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Motivational Resilience during COVID-19 across At-Risk Undergraduates

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Media reports suggest the switch to online courses due to COVID-19 has "demotivated" undergraduates. Our semester-long study of motivation for biology was in progress when COVID-19 was declared a pandemic. We analyze changes in student (*N* = 182) motivation from before and after. Across variables, subgroups of students changed in adaptive and maladaptive ways; some remained stable. In cross-tabulations, one significant difference was found by sex, and a number of adaptive and maladaptive differences by race and socioeconomic status (SES). Despite obvious burdens on low-SES groups, undergraduate motivation was affected positively and negatively in this sample; only some variables were related to intention to remain in STEM.

INTRODUCTION

Recent media reports suggest the switch to online courses due to COVID-19 has "demotivated" undergraduates (1–3), especially students from groups known to be at higher risk of STEM dropout, including females, historically underrepresented racial and ethnic groups (UREGs), and first-generation (1stGen) college students (4–6). Our online, semester-long study of biology student motivation was in progress when COVID-19 was declared a pandemic. Here, we analyze changes in student motivation from before and after the onset of COVID-19 in the United States by demographic group and we relate motivation to intention to remain (ITR) in a STEM major.

Motivation is not a unitary construct; a number of theories use different variables to predict academic achievement and choices (7) (Table 1). Many of these predict persistence: expectancy-value predicts this from valuing what is taught and not experiencing too many drawbacks (nonmonetary costs). Goal orientation (GO) predicts that learners' goals for education: to understand (mastery), to achieve a grade (performance), or avoid bad grades (avoidance) matter. Interest theory posits that a well-developed individual interest in a topic leads to more effort. Self-concept, the belief that one is good at a topic, is a predictor of persistence. Self-determination theory uses basic human needs for autonomy, relatedness, and competence as predictors of persistence. Social-cognitive theory focuses on task-specific confidence as a predictor of persistence. All have been tested across multiple ages, domains, and with achievement and choice (persistence) outcomes, but group differences in these effects have rarely been tested (14).

Most motivational variables decline over time, despite their importance for persistence (15). Originally we planned to track those declines, but we switched our focus to the changes from living on campus to stay-at-home, attending in-person to online, and to a country where, at that time more than 70,000 people had died, with Black, Latinx, and low-socio-economic status (SES) Americans disproportionately affected (16, 17).

While news stories have focused on economic, health, parenting, and other challenges faced during the pandemic (1–3, 16, 17), many families have at the same time found themselves closer. Might students show decreased motivation? Faced with these crises, perhaps undergraduates will lose interest, stop studying, and make learning a lower priority. Even in these circumstances, research on resilience suggests that some UREG students will see obstacles as challenges and rise to the occasion (18). Might undergraduates show a renewed interest and value for science, with an eye towards solving societal challenges?

The claim that the changes are demotivating the students placed at risk rests on the assumption that all low-SES students are in the former group, so beleaguered that they are giving up. Should we assume that low-SES students are not in the latter group, seeing the challenges as something they can help solve? This led to the following research questions and hypotheses: (1) How did motivation change? and (2) Were adaptive patterns of change more likely for placed-at-risk (female, UREG, or 1stGen/low-SES) college students? Regarding research question 1, the known difficulties of the pandemic might lead scores for all students to

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TABLE 1
Motivational variables, theoretical foundations, and effects on persistence.

Theory	Variable	Definition	Effect on Persistence
Expectancy-value (8)	Costs	Perceptions that time, effort, and foregone activities required by a major/course are too great	Negative
Goal orientation (9)	mastery GO	Construing the aim of learning as deep understanding of the content	Positive
	Performance GO	Construing the aim of learning as getting a good grade	Mixed
	Avoidance GO	Construing the aim of learning as avoiding getting a bad grade	Negative
Interest (10)	Topic interest	Feeling drawn toward a topic, wanting to spend more time learning about it and engaging with it	Positive
Self-concept (11)	Academic self-concept	Seeing oneself as good at a topic, seeing oneself as, e.g., a ‘biology person’	Positive
Self-determination theory (12)	Autonomy	Feeling that one has choices in learning, not feeling like a pawn manipulated by others	Positive
	Relatedness	Feeling connected, close to others with whom one learns (students, instructors)	Positive
	Competence	seeing oneself as good at a topic	Positive
Social cognitive theory (13)	Self-efficacy	Feeling confident that one can perform the subject-specific tasks required in a learning situation (e.g., take notes, do homework, write a lab report)	Positive

change in unfavorable directions (e.g., costs increase, self-efficacy decreases, and so on; Hypothesis 1a). On the other hand, some students might respond in a resilient manner, leading to variability in changes in motivation (Hypothesis 1b). Regarding research question 2, as with general changes in motivation, at-risk students might respond with resilience, based on the previous obstacles they have faced and overcome (Hypothesis 2a). On the other hand, they might be so beleaguered with health, familial, and economic challenges that they would show unfavorable changes (e.g., value decreasing; Hypothesis 2b).

