

Supplemental Material

CBE—Life Sciences Education

Cooper *et al.*

Supplemental materials for
The experiences of students with depression in undergraduate research
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Establishing depression and cause

The goal of this study is to interview students about their experiences with depression, so my first question is, have you experienced depression, either currently or in the past?

Many people with depression also have extreme feelings of anxiety. Have you experienced extreme feelings of anxiety, either currently or in the past?

- If yes:
Is there a link between your feelings of depression and anxiety? Can you describe this?

What tends to trigger your feelings of depression broadly?

What tends to trigger your feelings of depression in undergraduate research?

What are the symptoms of your depression broadly?

What are the symptoms of your depression in undergraduate research?

Effect of undergraduate research on depression

What, if anything, about undergraduate research makes your depression worse?

What, if anything, about undergraduate research helps you manage your depression?

Relationships in the lab and depression

Did you work with a graduate student or postdoc research advisor during your undergraduate research experience?

- If yes:
- How, if at all, did your relationship with your grad student or postdoc research advisor negatively affect your depression?
- How, if at all, did your relationship with your grad student or postdoc research advisor help you manage your depression?

Did you ever interact with your faculty research advisor during your undergraduate research experience?

- If yes:
- How, if at all, did your relationship with your faculty research advisor negatively affect your depression?
- How, if at all, did your relationship with your faculty research advisor help you manage your depression?

Did you ever interact with other undergraduates during your undergraduate research experience?

- If yes:
- How, if at all, did your relationship with the undergraduate researchers negatively affect your depression?

- How, if at all, did your relationship with the undergraduate researchers help you manage your depression?

How depression symptoms affect undergraduate research experiences

How do you think depression affected your research experience?

- How, if at all, think that your depression affected your research creativity?
- How, if at all, do you think that your depression affected your relationships with your mentors?
- How, if at all, do you think that your depression affected your ability to complete tasks?
- How, if at all, do you think that your depression affected what you accomplished in your research experience?
 - If depression affects the student's ability to complete tasks or what they accomplish in research follow up with: Does your mentor (grad student, postdoc, or faculty) ever notice when you don't complete a task or accomplishment?

Copy of student and research demographic questions

I most closely identify as

- Female
- Male
- Other (please describe)
- Decline to state

I most closely identify as

- American Indian or Alaska Native
- Asian
- Black or African American
- Hispanic, Latino, or Spanish origin
- Pacific Islander
- White/Caucasian
- Other (please describe)
- Decline to state

I most closely identify as

- A first-generation college student whose parents' highest level of education is a high school diploma or less
- A first-generation college student (at least one parent has some college)
- Non-first generation college student (at least one parent has finished college)
- Decline to state

Please indicate the option that most closely reflects your college experience

- I transferred to this institution from a 2-year college, community or junior college
- I transferred to this institution from another 4-year institution
- I started my college career at this institution
- If none of the above reflect your experience, please describe your experience below
- Decline to state

What is your major?

- Biological Sciences/Biology
- Biochemistry
- Chemistry
- Physics
- Other, please describe

How old are you?

During your time in undergraduate research, did you consider yourself financially stable (e.g. have enough money for necessities such as rent and groceries)?

- Yes
- Yes, but only sometimes
- No
- Decline to state

How long have you attended college while pursuing your undergraduate degree?

- 1 year or less (first-year student)
- 2 years (sophomore)
- 3 years (junior)
- 4 years (senior)
- 5 years or more
- I have graduated with my undergraduate degree
- Decline to state

Please choose the response that reflects how long you participated in your first undergraduate research experience.

- Less than 6 months
- 6 months
- 1 year
- 1.5 years
- 2 years
- 2.5 years
- 3 years
- 3.5 years
- 4 years or more
- Decline to state

On average, how many hours per week do/did you spend working on research (inside or outside of the lab)?

- 1-5 hours
- 6-10 hours
- 11-15 hours
- 16 hours or more
- Decline to state

Please choose the response that most accurately describes how you are/were compensated for your time working in undergraduate research. Choose all that apply.

- I receive/received course credit for my time participating in undergraduate research
- I receive/received money for my time participating in undergraduate research
- I volunteer/volunteered my time in undergraduate research (do not/did not receive credit or money)
- Decline to state

Please indicate who you work/worked with most closely during your first undergraduate research experience.

