University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

The Impact of User-Control in Study Spaces on Student Stress

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Executive Summary

This study aimed to investigate the effect of increased-user-control design features on perceived stress levels among undergraduate students in study spaces. Although we investigated multiple hypotheses, simply put, we hypothesized that increased user-control would lower perceived stress levels. We conducted a between-subjects experimental design with two conditions: a no-user-control condition, and an increased-user-control condition, where participants rated their stress levels before and after exposure to photographs [with descriptions] of study space features varying in user-control. Results from Welch's t-tests revealed that students in the increased-user-control condition reported significantly lower stress levels and a greater reduction in stress levels than those in the no-user-control condition. Furthermore, a repeated measures ANOVA test indicated for both groups similarly significant preferences for increased-user-control study space features. Despite some limitations, these findings suggest that including user-control in study spaces can lower perceived stress levels among students. Moreover, our findings emphasize the importance of increased-user-control study space features in accommodating students' preferences. Considering our results, we recommend that universities design learning spaces with user-control features to reduce student stress and create more inclusive environments that cater to the diverse needs of their student population.

Keywords: user-control, perceived stress, between-subjects, Welch's t-test, repeated measures ANOVA

The Impact of User-Control in Study Spaces on Student Stress

The availability of control influences how people experience and respond to stressful situations. *User-control* is defined as the extent to which an individual can manipulate their environment to suit their preferences and needs (Robertson & O'Neill, 2016). In recent years, more institutions are incorporating user-control strategies, such as office ergonomics, to alleviate worker stress (Huang et al., 2004; Kellert & Calabrese, 2015). Integrating user-control into workspaces can also optimize an individual's performance and health (Robertson & O'Neill, 2016). For instance, research shows that workstation designs that offer greater control over thermal settings promote environmental satisfaction and positive well-being (O'Neill, 1992). It has also been shown that a person's ability to cope with stress depends on their understanding of their ability to alter environmental circumstances (Linden et al., 2005; Khan et al., 2012). While these studies measure various quantifications of stress, our research will focus on *perceived stress* — the degree to which a person experiences stress based on their assessment of their stress levels.

While previous studies have addressed the effects of perceived control over a work environment on stress, there is a lack of research on how control over one's *study* environment may alleviate *student* stress. Ahmad et al. (2022) found that workplace factors, such as the quality of a working space atmosphere, can increase stress among university instructors. They observed that low-quality workspaces exaggerated stress, which then interfered with work performance. Considering that work environment conditions can impact stress levels, Robertson & O'Neill (2016) found that an increased sense of control over a physical workspace, achieved through adjustable features, is linked to decreased levels of stress. Similarly, Huang et al. (2004) found that integrating ergonomics training into office workplaces can improve a worker's knowledge of their control over their working environment. They found that optimizing a study space by giving the user an increased sense of control can have a direct influence on psychological stress. These studies conclude that greater perceived control over situations improves stress resilience. Our research takes this notion and centers it on university students who encounter high-stress situations, particularly in academic settings (Eisenberg et al., 2007).

The current study aims to fill in this knowledge gap by examining the relationship between user-control over a study space and perceived stress levels. This study's importance lies in its potential to inform educational institutions and designers about how to create spaces that encourage and support student success. This research will be novel as it will contribute to the limited knowledge of the relationship between user-control and stress levels in study spaces. However, the lack of understanding of the benefits of user-centered designs and the cost to include them in study spaces may also be limiting factors.

Research Question and Hypothesis

We aimed to answer the question: "How does user-control in study spaces impact students' perceived stress?"

First, we hypothesized that participants with no user-control will experience significantly higher perceived stress levels than participants with increased user-control [H_1: $x_1 > x_2$].

Second, we hypothesized that participants with no user-control will have an increase in their perceived stress level [compared to their preliminary stress level], whereas participants with increased user-control will experience a decrease in perceived stress, and these changes will be significantly different [let x_0 = mean preliminary stress; H_2: $(x_1 - x_0) > (x_2 - x_0)$].

Last, we hypothesized [H_3] that when participants in both conditions are asked about their preferences for study space features [after their assigned condition], both groups will show a

strong preference towards increased-user-control features (i.e., the mean preference values will be significantly closer to 7 than 1 for all features). This is further explained in the results section through a data modulation.