METHODS

Context

We recruited participants from a traditional lecture course delivered in person through the eighth week of a 15-week spring 2020 semester at a large U.S. research university with almost no commuter students. Students attended one large lecture; hence there was no nested structure of the data. After a planned spring break week, the university required all teaching to move online due to the COVID-19 pandemic; almost all facilities were closed, and most employees were required to work from home. Students were also asked, if at all possible, to move out of on-campus student housing, and were provided prorated refunds for their room and board charges. Students who could not return home were permitted to remain in dormitories; recreation and most other fees were refunded to all students.

Participants

The original sample was 242 undergraduate students in an introductory biology course required for biology and related majors, who participated in exchange for a small amount of extra course credit. Students provided electronic consent via a waiver of documentation, and the entire study was approved by the university’s Institutional Review Board (IRB). Historically, 74% of the students in the course were STEM majors. Of the 242 participants, 182 provided both March and April data, which are analyzed here. Of the $N = 182$, the majority of those who answered the question on sex were female (67%). They were racially diverse, with the 44% White and 32% Asian students categorized as historically overrepresented (HO) and the 12% Latinx, 6% African American, and 6% of other or multiple races categorized as UREG. The majority (75%) were freshman, 13% were sophomores, 5% juniors, and 7% seniors, with a mean age of 18.85 ($SD = 0.94$). Twenty-four percent were from families where neither parent had earned a Bachelor’s degree (1stGen college students; our operationalization of SES). Students participated for 8 extra credit points out of 1,000 possible course points, prorated for completion of each of four monthly survey sessions. Per the approved IRB protocol, those under 18 or not desiring to be in a research study were offered an alternative activity for the same amount of extra credit.

PROCEDURES

Students expressing interest in the study were randomly assigned to a condition in a study-specific Blackboard site in January 2020. Each condition included answering an assigned 2 of 10 motivation questionnaires monthly (45 possible equally assigned conditions/pairs of motivation questionnaires using matrix sampling). The Blackboard site was constructed using adaptive release features such that the IRB-approved consent form had to be completed before the assigned questionnaires could be accessed, and only the assigned questionnaires were visible. Each participant then completed the following measures online at a time and place convenient to them: a demographics form, their two assigned motivational questionnaires (out of 10 questionnaires; see below), one open-ended contextual question, and the Intention to remain in STEM questionnaire. In February, March, and April, the same participants were asked to again complete the same two motivational questionnaires they had been assigned to and answered previously, the open-ended contextual question, and the Intention to remain in STEM questionnaire. Based on time recorded in the Blackboard site, each session lasted less than 10 minutes.

Data sources

We describe the demographics form, the 10 motivation questionnaires, the open-ended contextual question, and the intention to remain in STEM (ITR) questionnaire. The 11 questionnaires used 6-point Likert-type response options,

TABLE 2
Sources, number of items, published reliability, and sample item for each motivational scale.

Scale [Expected Direction of Change from Pandemic]	Source	No. of Items in this Scale	Cron-bach's α	Sample Item (Adapted to Read Biology Course or Major)
Interest [decrease]	PISA, 2012 (20)	4	0.91	"I am interested in the things I learn in mathematics [biology courses]."
Value [decrease]	Perez *et al.*, 2014 (21)	6	0.85	"How useful is taking science [biology] courses for what you want to do after you graduate and go to work?"
Costs [increase]	Perez *et al.*, 2014 (21)	6	0.81	"When I think about the hard work needed to get through my science [biology] major, I am not sure that getting a science degree is going to be worth it in the end."
Self-efficacy [decrease]	Pisa, 2012 (20)	5	0.92	"I am certain I can master the skills taught in this biology course."
Self-concept [decrease]	PISA, 2012 (20)	5	0.90	"I have always believed that mathematics [biology] is one of my best subjects."
Autonomy [no expectation]	Sheldon *et al.*, 2001 (22)	3	0.69	"[In biology courses] I feel that my choices are based on my true interests and values."
Relatedness [decrease]	Sheldon *et al.*, 2001 (22)	3	0.77	"[In biology courses] I feel close and connected with other people."
Mastery Goal Orientation [decrease]	Elliot & Murayama, 2008 (23)	3	0.84	"My aim is to completely master the material presented in [biology] class[es]."
Performance-Approach Goal Orientation [decrease]	Elliot & Murayama, 2008 (23)	3	0.92	"I am striving to do well [in biology courses] compared to other students."
Performance-Avoidance Goal Orientation [increase]	Elliot & Murayama, 2008 (23)	3	0.94	"My goal is to avoid performing poorly [in biology courses] compared to others."
Intention to remain in STEM [decrease]	Perez *et al.*, 2014 (21)	6	0.93	"I am not likely to leave my science major or science-related track."