- PI (Principal Investigator)/faculty member
- A graduate student
- A post-doc
- A staff member (e.g. lab coordinator, lab manager)
- Other, please describe

What is the focus area of your first research experience? (e.g. animal behavior, neurobiology, cancer bio)

Copy of depression demographic questions

For these interviews, we are interested in the experiences of **all students, regardless of whether they have been formally diagnosed with depression, and regardless of whether they are being treated for depression**. Thus, there are no right or wrong answers to these questions. We are simply trying to learn more about your experience.

Have you been diagnosed with depression?

- Yes
- No
- Decline to state

Are you currently being treated for, or have you previously been treated for depression?

- Yes
- No
- Decline to state

If yes, how has your depression been treated?

- Medication (e.g. antidepressants)
- Counseling/therapy (e.g. working with a psychologist or therapist)
- Other (please describe)
- Decline to state

Table S1. Individual student demographics

Pseudonym	Gender	Race/ethnicity	College gen. status	Transfer	Financially stable	Year in college	Age	Major	Focus area of research	Length of research experience	Avg. hours per week in research	Compensation for research	Primary mentor	Institution	Clinically diagnosed with depression	Treated for depression
Marta	Female	Latinx	Yes	No	No	4+	21	Biology	Immunology	6 months	16+ hours	Money, credit	Graduate student	Public R1, #1	Yes	Yes, medication, counseling, other
Mia	Female	Asian	No	No	Sometimes	3rd	20	Biology	Epigenetics	1 year	11 - 15 hours	Credit	Graduate student	Public R1, #11	Yes	Yes, counseling
Alexandra	Female	Latinx	Yes	No	Sometimes	4+	22	Biology	Animal physiology	1.5 years	11 - 15 hours	Credit	Graduate student	Public R1, #1	No	No
Abby	Female	White	No	No	Sometimes	4+	21	Biology	Genetics	3 years	6 - 10 hours	Credit	Graduate student	Public R1, #1	No	No
Taylor	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Decline	Public R1 #6	Yes	Yes, medication, counseling
Michelle	Female	Asian	Yes	No	Sometimes	3rd	20	Biology	Psychology	1 year	6 - 10 hours	Credit, volunteer	Graduate student	Public R1, #4	Yes	No
Rose	Female	Asian	No	No	Yes	3rd	20	Biology	Neurobehavior	3 years	11 - 15 hours	Money, credit, volunteer	Graduate student	Public R1, #1	Yes	Yes, medication, counseling
Sydney	Female	Mixed race	No	No	Yes	1st	18	Biology	Climate paleontology	less than 6 months	6 - 10 hours	Volunteer	Postdoc	Public R1, #2	No	No
Megan	Female	White	Yes	Yes	Sometimes	4+	22	Biology	Animal behavior	1.5 years	16+ hours	Money, credit	Graduate student	Public R1, #8	Yes	Yes, medication, counseling
Ashlyn	Female	White	No	No	Sometimes	2nd	19	Biology	Pathology/immunology	1 year	6 - 10 hours	Credit	Staff	Public R1, #1	No	No
Julie	Female	White	No	No	Yes	4+	21	Biochemistry	Structural biology	1 year	16+ hours	Money, credit	PI	Public R1, #5	Decline	Decline
Adrianna	Female	Latinx	Yes	No	Sometimes	4+	21	Biology, chemistry, mathematics	Cancer	2 years	6 - 10 hours	Credit	Staff	Public R1, #1	Yes	Yes, medication
Kristine	Female	White	No	No	Yes	4+	21	Biology	Biological oceanography	1.5 years	6 - 10 hours	Credit, volunteer	Graduate student	Public R1, #7	Yes	No
Clint	Male	White	No	Yes	No	4+	23	Biology	Entomology	2 years	16+ hours	Money	Staff	Public R1, #1	No	Yes, medication, counseling
Shannon	Female	White	No	No	Sometimes	4+	20	Biology	Virology/immunology	6 months	11 - 15 hours	Decline	Graduate student	Public R1, #7	No	No
Crystal	Female	White	No	No	Yes	4+	22	Biology	Microbiology	less than 6 months	1 - 5 hours	Credit	Graduate student	Public R1, #10	Yes	Yes, medication, counseling
Briana	Female	Black	Yes	Yes	No	4+	21	Biology	Genetics	less than 6	1 - 5	Volunteer	PI	Public R1,	Yes	No

