



Computer passwords as a timely booster for writing-based psychological interventions

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ABSTRACT

Writing-based psychological interventions have been widely implemented to produce adaptive change, e.g., through self-affirmation (reminding people of their most important values). To maintain the long-term effects of these interventions, we developed a form of intervention boosters—using user-customized computer passwords to convey the therapeutic messages. We examined whether computer passwords could enhance the effect of a self-affirmation intervention on the psychological well-being of sexual minority undergraduate students as they begin university. Participants were randomly assigned to either complete a self-affirmation writing exercise and create a self-affirming computer password to use for 6 weeks or complete a control writing exercise and create a control computer password. We found that frequency of password usage moderated the intervention effect, such that frequent use of self-affirming passwords buffered decreases in psychological well-being over the study period. These findings suggest that passwords can serve as a low-cost, low-burden, and timely booster for writing-based psychological interventions.

1. Introduction

Writing-based psychological interventions have been used to address social and psychological issues including intergroup and interpersonal conflicts, academic underachievement, and mental health problems (reviewed in Cohen and Sherman, 2014; Walton and Wilson, 2018). These interventions typically involve a brief writing exercise that introduces a new way of thinking (e.g., “intelligence can grow”), aiming to induce adaptive change in a person. For the change to emerge and persist, the person is often asked to engage in additional identical writing exercises, referred to as “boosters,” which help the person to remember and internalize the message (e.g., Borman et al., 2018). Despite their brief duration (less than an hour), traditional boosters require administrative effort and may not take place at the correct time (e.g., may not be delivered shortly after a stressful experience), which may reduce their effectiveness in large-scale implementations (Ferrer and Cohen, 2019; Hanselman et al., 2017). In contrast, computer passwords are frequently used by many people multiple times per day.

Because of their text-string format, passwords can be adapted to encapsulate therapeutic messages. In this study, we apply a self-affirmation intervention in sexual minority young people who identify as lesbian, gay, bisexual, transgender, queer, questioning, or “mostly heterosexual” (defined as “primarily attracted to persons of the other gender, but also somewhat attracted to persons of the same gender”) (LGBTQ+), using computer passwords as a novel booster.

1.1. Self-affirmation intervention

Maintaining self-integrity, which is defined as “the perception of oneself as morally and adaptively adequate” (Cohen and Sherman, 2014, p. 334), represents a core human need (Steele, 1988). The motive for maintaining self-integrity is activated when an individual faces psychological threat from the environment, such as when a Black or Latinx student in the United States is affected by negative stereotypes about the racial gap in academic performance (Borman et al., 2018; Cohen et al., 2006, 2009). Self-affirmation aims to validate a person’s core values in

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unthreatened domains of the self, thereby sustaining the person's self-integrity and ultimately promoting positive outcomes (Cohen and Sherman, 2014). For example, after doing a few brief writing exercises to reflect on their nonacademic values, Black and Latinx students had a smaller disparity in grades from European-American and Asian-American students relative to students in the control condition, and this reduced racial achievement gap persisted from middle school to high school (Borman et al., 2018; Cohen et al., 2006, 2009).

There have been no published studies examining self-affirmation effects on sexual minority people. However, given that sexual minority people are often exposed to psychological threat resulting from both distal minority stress (e.g., sexual orientation microaggressions, including hostile expressions about and social exclusion targeting sexual minority people; Swann et al., 2016) and proximal minority stress (e.g., internalized homophobia, defined as negative self-stigmatization towards one's own same-sex sexuality; Tran et al., 2018), it is plausible that sexual minority people may benefit from a self-affirmation intervention. Indeed, in a pilot online experiment ($N = 249$), we found that a one-time self-affirming writing exercise decreased short-term internalized homophobia among sexual minority adults in a small to moderate magnitude, Cohen's $d = 0.35$ (Li and Chen, 2019). Despite this promising finding, however, the short- and long-term effects of self-affirmation on sexual minority people in a real-world setting remain unclear. Estimating real-world impact is important because many psychological interventions—including self-affirmation interventions—show weak and heterogeneous effects when taken outside of the lab and into real-world settings (Bryan et al., 2021; Hanselman et al., 2017).

