activity	50.0	50.0	25.5	7.83*
Faculty Recommendation	41.4	55.3	16.0	15.30***
Faculty Contact	19.0	45.0	20.0	9.10**

* $p < .05$. ** $p < .01$. *** $p < .001$.

TABLE 3.
Chi-Square Analyses by Research Participation on Key Outcome Variables—
White and Asian American Students ($n = 152$)

Variable	Group			Chi-Square
	UROP ($n = 39$) %	Other Research ($n = 59$) %	No Research ($n = 54$) %	
Graduate Education	84.6	81.4	74.1	1.73
Professional Education	75.8	72.9	45.0	9.95**
Research Activity	54.1	61.0	34.6	8.03*
Faculty Recommendation	46.4	42.2	28.9	2.77
Faculty Contact	17.9	31.0	18.5	3.27

* $p < .05$. ** $p < .01$.

by group, 18.5% of the UROP students, 36.7% of the other research students, and 19.2% of the no research students remained in contact with faculty. UROP students, in fact, appear no different from the no research students on remaining in contact with faculty. So, although UROP and other research students did not differ on the degree to which they used faculty for job recommendations, other research students were significantly more likely than the UROP students to remain in contact with undergraduate faculty.

Effect of Undergraduate Research Participation by Race or Ethnicity

Tables 2 and 3 show chi-square analyses by race or ethnicity on our key outcome variables of interest. We performed the chi-square analyses on subsamples, first, comparing underrepresented students of color to one another, and second, White and Asian American students to one another. The chi-square was significant, $\chi^2(2, N = 136)$

$= 9.39, p < .01$, for graduate education for the underrepresented student of color sample, but not for the White and Asian American sample. Broken down by group, 78.6% of the UROP, 82.9% of the other research, and 56.6% of the no research students of color pursued graduate education. This result indicates that UROP and other research students of color were significantly more likely to pursue graduate education than were students of color who did not participate in undergraduate research. However, for White and Asian American students, participation in undergraduate research was not related to pursuit of graduate education.

On professional education pursuit, the results differed slightly. The chi-square for the underrepresented students of color sample was significant, $\chi^2(2, N = 136) = 7.44, p < .05$, but the significance was being driven by the UROP students; 66.7% of the UROP compared to 38.2% of the other research and 36.7% of the no research

underrepresented students of color, pursued professional degrees. The chi-square for White and Asian American students' professional education pursuit is significant, $\chi^2(2, N = 152) = 9.95, p < .01$; 75.8% of the UROP and 72.9 % of the other research compared to 45.0% of the no research White and Asian American students pursue professional education. For underrepresented students of color, therefore, research experiences are related to graduate education pursuit, and UROP participants are more likely to pursue law, medical, or doctoral degrees. In contrast, for White and Asian American students undergraduate research participation is not related to graduate education pursuit, but undergraduate research participation of any type is related to the pursuit of professional degrees.

Table 4 shows Chi-square analyses further detailing the racial or ethnic differences. In Table 4 we present comparisons between (a) White and Asian American students, and (b) students of color by research type for the two education variables. There were no differences on research activity, faculty recommendations, or faculty contact in these analyses. White/Asian and students of color do not differ on education variables for the no research and UROP groups. The two groups do not differ on pursuit of graduate education for the other research group, however, they did differ on the pursuit of professional education, with White and Asian American students significantly more likely than their other research underrepresented student of color counterparts to pursue professional degrees. In

TABLE 4.
Chi-Square Analyses Comparing Graduate Education Pursuit by Race or Ethnicity for UROP and Other Research Participants

Variable	Group		Chi-Square
	White and Asian American Students %	Underrepresented Students of Color %	
No research			
Graduate Education	74.1	56.6	3.61
Professional Education	45.0	36.7	0.49
UROP			
Graduate Education	84.6	78.6	0.49
Professional Education	75.8	66.7	0.67
Other Research			
Graduate Education	81.4	82.9	0.04
Professional Education	72.9	38.2	9.86**

contrast, in the UROP group, White and Asian American students did not differ from underrepresented students of color on professional education. In other words, UROP underrepresented students of color looked more like their UROP White and Asian American counterparts in pursuit of professional degrees, whereas White and Asian American other research participants were significantly more likely to pursue these degrees than their underrepresented student of color counterparts.