										months	hours			#11		
Landon	Male	White	No	No	Yes	2nd	21	Neuroscience	Neuroscience	6 months	6 - 10 hours	Credit	PI	Public R1, #1	Yes	Yes, counseling, other
Donovan	Male	White	No	No	Yes	3rd	20	Biology	Molecular microbiology	3 years	16+ hours	Money, credit	PI	Public R1, #7	Yes	Yes, medication, counseling
Christian	Male	White	No	No	Sometimes	3rd	20	Biology	Neuroscience	1 year	11 - 15 hours	Credit	Staff	Public R1, #1	Decline	No
Jill	Female	White	No	No	Yes	4+	21	Biology	Ecology	less than 6 months	6 - 10 hours	Credit	PI	Public R1, #11	No	No
Reema	Female	Middle Eastern	Yes	Yes	Sometimes	4+	22	Biology	Molecular biology	6 months	6 - 10 hours	money, volunteer	Postdoc	Public R1, #5	Yes	No
Kelley	Female	White	Yes	No	No	4+	22	Biochemistry, chemistry	Plant pathology	1.5 years	6 - 10 hours	Money	Postdoc	Public R1, #12	No	No
Natasha	Female	Asian	No	No	Yes	4+	22	Biology	Linguistics	1 year	6 - 10 hours	Money	Staff	Public R1, #9	Yes	Yes, medication, counseling
Heather	Female	Asian	No	No	Yes	4+	22	Biology	Linguistics	1 year	6 - 10 hours	Money	PI	Public R1, #9	Decline	Decline
Meleana	Female	Asian	No	No	Yes	4+	22	Biology	Linguistics	1 year	6 - 10 hours	Money	Staff	Public R1, #9	Yes	Yes, medication, counseling
Naomi	Female	Asian	No	No	No	3rd	20	Biology	Public health	1 year	6 - 10 hours	Credit	Staff	Public R1, #11	No	Yes, counseling
Freddy	Male	White	No	No	Yes	4+	22	Biology	Diabetes	3.5 years	11 - 15 hours	Money, credit	PI	Public R1, #10	Yes	Yes, medication, counseling
Brian	Male	White	No	Yes	No	4+	25	Biology	Aquatic vegetation	less than 6 months	1 - 5 hours	Credit	PI	Public R1, #1	No	No
Amy	Female	Latinx	Yes	No	Sometimes	4+	22	Biology	Genetics	1 year	6 - 10 hours	Money	Graduate student	Public R1, #4	Yes	Yes, medication, counseling
Carli	Female	Latinx	Yes	No	Sometimes	2nd	19	Biology	Herbalism	less than 6 months	6 - 10 hours	Credit	PI	Public R1, #1	Decline	No
Brandi	Female	White	No	No	Yes	4+	21	Biology	Antibiotic resistance	6 months	1 - 5 hours	Credit	Graduate student	Public R1, #10	Yes	Yes, medication, counseling
Hope	Female	Asian	No	No	Yes	2nd	19	Biology	Social insects	6 months	1 - 5 hours	Credit	Graduate student	Public R1, #1	Yes	Yes, medication, counseling
Jessica	Female	Asian	No	No	Yes	4+	21	Biology, sociology	Group processes/sociology	1 year	11 - 15 hours	Credit, volunteer	Undergraduate student	Public R1, #11	Yes	No
Tim	Male	White	No	No	Yes	2nd	19	Biology	Genetics	less than 6 months	1 - 5 hours	Credit	Graduate student	Public R1, #3	Yes	Yes, medication, counseling

Table S2. Characteristics of the institutions that the interview participants represent

University	Type	Geographic location	Undergraduate enrollment (approximate)
#1	Public, R1	Southwest	~52,000
#2	Public, R1	Southeast	~16,000
#3	Public, R1	Midwest	~33,000
#4	Public, R1	Northeast	~18,000
#5	Public, R1	Southwest	~31,000
#6	Public, R1	Southwest	~30,000
#7	Public, R1	Southeast	~19,000
#8	Public, R1	Southeast	~59,000
#9	Public, R1	Northeast	~24,000
#10	Public, R1	Midwest	~22,000
#11	Public, R1	Northeast	~31,000
#12	Public, R1	Northwest	~24,000