Methods

Participants. For our results to be statistically significant, a sample size of 134 participants was needed. This was based on a power analysis with a power of .8, an alpha of .05, and an effect size of .2. We initially surveyed 159 participants, however, 22 were excluded due to blank surveys. Our final sample was N = 137, with 59.40% undergraduate UBC students and 40.60% undergraduate students from other universities. The mean participant age was 21 with a standard deviation of 2.75. The youngest participant was 17 years old, and the oldest was 41. Exactly 50.00% of our sample identified as women, 46.27% as men, and 3.73% as non-binary. We gave the option of "Two Spirit" and "Other", but no participants identified as such. 2.24% of participants were first years, 17.16% were second years, 25.37% were third years, 48.51% were fourth years, and 6.72% chose the "other" option.

Conditions. In our study, the independent variable was the degree of user-control within study space features. Our study consisted of two conditions: no-user-control vs. increased-user-control. Participants were randomly assigned one of two conditions, with the no-user-control condition consisting of 67 participants, and the increased-user-control condition having 70 participants. Participants in the no-user-control condition were shown features with limited user-control, such as a study desk that is not height-adjustable, a stationary chair, a window that cannot open, and a "no food or beverage" sign. Participants in the increased-user-control condition were shown features with increased user-control, such as a height-adjustable desk, a swivel chair, a window that can open, and a sign that indicates that they are allowed to eat and drink in the study space.

Measures. Our dependent variable was an individual's perceived stress level. We defined perceived stress as the degree to which an individual assesses their personal stress level at a given moment in time. We found existing scales, such as the 'Perceived Stress Scale' (PSS) and 'Positive and Negative Affect Schedule' (PANAS), not aligned to our research focus, so we chose to use a seven-point Likert Scale (i.e., 1 to 7) instead of the five-point scale (i.e., 0 to 4) found in PSS and PANAS (refer to Appendix A). This gave participants a wider range of options to describe their perceived stress level. We combined a measurement for perceived stress with a UX approach, which enabled participants to imagine themselves using their assigned study space features. After this, we asked preference questions to see if participants favoured increased-user-control or no-user-control study space features.

Procedure. First, participants were shown the consent form (refer to Appendix A). Once they consented to the survey, they were randomly assigned to one of the two conditions (refer to Appendix D figure 1, for a flowchart of the condition assignments). Initially, participants in both conditions were asked to rate their current perceived stress levels ranging from 1, which meant "not at all stressed", to 7, which meant "extremely stressed". This data was recorded as the "preliminary perceived stress level". Afterwards, participants were shown four study space features. Those in the no-user-control condition were shown features with limited user-control, such as a stationary wooden chair. Participants in the increased-user-control condition were shown features with more user-control, such as a swivel chair. Participants were asked to imagine that they are studying in the space for one hour with the given study space features. After, they were asked how stressed they would feel in the space using the same seven-point Likert Scale as before. This data was the "post-condition perceived stress level."

After the primary questions that directly related to our initial hypothesis, participants were asked about element preferences and their demographics. Participants were shown both versions (i.e., no-user-control vs. increased-user-control) of each feature and asked about which they would prefer in their on-campus study space. A seven-point Likert Scale was utilized to measure responses with 1 meaning "strongly prefer the original [feature]" and 7 meaning "strongly prefer the new [feature]." 'Original' refers to the version of the feature that was a part of their condition, and "new" refers to the feature from the condition they were not exposed to. For example, if a participant was in the no-user-control condition, "original" would refer to the stationary chair, and "new" would refer to the swivel chair.

The demographic questions asked for participants' gender identity, age, level of education, and whether they are UBC students. The end of the survey included a reference page that cited the images used as study space features. The survey was distributed via social media (e.g., Instagram), and through sending an anonymous link to students (see Appendix B).