On research activity, the chi-squares were significant for both the underrepresented students of color sample and the White and Asian American sample. Within groups, 50% of the UROP, 50% of the other research, and 25.5% of the no research students of color were engaged in research activity, $\chi^2(2, N = 136) = 7.83, p < .05$. Among White and Asian American students, 54.1% of the UROP and 61.0% of the other research students were engaged in post-graduation research activity as compared to 34.6% of the no research students, $\chi^2(2, N = 152) = 8.03, p < .05$.

On faculty recommendations and faculty contact, the chi-squares are only significant for the student of color sample. Table 3 shows that 41.4% of the UROP and 55.3% of the other research students of color used a faculty member for a job recommendation, whereas only 16.0% of the no research students of color did so, $\chi^2(2, N = 136) = 15.30, p < .001$. Though significant, the chi-square results for faculty contact differed slightly from the faculty recommendation results. More students of color in the other research sample maintained contact with faculty (45%) compared to the UROP (19%) or no research students (20%), $\chi^2(2, N = 136) = 9.10, p < .01$.

DISCUSSION

This study was designed to assess the influence of students' participation in UROP on several key outcomes related to their pursuit of graduate education. The research design was conceptualized as an experimental-control group comparison. Many of the non-UROP students who were in the control group indicated, however, that they had participated in some type of undergraduate research activity. We, therefore, reconceptualized our analytic strategy to make comparisons among three groups: students who participated in UROP, students who participated in other undergraduate research, and students who did not participate in any undergraduate research. The findings show a uniformly positive influence of undergraduate research participation. Students who were involved in undergraduate research were more likely to pursue graduate education, pursue postundergraduate research activity, and use faculty for job recommendations than students who did not participate in undergraduate research. Our results also indicate that UROP has a particular relationship to the pursuit of professional degree programs, presumably more selective in their admissions and more challenging than two-year graduate programs, for underrepresented students of color.

These findings are consistent with higher education literature that suggests that faculty-student interaction and research participation does influence education aspirations (Astin, 1993; Pascarella & Terenzini, 1991). Our findings, however, extend prior research conclusions, indicating that such interaction and participation is related to actual graduate education enrollment, not just the aspiration to pursue

graduate or professional education. Although the literature also suggests that students at large or public institutions are less likely to pursue graduate or professional education, our findings show that undergraduate research participation can potentially counteract some of the factors at large research institutions that may inhibit graduate education pursuit (see Astin). Undergraduate research and faculty-student interaction may involve students in smaller communities or may offer them closer contact with faculty not easily accessible at large public institutions, providing an inroad for students to connect to the institution and ultimately, may facilitate their pursuit of graduate education. Our findings support the wisdom of the growing national development of undergraduate research programs (Strassburger, 1995).

Does the Type of Undergraduate Research Experience Matter?

Higher education institutions today are offering a wide range of undergraduate research programs. Some, such as UROP or research-based living-learning programs, are highly structured and provide many support systems for students—peer advisors, special workshops and seminars, regular meetings, and financial incentives—that require substantial resource investment by institutions. Other programs may be thought of as clearinghouses. They solicit faculty projects and make these research opportunities available to interested students. Although they may have some incentives for students, such as financial stipends, they typically do not have any systemic ways of supporting or monitoring student progress. Although also requiring resources, these programs may require less institutional investment than do structured programs.

Finally, faculty may hire undergraduate students to work on research projects independent of any program or institutional incentive.

With the diversity of undergraduate research experiences rising on college and university campuses, it is important to note that the current literature does not address the issue of whether the structure of undergraduate research influences the type of graduate or professional education that students decide to pursue. This study showed some notable differences between students who participated in UROP, a structured program, and in other undergraduate research activities. UROP students were significantly more likely to pursue law, medical, or doctoral degrees than students who participated in other undergraduate research and students who did not participate in any form of undergraduate research. UROP students who participate on medical science research projects and who attend the medical sciences peer group meetings may develop a more nuanced understanding of the requirements and demands to gain acceptance to professional degree programs and pursue careers in these fields. Within the structure of peer advisor meetings, career workshops, and peer group meetings, students may acquire experiences that develop their undergraduate transcripts and resumes, and make them more competitive and more likely to enter more demanding postgraduate and professional programs. The UROP programmatic support combined with having daily and weekly contact with faculty and graduate students in a research setting may assist students to better understand what it is like to be a faculty member, medical doctor, Ph.D. student, or lawyer. Although UROP may attract incoming students with a predisposition to pursue these degrees, both

the controls and other research students were students who applied to UROP and were randomly rejected, and ought to have had the same predisposition to pursue these degrees as did the UROP students. The impact of a structured program may lie in building on this predisposition and exposing students to ways they can connect their motivation to research experience in preparation for doctorate or professional degree programs.