Coding rubric - General symptoms of depression

Theme	Description of theme	n (%) (n = 35)
Has anxiety that is related to depression	Student indicates that their depression is also linked with feelings of anxiety. Student can indicate that anxiety precedes depression or that depression results in anxiety.	29 (83%)
Difficulty getting out of bed or leaving the house	Student describes that their depression causes them to not want to get out of bed or causes them to struggle to leave the house.	20 (57%)
Tiredness	Student describes that a symptom of their depression is feeling fatigue or tired. This can also be described as sleeping a lot.	14 (40%)
Lack of motivation	Student describes not being motivated or feeling lazy.	12 (34%)
Self-criticism or lack of self-confidence	Student describes being particularly hard on themselves, criticizing themselves, feeling inadequate, or lacking self-confidence.	11 (31%)
Apathetic	Student describes a lack of interest, enthusiasm, or concern for tasks, events, opportunities, or people.	9 (26%)

Difficulty concentrating	Student describes that a symptom of their depression is having difficulty concentrating.	7 (20%)
Difficulty completing tasks	Student describes that they have difficulty completing tasks or getting things done. This is general and not specifically related to their research.	5 (14%)
Trouble sleeping	Student has difficulty falling asleep or staying asleep.	4 (11%)
Hopelessness	Student describes that a symptom of their depression is a general feeling of hopelessness.	4 (11%)

Coding rubric – Symptoms of depression that affect undergraduate research

Theme	Description of theme	n (%) (n = 35)
Motivation and productivity (reported by 80% of students)		
Lack of motivation in research	Student describes that their depression causes them to be less motivated or too lazy to do research. A student can also mention that depression causes them to be uninterested in the work, which we are coding here because disinterest is tightly tied to lack of motivation.	24 (69%)
Lower productivity	Student describes that their depression causes them to be less productive in their research. This can also be described as being less efficient or having trouble completing research tasks. Student describes that their depression causes them to work more slowly than they usually would when they are feeling OK.	19 (54%)
Creativity and risk taking (reported by 54% of students)		
Lack of creativity	Student describes that they are less likely to be creative in research because of their depression.	14 (40%)
Held student back from contributing thoughts/ideas or taking risks	Student describes that they are less likely to contribute a thought, idea, etc. that they already had or that they are less likely to take risks and try new things related to their experiments during research when they are depressed.	7 (20%)
Engagement and Concentration (reported by 57% of students)		
Difficulty concentrating or remembering	Student describes that their depression causes them to have difficulty concentrating, remembering things, or focusing during research.	13 (37%)
Lack of intellectual engagement	Student describes that they have trouble intellectually engaging in a project or they have trouble doing intellectually draining research tasks.	12 (34%)
Self-perception and socializing (reported by 57% of students)		
Less social	Student describes that their depression causes them to not want to interact with others in the lab as much and can hinder their relationships with others in the lab.	11 (31%)
Overly self-critical/low self-esteem/low self-confidence	Student describes that their depression causes them to be overly critical of their performance in research.	14 (40%)

Coding rubric - Factors associated with undergraduate research that negatively affect student depression

Theme	Description of theme	n (%) (n = 35)
Social comparison to successful others in the lab (students and faculty)	Student states that they compare themselves to others. Student describes that they compare their success to someone, how intelligent someone else is, or how others have relationships with certain people in the lab, including the PI. The people whom the student is comparing themselves to need to be a member of the research team or related to research in order for this to be coded; for example, comparing themselves to a friend who is not in the lab is not coded here.	23 (66%)
Research is time-consuming and there are an overwhelming number of responsibilities	Student states that an overwhelming number of responsibilities in research or that research demands a high time commitment, which negatively affects depression. Student can also discuss how it would be helpful if the PI or others in their lab understood a student schedule or accommodated for exams, etc. Student states that research is time consuming or inflexible; student describes needing to be in lab at certain times, being needed for too much time, and/or not being able to call out or not show up negatively contributes to their depression. This includes needing to do research late at night, over the weekend, etc.	23 (66%)
Failing in science/messing up	Student describes that failing in science or messing something up can cause depressive feelings.	17 (49%)
Feeling alone or isolated, or a lack of stimulation, lets the mind run	Student describes a situation that is lacking stimulation, (e.g. being alone or doing a specific task) that lets their mind run, can lead to depressive thoughts. This theme also includes if a student explains that being lonely can negatively affect their depression	16 (46%)
Not enough guidance	Student describes feeling uncertain about what to do, there is not enough guidance, or there are miscommunications about what they should be doing. Student describes that the expectation that they will figure something out on their own or be independent can exacerbate depression.	15 (43%)
Contribution is unimportant	Student describes that they believe that their contribution to the lab is unimportant or that their work is not viewed as important by others.	12 (34%)
Too high of intellectual expectation from others/too much	Student states that others demand too much of them intellectually. This could also be too high of expectations on one's self.	10 (29%)