Results

To investigate the research question and hypotheses, a series of statistical analyses were conducted to examine the impact of user-control on participants' perceived stress levels and their preferences for certain study space features. Since the sample sizes were unequal in each group, we first conducted Welch's t-tests for independent samples to investigate Hypotheses 1 and 2 (H_1 & H_2). For H_1, we conducted a one-tailed Welch's t-test to compare the perceived stress levels of students with no user-control to those with increased user-control. The results showed a significant difference between the two conditions, $t(126.448) = 8.322$, $p < .001$ (see Appendix E, Figure 2), with students in the increased-user-control condition reporting significantly lower stress levels (Mean = 2.471, SD = 1.282) compared to those in the no-user-control condition (Mean = 4.537, SD = 1.599). Refer to Appendix E Figure 2 for the descriptive data. The mean difference between the two conditions was 2.066, with a 95% confidence interval (CI) ranging from 1.655 to infinity. The effect size (Cohen's d) was large at 1.426 (see Appendix E, Figure 2). These results support H_1's notion that participants in the increased-user-control condition would experience significantly lower perceived stress levels than those in the no-user-control condition. For visualizations of the [post] perceived stress levels, refer to Appendix E Figure 2.

The second one-tailed Welch's t-test was conducted to investigate the change in perceived stress from preliminary to post-condition [H_2: $(x_1 - x_0) > (x_2 - x_0)$]. The results showed a significant difference in stress level change between the two conditions, $t(128.709) = 6.646$, $p < .001$ (see Appendix F Figure 3). Students in the increased-user-control condition reported a reduction in stress levels (Mean = -1.314, SD = 1.499); whereas participants with no user-control experienced an increase in their perceived stress (Mean = +0.567, SD = 1.794). Further details concerning the descriptive data for the changes in perceived stress can be found in Appendix F Figure 3. The mean difference in stress level change was 1.881, with a 95% CI ranging from 1.412 to infinity. The effect size (Cohen's d) was also large at 1.138 (see Appendix F, Figure 3). The results directly align with H_2's inference that participants with no user-control would have an increase in perceived stress [compared to their preliminary stress level], whereas participants with increased user-control would have a decrease in perceived stress; and that there is a significant difference between these changes.

Lastly, we performed a 'Repeated Measures ANOVA' to investigate the preferences for study space features among participants, focusing on between-subjects effects. To make this work, we modulated the preference values for the participants in the increased-user-control condition to match the scaling order of those in the no-user-control condition (see Appendix G

for a thorough explanation). The descriptive statistics for the combined modulated preference values of all study space features were as follows: chair (M = 5.971, SD = 1.740), table (M = 4.876, SD = 1.965), window (M = 5.832, SD = 1.647), and sign (M = 5.803, SD = 1.714). Evidently, the mean preference values leaned significantly towards the increased-user-control features for both groups (see Appendix G Figure 4). The results indicated insignificant differences between the two groups ($F = 3.604$, $p = 0.060$), which supports Hypothesis 3's notion that both groups will have a similarly significant preference towards increased-user-control study space features. Refer to Appendix G Figure 5 for the between-subjects effects.

All in all, the results support our hypotheses, and highlight the possible importance of increasing user-control in study spaces, for students' perceived stress levels and preferences.

Discussion

The current study examined the effect of user-control on perceived stress levels in university students. Our results revealed that user-control positively impacts student stress, as user-control study space features effectively decreased perceived stress levels in our study. This finding is consistent with previous research stating that an increased sense of control over circumstances and the physical environment reduces psychological stress in working people (Bollini et al., 2004; Robertson & O'Neill, 2016). A possible explanation for this consistency is that increased-user-control features allow students to alter study spaces according to their unique needs. This ability to adjust environmental features likely promotes student stress reduction and resilience by increasing their perception of physical control over their space. Furthermore, we found that students in both conditions preferred to use increased-user-control features over no-user-control features. This finding is consistent with previous research showing that knowledge of one's control over workspaces decreases stress levels (Robertson & O'Neill, 2016). Participants likely preferred the increased-user-control features because they gave participants greater knowledge of their physical control over the study space. These results further suggest that increased-user-control features may lower stress and encourage healthy stress resilience in university students.