In a different vein, our findings show that students who participated in non-UROP undergraduate research were significantly more likely than UROP students to remain in contact with undergraduate faculty after graduation. Although we do not know whether these faculty were their research mentors or other faculty, we can speculate that students seeking out research opportunities for themselves may initiate contact with faculty members whose research interests are closely aligned to their own, and also develop academic relationships with other experts in the field with whom they did not do research. In UROP first-year and sophomore undergraduate participants were interested in research, but perhaps had not fully defined their particular focus. Because incoming students refine their interests and career goals through a multitude of campus experiences, the UROP program emphasizes students' exposure to the research process and acquisition of research experience. Instead of students finding a perfect match for their interests in UROP, they are advised to take a broad look at the opportunities available. Thus, there may be great variance in how much a student's own interest area corresponds to their UROP faculty sponsor's work, so that not all UROP students may see their faculty sponsors as long-term mentors or advisors.

Who Should Be Involved in Undergraduate Research Opportunities?

Many undergraduate research programs are targeted toward attracting high-achieving students to particular college campuses. The availability of such programs, and the possibilities of working closely with faculty on important issues, can significantly affect a student's choice of college. In addition, administrators may believe that research requires students to have high intellectual and academic capacity, and that undergraduate research opportunities, therefore, should be restricted to students who have shown such competence, such as students in honors programs. Our findings indicate that students from a range of incoming abilities can benefit from participating in undergraduate research.

The UROP admissions process was randomized to include students at all different performance levels. A broad range in undergraduate academic performance was probably present across the both the UROP and the non-UROP students. Some non-UROP (control) students participated in other undergraduate research and some did not, possibly indicating differences in motivation. We do not know whether the controls who participated in undergraduate activities sought out those experiences or were asked by faculty to participate. In addition, and most importantly, if there were differences in motivation to pursue undergraduate education among the controls in our study, these differences should also be evident in the UROP sample because the sample was randomly selected. Therefore, some of the UROP students could have had lower levels of motivation, but they still evidenced positive benefits of undergraduate research participation that their graduate

education attendance rate was higher in comparison to that of the control group students. The findings of this study suggest that undergraduate research programs have a common impact on students with different levels of academic performance and motivation.

Our findings suggest the importance of first-year students participating in undergraduate research, particularly structured program interventions. The fact that UROP is a first-year program indicates that the benefits of such participation are related to long-term educational pursuits. We do not know when the students in the non-UROP research experiences participated in their undergraduate research, which adds some support that UROP does have a strong relationship between first-year student participation and continued educational pursuit. One obstacle universities may face is the possible belief on the part of faculty that undergraduate students, let alone first-year undergraduate students, may not be capable of engaging in the research process. However, the long-term benefits of first-year research participation are evident in our findings.

Our findings indicate that undergraduate research programs may be geared toward those who have faced, or could potentially face, barriers to academic opportunities and success. UROP was originally created to increase the retention and academic achievement of underrepresented minority students. African American, Latino/a, and Native American students have high attrition rates both in high school and college (Brower, 1992; Tinto, 1993). An earlier study showed that UROP was effective in increasing the retention of African American students (especially those with low GPAs) and Latino/as who participated in research during their

sophomore year (Nagda et al., 1998). Undergraduate research programs can, therefore, intervene effectively to retain and promote the success of such students. In this study, underrepresented students of color who participated in undergraduate research were more likely to pursue graduate education and to participate in further research activity than were their nonresearch counterparts, both key objectives of UROP. Yet, among those underrepresented students of color who did pursue graduate education, two thirds of the UROP students pursued doctoral, medical, or law degrees, compared to one third of the students who did not participate in undergraduate research and one third who participated in another form of undergraduate research. It appears that UROP underrepresented students of color were more likely to pursue doctoral and professional education degrees. Hence, UROP-type undergraduate research participation may close the gap between underrepresented students of color and White and Asian American students with regard to doctorate or professional education pursuit. That is, undergraduate research opportunities can level the playing field for students who may potentially be at a disadvantage to pursue professional education.

Undergraduate research also appears effective in facilitating relationships with faculty for underrepresented students of color as measured by job recommendations and continued contact with faculty. Underrepresented students of color who participated in undergraduate research were significantly more likely to use faculty for job recommendations and remain in contact with faculty after graduation compared to those who did not participate in undergraduate research. For White and Asian American students, this is not the case.

Underrepresented students of color often feel distant from faculty (Fullilove & Treisman, 1990), and these findings suggest that undergraduate research participation can facilitate connections between students of color and their undergraduate faculty.