pressure		
Not wanting to disappoint or let down others	Student describes that a fear of letting down or disappointing others affects their depression. This also includes if a student worries about inconveniencing someone.	10 (29%)
Critique or blame from others	Student states that when others in the lab critique them, yell at them, or blame them for something, it can exacerbate their depression. This does not include if someone is generally in a bad mood or yelling at someone else because that would be coded under “negative interactions in lab.”	10 (29%)
Fear of being negatively evaluated	Student describes that they have a fear of others negatively evaluating them. This can include a student worrying that someone hates them, dislikes them, etc. This includes a student worrying that they might be perceived of as stupid or incompetent.	9 (26%)
Uninterested in their research project	Student describes that being uninterested in their research project can negatively impact their depression. Student often describes that it is difficult to be motivated to engage with research that they do not find interesting.	9 (26%)
Negative interactions in the lab	Student mentions that anyone's nasty attitude, disparaging comments (not criticism), or acts of harassment can negatively contribute to their depression. However, if a student mentions being critiqued by others, this is coded in a different category. Student can mention that other people's attitudes can make the lab feel a certain (negative) way and that attitudes can spread from one person to another. Student can also mention that they feel left out in the lab because they are intentionally left out or uninvited to go places - this is distinct from feeling lonely which is categorized elsewhere.	8 (23%)
Student is intimidated by the intelligence of others in authority	Student describes that they are intimidated by how smart others in authority in the lab are. This includes feeling stupid or dumb because they feel like you can't ask a question (not because they won't answer it or will be mean) but because they feel like they aren't smart enough.	5 (14%)
Someone is actively working/fighting against their success in research	Student describes that someone (e.g. a PI or grad student) is actively working to prevent them from being successful in research.	4 (11%)
Lack of validation/praise	Student describes that not being praised or validated for their effort/work in research can exacerbate depression.	3 (9%)

Coding rubric - Factors associated with undergraduate research that positively affect student depression

Theme	Description of theme	% (n) (n = 35)
Social connections in the lab	Student describes that connecting with others in the lab is helpful for their depression. This can include building relationships with other undergraduates, graduate students, postdocs, lab staff or faculty. Students often describe that building relationships with others helps them to not feel lonely, feel like they can relate to others, or feel understood by others. This category includes students enjoying talking with others.	23 (66%)
Research is something to do and keeps the mind busy	Student describes that research in general helps their depression or describes research as an escape from their depression. Specifically, students will describe that doing a certain type of task is helpful for their depression.	22 (63%)
Interest	Student describes that they are interested in their research, which positively affects their depression.	20 (57%)
Professional connections in the lab	Student describes a mentor (PI, postdoc, or graduate student) who supports them professionally, respects their professional goals, or provides professional encouragement - this often comes in the form of giving advice or sharing their own experience. Professional encouragement includes whenever a member of the lab (including the PI) shares their struggles (unrelated to depression). If student discusses that their relationship with someone helps them with their research, this is coded as "help in the lab." Be aware that students may describe a "personal" relationship with faculty but then describe what we would code as a professional relationship.	19 (54%)
Contributions are important	Student states that making important contributions or accomplishing an important task positively affects their depression. The student can describe that they are making an important contribution to the project or to the greater science community.	19 (54%)
Positive validation or praise from others	Student describes that praise, validation, or recognition from others in the lab (typically more senior people) helps their depression.	18 (51%)
Help in the lab	Student describes that when others in the lab offer help with regard to lab tasks or make themselves available for students to ask for help it helps their depression.	17 (49%)
Flexible schedule	Student states that being able to come in when they want, being able to take time off when they want, or being able to work when they feel most productive positively impacts their depression. Student can also mention that their PI is	15 (43%)

	flexible and that they understand that they have other commitments besides research.	
Completing tasks gives a sense of accomplishment	Student describes that they enjoy completing tasks because it gives them a sense of accomplishment and therefore, it is helpful for their depression. If students like completing tasks because it keeps their mind busy, that is not coded here. If student indicates completing tasks is helpful for their depression because the task is important to the lab, that counts as "contributions are important."	14 (40%)
Reasonable/high expectations	Student states that they like having reasonable or high intellectual expectations placed on them by a mentor.	5 (14%)
Norming or talking about depression	Student mentions that others in the lab are open about having depression or talk positively about mental health.	2 (6%)