We also acknowledge several limitations to our research. First, our study mainly surveyed cisgender women and men. We did not collect a lot of data from students with different gender identities. Owing to this fact, the findings from our study do not accurately reflect the gender diversity of the student body and thus may not generalize well. Second, our image selection for the conditions may have been a confound. It is possible that the increased-user-control images were more aesthetically pleasing than the images for the no-user-control features. As such, our results may reflect an inclination towards prettier interior elements and their ability to reduce stress instead of a preference for increased-user-control features. Third, and related to the second limitation, there may have been a difference in the perceived comfort levels of our features. For example, the plush increased-user-control chair may have seemed cozier and more enjoyable than the wooden no-user-control chair. Thus, the exaggerated decrease in stress within the increased-user-control condition and the overall preference for increased-user-control features may have been due to differences in comfort rather than differences in user-control. We failed to eliminate these two alternative explanations for our data. To prevent these confounds, future replications should ensure that the only difference between the study space features is their degree of user-control. Any variability in aesthetics and comfort should be eliminated. Future researchers should avoid using internet images and instead consider using design software to digitally construct study space features that only vary in their user-control. Finally, our method to use photographs in the survey limited our research. Images do not accurately reflect the

functional differences between using features with and without user-control. As a result, participants may not have understood how differences in user-control would impact them in a study space. They may have made their preference choices uninformed by user-control. Future replications should present the increased-user-control and no-user-control features with a method that has high-quality immersion such as videos, virtual reality, or in-person interactions with the features. Doing so will ensure that participant responses are more likely driven by differences in user-control.

Despite these limitations, the current study presents novel research that investigates the relationship between the physical environment and well-being factors like stress. The present study may encourage researchers to examine how the functional attributes of features within a space can influence the cognitive processes of those within it. This research may also yield new solutions for mitigating negative mental states in high-stress environments such as the workspaces of students and business workers. Furthermore, it may inspire UBC and other educational institutions to employ user-control as a cost-effective solution for designing campus spaces that reflect the diverse needs of their student body. Instead of constructing separated areas for students with unique needs, universities can use increased-user-control features to design flexible spaces that support the learning and stress resilience of all students. Such spaces will be more inclusive and may foster a stronger sense of empathy and community among students.

Recommendations

University students commonly experience high levels of stress, particularly while they study. Our research intended to explore the impact of increased-user-control design features on the perceived stress levels of university students. In light of our findings, it is clear that incorporating design features with increased user-control in study spaces can help alleviate stress and promote stress resilience in students. Our results indicate that increased-user-control features such as swivel chairs, height-adjustable tables, operable windows, and the option to eat and drink were strongly preferred by students over the no-user-control features. Thus, we recommend that these design features be implemented into learning spaces across campus, such as in lecture halls, study rooms in residences and other campus buildings, computer labs, and libraries. In such spaces, stationary chairs can be replaced with swivel chairs that have a wider range of movement. In addition, height-adjustable or standing tables can be added amongst existing regular tables within study spaces so students have the option to use increased-user-control tables. Learning spaces should also be designed with windows that open/close and designated areas where students can eat and drink. These recommendations are in line with UBC's Learning Space Guidelines, which aim to minimize designs that may negatively affect learning (*Learning Space Design Guidelines*, 2022). We suggest that increased-user-control features be incorporated into study spaces in the new UBC Surrey campus, as this would be an opportunity to create learning spaces that reflect the needs of all students and help reduce student stress. Overall, our research suggests that the inclusion of user-control design features can provide significant benefits to university students, particularly those who experience high levels of stress. By prioritizing the implementation of increased- user-control features, institutions can create more effective learning environments that help students mitigate stress and promote their well-being.

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Appendices

Appendix A: Qualtrics Survey

Consent Form (page 1)

UNIVERSITY OF BRITISH COLUMBIA

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Fax: 604.822.6923

Consent Form

Class Research Projects in PSYC 421 - Environmental Psychology

Principal Investigator: Dr. Jiaying Zhao
Course Instructor
Department of Psychology
Institute for Resources, Environment and Sustainability
Email: jiayingz@psych.ubc.ca

Introduction and Purpose

Students in the PSYC 421 – Environment Psychology class are required to complete a research project on the UBC campus as part of their course credit. In this class, students are required to write up a research proposal, conduct a research project, collect and analyze data, present their findings in class, and submit a final report. Their final reports will be published on the SEEDS online library (https://sustain.ubc.ca/teaching-applied-learning/seeds-sustainability-program). Their projects include online surveys and experiments on a variety of sustainability topics, such as waste sorting on campus, student health and wellbeing, food consumption and diet, transportation, biodiversity perception, and exercise habits. The goal of the project is to train students to learn research techniques, how to work in teams and work with UBC clients selected by the UBC SEEDS (Social Ecological Economic Development Studies) program.