most of which were: 1 = strongly disagree to 6 = strongly agree. Mean scores were calculated for each scale at each time point (see the ITR scale for one exception).

Demographics. In January, participants self-reported their sex (binary), race, age, year in college, major, mother's and father's highest level of education, and ACT reading and mathematics test scores.

Theoretical foundation for each motivation scale. All motivation scales were taken from the published literature and were constructed by their original authors from existing motivational theories. Autonomy and relatedness questionnaires were based on self-determination theory (12). The self-efficacy questionnaire was based on social-cognitive theory (13). The interest questionnaire was based on the topic interest construct from interest theory (10). The mastery goal orientation, performance-approach goal orientation, and performance-avoidance goal orientation questionnaires were based on goal orientation theory (9). The self-concept questionnaire was based on self-concept theory (11). The value and costs questionnaires were based on expectancy-value theory (8). The specific sources, number of items, published Cronbach's alpha reliability from the cited source, and a sample question from each scale are shown in Table 2. Obtained Cronbach's alpha reliability from the present study at each time point, ranging from acceptable (0.70) to excellent (>0.95), is shown in Table 3.

The Intention to remain in STEM questionnaire scores showed a very severe negative skew, as 42% of the sample was at ceiling in January. For analyses, we therefore divided respondents at each time point into a "completely committed to STEM" group (at ceiling) and an at-risk-of-dropout (not-at-ceiling) group.

Open-ended contextual question. One brief-response question was asked to gather data about the context for the student's responses, "What influences—from any part of your life—are impacting your feelings about your courses today?" We provide a few quotes from responses to this question in the present paper, but systematic analyses of those responses are reported in a separate submission.

Data analysis

For all students who reported both March and April scores on motivation variables, we calculated whether the student had increased, decreased, or stayed the same on that scale. For example, a student whose self-efficacy score increased from 25 in March to 30 in April was put in the increased group for self-efficacy. We then calculated chi-square tests and phi effect sizes using SPSS Ver. 26 for female vs. male, UREG vs. HO, and 1stGen vs. not 1stGen groups. We evaluate the phi effect size at 0.1 = small (representing about 15% more students in that demographic group decreasing in motivation compared with the reference group), 0.3 = medium (about 43% more students), and 0.5 = large (about 50% more students; [19]); all statistical tests were evaluated at an alpha level of <0.05.

RESULTS

For all variables, there were three subsets of students: increased on the variable from before to after the change, decreased, and stayed the same. Table 4 shows that almost all demographic comparisons were nonsignificant, but we take seriously the importance of effect sizes, especially given our small sample sizes.

Female students were more likely to decrease in self-concept and significantly more likely in self-efficacy; UREG students were more likely to decrease in mastery GO and valuing, and increase *or* decrease in performance-avoidance

TABLE 3
Differences in motivation between April at-risk-of-dropout vs. not-at-risk students.

	At Ceiling (Non-Dropout)			Not at Ceiling (Potential Dropout)			
Variable	***N***	***M***	***SD***	***N***	***M***	***SD***	***d***
Self-concept	14	17.0	4.5	21	12.0[a]	3.6	-1.23
PerfApp GO	19	16.2	2.4	24	13.0[a]	3.6	-1.07
Mastery GO	19	16.5	1.8	20	14.1[a]	2.8	-1.04
PerfAv GO	14	14.8	3.3	21	11.6[a]	4.0	-0.88
Interest	17	19.5	2.3	24	17.4[a]	3.1	-0.78
Autonomy	18	13.8	2.4	21	12.8	2.4	-0.42
Costs	15	17.8	7.9	18	20.1	6.9	0.31
Relatedness	16	12.4	3.4	19	11.3	3.7	-0.31
Self-efficacy	19	25.3	4.7	23	24.4	3.1	-0.23
Valuing	21	29.9	4.7	17	29.8	4.3	-0.02

[a] significant at $p < 0.05$.