Implications for Undergraduate Research Programs and Student Affairs

First, both structured and unstructured programs may be necessary on campuses. Students who seek out faculty to work with on their own may do it regardless of the type of program offered at an institution. A program with a good reputation on campus, however, can attract students who may need added encouragement, support, and more ready-made choices to help them fully realize their higher education experience. Such a program may also meet the needs of students looking for ways to investigate, in a structured manner, experiences related to their academic interests and long-term academic and career interests.

Second, our findings imply that research programs can target a diversity of students, both of different competencies as well as different racial and ethnic backgrounds. Many programs, both structured (such as honors programs) and unstructured, may count on student self-motivation and ability to negotiate the campus environment on their own. High academic performance may be seen to open doors for continued academic opportunities and future success. These are important programs on campus and serve a particular, albeit, small niche of students. Other campus programs that serve students who are academically at-risk may be seen as only remedial. Recent thinking and research asserts that such programs may not improve academic performance; instead,

programs that are challenging and push low-achieving students to engage actively with the academic material may be far more successful (Garland & Treisman, 1993; Fullilove & Treisman, 1990). Our findings suggest that a structured program such as UROP may play an important role in challenging underrepresented students of color to pursue professional degree programs, such as law, medical, and doctoral degrees. Overall, undergraduate research participation is strongly related to students' pursuit of additional education beyond their undergraduate degrees. Therefore, targeting students with different academic performance levels may be beneficial in terms of student outcomes.

Our findings have implications for structured collaboration between academic and student affairs. UROP supports students' endeavors in out-of-class academic experiences by providing opportunities to participate on faculty research projects, exposing them to a core value of higher education—pursuit of knowledge via research. In addition, UROP's programmatic student support may help students to connect what they learn in the classroom with what they learn in their research experiences, as well as to negotiate the demands of the early years as an undergraduate at a large research institution. By providing a subenvironment, UROP helps students to integrate into the larger academic and social environment at the university. The creation of a smaller environment that fosters a sense of belonging for students may explain how UROP offsets the negative effect on graduate education pursuit of attending a large public research institution cited in the literature (Astin, 1993). Student affairs professionals can use undergraduate research participation programs as an avenue to facilitate more

structured and sustained faculty-student interactions. Conversely, undergraduate research programs can develop partnerships with student affairs to provide more comprehensive support services to their student-researchers.

Implications for Future Research

Future research may address the limitations of this study and the new questions that arise from its findings. First, though our analyses suggest that undergraduate research influences graduate education enrollment, we do not know the quality of the graduate programs that these students attended or their experiences. Did undergraduate student-researchers attend more competitive graduate or professional schools than did students who did not participate in undergraduate research? Were undergraduate researchers higher achievers than were undergraduate nonresearchers in similar graduate programs? Although we found overall positive results for any form of undergraduate research partnership on the pursuit of postbaccalaureate education, is there a qualitative difference in the preparation, performance, and experience of UROP students compared to non-UROP research students when they enter the graduate school? These same questions may help shed light on the similarities and differences between students who participate in structured programs such as UROP and those who participate in other types of undergraduate research.

Second, future research can also determine the role of college entrants' educational aspirations and their connection to graduate education pursuit. Though the undergraduate research and control students should be similar in terms of educational aspirations, we did not specifically control for aspiration

influence on graduate education enrollment. Research also needs to identify the components of the undergraduate research experience that are influential. We found that a programmatic research experience and other research experiences both influenced graduate education pursuit, but the programmatic research experience, UROP, appeared related to students' choice to pursue doctoral, medical, or law degrees. Why this difference? Future research can identify the components of students' undergraduate research experiences, such as what years in college they did research, through what means or programs, an assessment of specific parts of the research experience, and a ranking of what aspects of college influenced their graduate pursuits. A qualitative investigation can also look into the students' own understanding of the influences on their pursuit of graduate or professional education. Third, although we used undergraduate research participation as an indication of more personalized faculty-student interaction, future research is needed to determine the elements of that interaction that are related to graduate education and postgraduate research activity pursuit.