Study Procedures

If you agree to participate, the study will take about 10 minutes of your time. You will answer a few questions in the study. The data will be strictly anonymous. Your participation is entirely voluntary, and you can withdraw at any point without any penalty. Your data in the study will be recorded (e.g., any answer you give) for data analysis purposes. If you are not sure about any instructions, please do not hesitate to ask. Your data will only be used for student projects in the class. There are no risks associated with participating in this experiment.

Confidentiality

Your identity will be kept strictly confidential. All documents will be identified only by code number and kept in a locked filing cabinet. You will not be identified by name in any reports of the completed study. Data that will be kept on a computer hard disk will also be identified only by code number and will be encrypted and password protected so that only the principal investigator and course instructor, Dr. Jiaying Zhao and the teaching assistants will have access to it. Following the completion of the study, the data will be transferred to an encrypted and password protected hard drive and stored in a locked filing cabinet. Please note that the results of this study will be used to write a report which is published on the SEEDS library.

Remuneration

There is no remuneration for your participation.

Consent Form (page 2)

UNIVERSITY OF BRITISH COLUMBIA

Department of Psychology
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Contact for information about the study

This study is being conducted by Dr. Jiaying Zhao, the principal investigator. Please contact her if you have any questions about this study. Dr. Zhao may be reached at (604) 827-2203 or jiayingz@psych.ubc.ca.

Contact for concerns about the rights of research subjects

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

Consent: Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the study at any time. You also may postpone your decision to participate for 24 hours. You have the right to choose to not answer some or any of the questions. By clicking the "continue" button, you are indicating your consent to participate; hence, your signature is not required. The researchers encourage you to keep this information sheet for your records. Please feel free to ask the investigators any additional questions that you have about the study.

Ethics ID: H17-02929

Introduction (Both Conditions)

Dear participants,

Thank you for taking the time to participate in this study. In this survey, you will be asked to imagine yourself in a study space and then answer a series of questions about your perceived stress levels. You will be asked to rate your perceived stress levels on a scale from 1 to 7 (i.e., 1 = not at all stressed; 7 = extremely stressed). Please provide accurate and honest responses to the questions.

Please answer the following:

	1 - Not at all stressed	2	3	4 - Moderately stressed	5	6	7 - Extremely stressed
How stressed do you feel right now?	○	○	○	○	○	○	○

Stress Question (No-User-Control Condition)

Imagine you are studying in a space for one hour with the following study space features: Non-adjustable desks/tables; non-adjustable chairs (i.e., stationary chairs); windows that do not open; and a "No Food or Drinks" sign.

Please answer the following:

	1 - Not at all stressed	2	3	4 - Moderately stressed	5	6	7 - Extremely stressed
If you were to study in the study space above for 1 hour, how stressed would you feel?	○	○	○	○	○	○	○

Preference Questions (No-User-Control Condition)

Between these two chairs (your original chair vs. a different chair), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original chair	2	3	4 - No preference	5	6	7 - Strongly prefer the different chair
Please select one of the following	○	○	○	○	○	○	○

Between these two tables (the original table vs. a different table), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original table	2	3	4 - No preference	5	6	7 - Strongly prefer the different table
Please select one of the following	○	○	○	○	○	○	○

Between these two windows (the original fixed window vs. a different window that can open), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original window	2	3	4 - No preference	5	6	7 - Strongly prefer the different window
Please select one of the following	○	○	○	○	○	○	○

Between these two signs (the original "Food and Drinks Not Allowed" sign vs. a different "Food and Drinks Allowed" sign), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original sign	2	3	4 - No preference	5	6	7 - Strongly prefer the different sign
Please select one of the following	○	○	○	○	○	○	○

Stress Question (Increased-User-Control Condition)

Imagine you are studying in a space for one hour with the following study space features: adjustable desks/tables (i.e., height adjustable tables); adjustable chairs (i.e., swivel chairs); window that can open; and you are allowed to eat [conscientiously] in this study space.