GO = Goal Orientation; PerfApp = performance-approach; PerfAv = performance-avoidance.

TABLE 4
Proportion of students in each change group on each measure, with tests by demographics.

	Increased		Stable	Decreased		Female		UREG		1stGen	
Variable (Max)	N%	Mi	N%	N%	Md	χ^2	Phi	χ^2	Phi	χ^2	Phi
Interest (18)	44%	3.1	26%	31%	2.5	0.031	0.030	1.774	0.225	4.333	0.352
Value (36)	42%	4.2	18%	39%	4.2	1.303	0.224	3.818	0.383	0.615	0.154
Autonomy (18)	38%	2.8	23%	40%	2.4	0.257	0.084	0.732	0.143	4.512	0.354
Self-Efficacy (30)	33%	3.1	31%	36%	3.3	6.545*	0.426	1.200	0.183	2.667	0.272
Self-Concept (30)	28%	2.0	25%	47%	2.7	2.951	0.304	0.958	0.173	1.055	0.185
Mastery goal orientation (18)	27%	1.6	41%	32%	2.8	0.943	0.177	5.162	0.415	0.159	0.073
Performance-Approach goal orientation (18)	20%	2.0	51%	29%	3.2	1.427	0.202	1.540	0.210	2.294	0.256
Relatedness (18)	20%	2.0	29%	51%	2.9	0.729	0.161	3.960	0.376	3.865	**0.378**
Performance-Avoidance goal orientation (18)	16%	2.4	56%	28%	3.6	0.162	0.077	3.732	**0.372**	2.146	**0.282**
Costs (24)	38%	3.9	7%	55%	2.5	0.382	0.121	1.052	0.201	0.563	0.147

* Significant at $p < 0.05$.

GO; 1stGens were more likely to increase in interest, performance-approach GO, and relatedness; 1stGens more often showed decreases in autonomy, self-efficacy, and performance-avoidance GO.

The differences in April motivation variables between those at ceiling on ITR and those not at ceiling (dropout at-risk) is shown in Table 3. Gaps between at-risk and not-at-risk were in all of the GO variables in interest and in self-concept; in all cases, the at-risk group scored lower.

DISCUSSION

The claim that moving online demotivates disadvantaged students was mostly unsupported. Adaptive and maladaptive responses are consistent with the resilience literature, and support Hypothesis 2a, where UREG students rise to challenges before them (18).

Other changes not specific to "disadvantaged" students are perhaps unsurprising considering the context: biology-relevant COVID-19 news coverage, leaving a perceived competitive campus for a close family or highly social students leaving campus for a socially isolated high-pressure family, no spontaneous connections with classmates, and physical distancing blocking activities that make studying "costly." The self-concept and interest findings are quite consistent with prior research (10, 11), but not so those for GO (9). Perhaps being pulled by forces at home and being away from the grade-focused atmosphere pulls students away from all aspects of achievement.

Considering placed-at-risk groups, perhaps self-variables decline more for females once separated from supportive friends. For UREGs, the dramatically higher burdens due to COVID-19 might move focus away from understanding and to simply finishing. For 1stGens, perhaps decreased social comparison at home lowers performance-avoidance, and aims for future achievement and economic mobility increase (24).

Both Hypotheses 2a and 2b were supported. Some students gave up: "This transition from in person classes to online classes has been really hard for me. I don't think i'll be able to pass X and my lack of knowledge will prevent me from [moving] onward to future classes" (Female, UREG, 1stGen), while others were inspired by their potential contributions: "The fact that I get to achieve my dreams of becoming a doctor and helping to end disparities within the healthcare system is what motivates me every day to try my hardest in this course" (Female, UREG, 1stGen).

Limitations

The small sample sizes result in a number of limitations to this study: statistical power is limited for measuring changes in motivation, and especially for looking at motivation changes by group. The sample was taken from one 4-year, research-intensive university only; results might have been different for 2-year and/or teaching-focused institutions.

CONCLUSION

Evidence does not suggest massive demotivation for disadvantaged students, but instead a much more nuanced picture. Students are reacting to the combination of worry about COVID-19, the move home, and online learning in quite individual ways that cannot simply be predicted by being in a placed-at-risk group or not. Low-SES, Black, and Latinx families have been disproportionately harmed medically and economically in the pandemic; no data suggest otherwise. In the face of these challenges, some students become more committed to learning, while others are so beleaguered their dedication to achievement flags.

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