Fourth, although the theoretical model of the study did not draw upon the literature regarding mentoring, our findings suggest that mentoring may indeed be an important avenue to pursue in future studies. Faculty-student relationships centered on research may be conceived of as mentoring relationships. Kram (1983) proposed that such relationships comprise at least two elements: career advancement and psychosocial well-being. Career development may be seen to include aspects such as supervised research work, copresenting research, coauthoring papers, and other career advancing advice and opportunities. Psychosocial develop-

ment may include developing a supportive relationship, advice on coping with academic and personal challenges, and enhancing the mentored student's self-efficacy in other activities. Our analyses have focused squarely on career development as defined by graduate education experiences. Future research can expand on these aspects as well as explore the psychosocial development inherent in the mentoring process. This research can look at students' competency development through research, such as the interpersonal and cognitive skills involved in doing research and being part of a project team, their sense of efficacy in academic situations and problem solving, and the availability of support networks—and their use of them—as well as their own experiences of being a support person. Students' satisfaction in their chosen fields or careers, their ambitions, and their sense of making an impact in the world can also be included among these factors of psychosocial development. In addition, future research can investigate how faculty construct and define the undergraduate research experiences they provide for students. Do faculty see undergraduate research as an important part of a student's experience and are they therefore more likely to mentor students? Do faculty see undergraduate research as a way to stimulate interest in their fields? This list is by no means exhaustive, but is intended to stimulate thinking about future research with a mentoring framework to inform investigation.

Limitations

Our findings indicate an overall positive benefit of undergraduate research participation on graduate education pursuit. Before discussing the findings, however, we note some limitations to the study. This study was conducted with graduates from one large

Midwestern research university who participated in an undergraduate research program. Therefore, the findings may be specific to the institution and to the specific organization and implementation of the undergraduate research program. We do not know the type, form, or extent of the research experiences of those students in the sample who participated in other undergraduate research not related to the structured program under investigation. In addition, we do not know the extent, nature, and quality of the faculty-student interactions of the students who participated in UROP or other undergraduate research experiences. Although we controlled for incoming motivation to participate in undergraduate research or graduate education pursuit by matching of UROP participants and controls at initial application, we did not specifically measure students' incoming commitments and interests. Another set of limitations is related to assessing graduate education and research involvement. Survey questions did not ask for specific graduate programs in which students were enrolled. Therefore, at this time, we are not able to determine any distinctions, such as quality, prestige, and challenge, among those experiences.

Conclusion

This study, an investigation of the impact of undergraduate research on graduate education and activities, affirms the positive value of undergraduate research. Such involvement for undergraduates not only has positive effects on student retention as found in an earlier study, but also an enduring positive impact after graduation. The findings and discussion imply that undergraduate research programs can significantly increase their influence by reevaluating their scope, structure, and audience. The findings support

ideas for structuring programs in ways that can increase access to research and promote successful career development for a broad diversity of students, as well as build on students' interests in research upon entry to college, especially for underrepresented students of color whose graduate and professional education aspirations may otherwise lay dormant.

Our findings also have implications for the theory and literature on faculty-student interaction and its effects of students. These findings suggest that such interaction extends beyond the immediate time frame of the undergraduate experience. Faculty-student interaction around a research experience appeared to influence not only undergraduate retention and achievement,

but also enrollment and retention in graduate education and pursuit of professional academic fields. This suggests that faculty-student interaction can be structured around activities and programs designed to influence particular outcomes. Undergraduate faculty-student interaction, which is often cited as the key to the involvement-integration outcomes of retention and academic achievement at the undergraduate level, appears to encourage students to enroll in graduate and professional education as well.

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APPENDIX.

1. *Graduate education:* We were interested in both whether the respondents pursued graduate education in general, and also the specific type of degree (Master's, doctorate, professional, or other).
 - a. In separate questions, we asked respondents to indicate whether they had attended or were attending a graduate school. The first variable indicated whether they had pursued or were pursuing further education (1 = *further education*, 0 = *no further education*).
 - b. The second education variable made a distinction between those who pursued a professional degree and those who pursued a two-year graduate degree. All respondents who had already received or were currently on track to receive a professional degree (doctorate, law, or medical) were coded as 1. Those respondents who had received, or were in the process of receiving, an equivalent of a two-year graduate degree (master's, MBA, or other), or in the process, were coded as 0. (1 = *doctorate, law, medical degree*, 0 = *master's, MBA, other degree*). This variable (professional education), therefore, only includes those students who had indicated on the first variable that they had received or were receiving a graduate degree.
2. *Current research involvement:* We asked if the respondents were currently involved in any research activities. Respondents could answer yes or no. Space was also provided for them to describe the type of research activities in which they were engaged.

Contact with faculty: There were two questions of interest to us. Response choices for both questions were *yes* and *no*.

- a. One question asked the participants whether they used faculty for job recommendations (faculty recommendation).
- b. Another question asked whether they remained in contact with faculty after graduation (faculty contact).

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