Please answer the following:

	1 - Not at all stressed	2	3	4 - Moderately stressed	5	6	7 - Extremely stressed
If you were to study in the study space above for 1 hour, how stressed would you feel?	○	○	○	○	○	○	○

Preference Questions (Increased-User-Control Condition)

Between these two chairs (your original chair vs. a different chair), which would you prefer to use in an on-campus study space?


	1 - Strongly prefer the original chair	2	3	4 - No preference	5	6	7 - Strongly prefer the new chair
Please select one of the following	○	○	○	○	○	○	○

Between these two tables (the original table vs. a different table), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original table	2	3	4 - No preference	5	6	7 - Strongly prefer the different table
Please select one of the following	○	○	○	○	○	○	○

Between these two windows (the original window that can open vs. a different window that can't open), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original window	2	3	4 - No preference	5	6	7 - Strongly prefer the different window
Please select one of the following	○	○	○	○	○	○	○

Between these two signs (the original "Food and Drinks Allowed" sign vs. a different "Food and Drinks Not Allowed" sign), which would you prefer to use in an on-campus study space?

	1 - Strongly prefer the original sign	2	3	4 - No preference	5	6	7 - Strongly prefer the different sign
Please select one of the following	○	○	○	○	○	○	○

Demographics Questions (Both Conditions)

What is your gender identity?

- ○ Woman
- ○ Man
- ○ Non-Binary
- ○ Two Spirit
- ○ Other: (please specify) _____

What is your age?

_____

Are you a UBC Student?

- ○ Yes
- ○ No

What is your level of education?

- ○ 1st-year undergraduate
- ○ 2nd-year undergraduate
- ○ 3rd-year undergraduate
- ○ 4th-year undergraduate
- ○ Other: (please specify) _____

END OF SURVEY

Appendix B: Distribution Poster

Appendix C: Group Project Contributions

Throughout the project, each member of the group contributed equally towards the project. Assignments were divided so that overall, each member would be required to do the same amount of work.

Proposal:
Everybody contributed equally to the proposal.

Survey Creation & Data Collection:
Everybody contributed equally to the creation of the Qualtrics survey and the collection of the data.

Statistics Analysis:
Danny: Was mainly in charge of conducting data modifications and statistical analyses.
Isanna: Helped clean data and problem solve after data collection was finished.

Project Presentation:
Malika: Discussion & Recommendation section
Danny: Results section
Paris: Introduction & Participants section
Deniz: Methods section
Isanna: Designing presentation slides & main editor
Jottie: Assisted in Methods section

Final Research Report:
Malika: Methods & Appendices B-D section(s)
Danny: Executive Summary, Hypothesis, Results, & Appendices E-G section(s) & Revision
Paris: Introduction, Discussion & Recommendations & Appendix A section(s) & Revision
Deniz: Recommendations & Appendix A section(s)
Isanna: Introduction section & Revision
Jottie: Introduction section, Image sorting/adjusting, & Revision

Appendix D: Methods Flow Chart

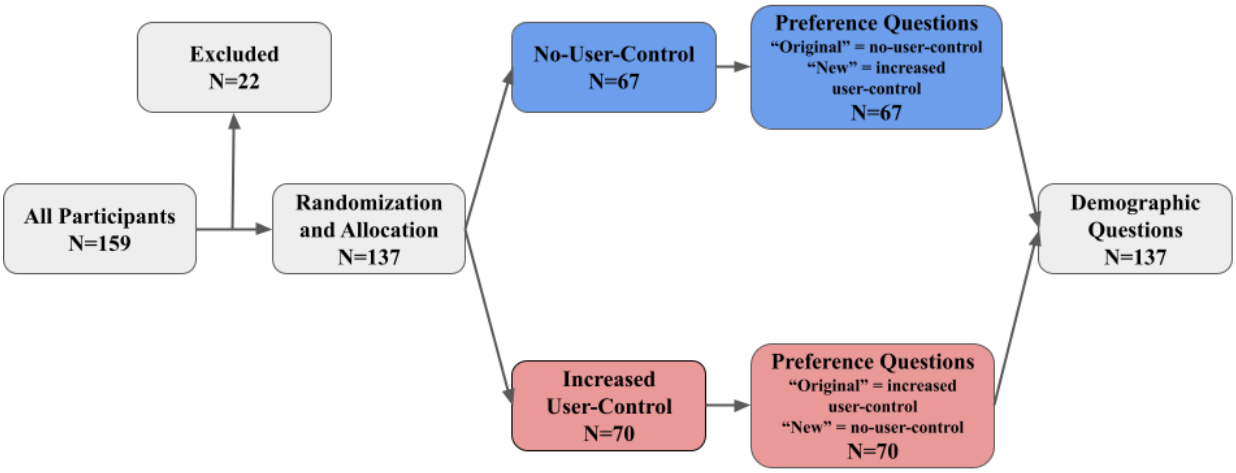


Figure 1: Methodology flow chart showing between subjects design

Appendix E: Data (i.e., descriptive tables, inferential tables, and plots) for the first Welch's t-test

One-tailed Welch's T-Test Comparing [Post] Perceived Stress Levels

Independent Samples T-Test

	t	df	p	Mean Difference	SE Difference	95% CI for Mean Difference		Cohen's d	SE Cohen's d
						Lower	Upper		
Stress Level (POST)	8.322	126.448	5.975×10^{-14}	2.066	0.248	1.655	∞	1.426	0.211

Note. For all tests, the alternative hypothesis specifies that group *1* is greater than group *2* .
Note. Welch's t-test.

Descriptives

Group Descriptives

	Group	N	Mean	SD	SE	Coefficient of variation
Stress Level (POST)	1	67	4.537	1.599	0.195	0.352
	2	70	2.471	1.282	0.153	0.519

Bar Plots

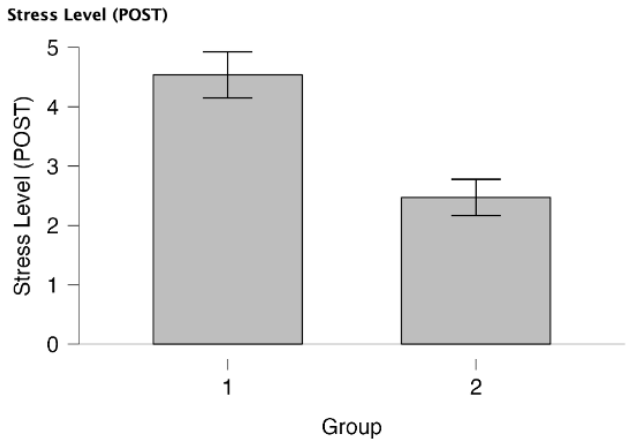


Figure 2: Includes a Welch's t-test, descriptive data, and a bar plot for [POST] stress levels.

Appendix F: Data (i.e., descriptive tables, inferential tables, and plots) for the second Welch's t-test

One-tailed Welch's T-Test Comparing Change in Perceived Stress Levels [Post - Pre]

Independent Samples T-Test

	t	df	p	Mean Difference	SE Difference	95% CI for Mean Difference Lower	95% CI for Mean Difference Upper	Cohen's d	SE Cohen's d
Delta Stress Level (POST - PRE)	6.646	128.709	7.734×10^{-10}	1.881	0.283	1.321	2.442	1.138	0.197

Note. Welch's t-test.

Descriptives

Group Descriptives

	Group	N	Mean	SD	SE	Coefficient of variation
Delta Stress Level (POST - PRE)	1	67	0.567	1.794	0.219	3.163
	2	70	−1.314	1.499	0.179	−1.141

Bar Plots

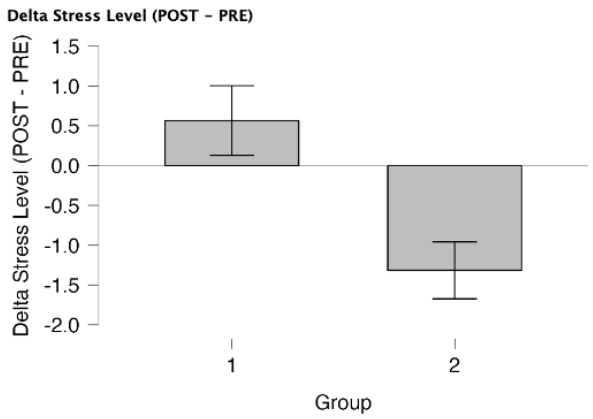


Figure 3: Includes a Welch's t-test, descriptive data, and a bar plot for change in stress.

Appendix G: Data (i.e., descriptive tables, inferential tables, and plots) for the repeated measures ANOVA

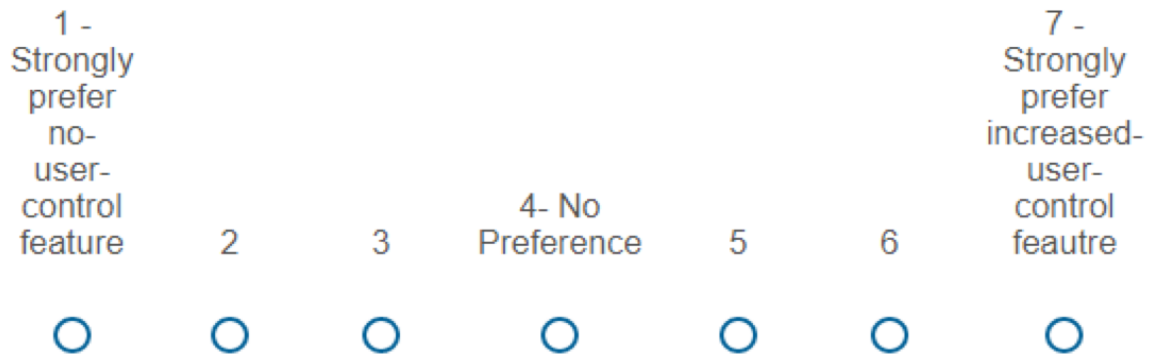
For the purposes of statistical analysis, we modulated the preference values for the participants in the increased-user-control condition to match the scaling order of those in the no-user-control condition. This was necessary because the scales for each condition's preference questions were not congruent to each other (see Appendix A; Preference Questions). The original values were opposites/flipped, so we adjusted the values in Excel to ensure that a value of 1 would indicate a strong preference towards the no-user-control feature, and 7 would indicate a strong preference towards the increased-user-control feature for both groups, rather than just for group 1. This adjustment was made for data analysis purposes only.

The following formula exemplifies how we modulated one of the preference columns for group 2 (the specific columns/rows varied for each feature's preference values):

=IF(ISBLANK(BA4:BA141), IF(ISBLANK(AK4:AK141), "", AK4:AK141), ABS(BA4:BA141-8))

We subtracted 8 from non-empty group 2 preference values and took the absolute value of the result. If the group 2 preference value cell was empty (i.e., "ISBLANK"), the formula checked the group 1 preference value for the same study feature in the same row. If that value was also empty, the formula left the cell blank; if it had a value, the formula copied that value (unchanged) into the empty cell.

Below is what would theoretically be the new scale [for both conditions], for data analysis purposes:



Descriptives

Descriptives

Preferences	N	Mean	SD	SE	Coefficient of variation
Chair	137	5.971	1.740	0.149	0.291
Table	137	4.876	1.965	0.168	0.403
Window	137	5.832	1.647	0.141	0.282
Sign	137	5.803	1.714	0.146	0.295

Descriptives plots

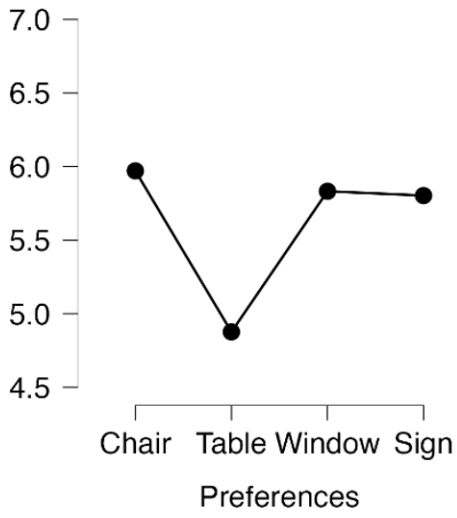


Figure 4: Includes descriptive data, and a descriptive plot of mean preference values.

Between Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p
Group	23.496	1	23.496	3.604	0.060
Residuals	880.055	135	6.519		

Note. Type III Sum of Squares

Figure 5: Repeated measures ANOVA 'Between Subjects Effects' for preference values.