1.2. Computer passwords as a timely booster

The “trigger and channel” framework proposes that self-affirmation effects are boosted by three conditions: psychological threat (“trigger”), resources for change (“channel”), and timely intervention delivered in temporal proximity to the first two conditions (Ferrer and Cohen, 2019). A meta-analysis confirmed that these conditions separately facilitated self-affirmation effects on health behavior (Ferrer and Cohen, 2019). In particular, two findings highlight the importance of intervention timeliness: (1) self-affirmation effects were enhanced when the intervention was timely relative to either threat or resources, and (2) self-affirmation effects were maximized when the intervention was timely relative to both threat and resources. These findings suggest that, if a self-affirmation intervention is delivered in close temporal proximity to a threatening situation, it could guide people to access nearby resources for positive change, thereby leading people into a positive channel rather than a negative channel. Furthermore, providing this timely intervention at every juncture where threat occurs should ensure a positive developmental trajectory.

For a predictable threat, determining an effective timing for a self-affirmation intervention is straightforward; for example, it could be scheduled to occur 1 week prior to an exam that is expected to be experienced as threatening by minority students (e.g., Cohen et al., 2006, 2009). For unpredictable threat, however, timeliness is more difficult to guarantee. One way to circumvent this obstacle is to increase the frequency of self-affirming writing exercises, a second is to provide frequent reminders of the self-affirming message, and a third is to enhance implementation intentions such that an individual may spontaneously implement an intervention when encountering an environmental cue (e.g., think of a personal value upon a threatening exam; Armitage et al., 2011). The first two requirements can be simultaneously fulfilled by encapsulating the self-affirming message into computer passwords, because user-customized passwords are an integral part of people's daily life in this digital era (Hayashi and Hong, 2011) and because typing a self-affirming password could both remind the users of and reinforce the message. Therefore, computer passwords are a promising low-cost and low-burden delivery format for timely boosters for the self-affirmation intervention.

1.3. The present study

This study focused on sexual minority first-year undergraduate students, who we believed were likely to benefit from the self-affirmation intervention. Young adults face many challenges during the transition to university, such as moving away from family and friends, making new friends, starting a new academic routine, and becoming independent (Gall et al., 2000; Paul and Brier, 2001). These challenges could elicit psychological threat, e.g., a belief they are less socially connected than their peers (Whillans et al., 2017). Moreover, as noted above, sexual minority students commonly experience minority stress during this critical transition period, such as encountering sexual orientation microaggressions (Swann et al., 2016). In summary, being a first-year student and sexual minority poses high threat to many young people (Li et al., 2019).

Therefore, we examined the effects of a self-affirmation intervention with timely boosters on the psychological well-being of sexual minority first-year undergraduate students. We tested (Hypothesis 1; H1) whether self-affirmation would lead to increased psychological well-being over the first few months at university, and (H2) whether the self-affirmation effect would be stronger among people who frequently use the self-affirming computer passwords. We additionally examined the moderation effect of microaggressions targeting sexual minority people, which may be perceived as a psychological threat. According to the “trigger and channel” framework (Ferrer and Cohen, 2019), we hypothesized that (H3) sexual orientation microaggressions would increase both the main effect of self-affirmation intervention and (H4) the moderating effect of the frequency of password usage on the intervention effectiveness.

2. Method

2.1. Participants

All procedures performed and materials used in this study were reviewed and approved by the Behavioural Research Ethics Board at University of British Columbia (UBC; H18-02007) and by the Institutional Review Board at New York University Shanghai (NYU Shanghai; 2020-028). Informed e-consent was obtained from all participants. Participants were recruited in two cohorts over 2 academic years. In 2019, participants were recruited from UBC's Vancouver campus, using classroom presentations, flyers and posters, digital signage and newsletters, social media posts, and email advertisements to student mailing lists. Recruitment was expanded in 2020 to additionally include the Department of Psychology's Human Subject Pool at UBC's Vancouver campus, email advertisements to UBC's Okanagan campus, and flyers and posters to NYU's Shanghai campus. To attract students of diverse sexualities and genders, the study was advertised as examining social integration and well-being of first-year students of all sexual orientations and gender identities, with a note that LGBTQ+ students were encouraged to participate.

Students were eligible to participate if they specified in a pre-screening survey that they (a) were first-year, full-time students, (b) were fluent in English, (c) endorsed a sexual identity other than “exclusively heterosexual,” (d) owned a laptop computer that they used regularly, and (e) were willing to change their computer password for the study's duration. Students from NYU Shanghai were additionally required to be 18 years and above in compliance with the regulations of the University's Institutional Review Board. Exclusion criteria were applied to delete data from participants who (a) indicated in a post-manipulation question that they had completed a similar writing exercise to the ones described in “Procedure,” (b) were simultaneously participating in a different intervention being conducted in the same laboratory at UBC, or (c) had failed to pass one or more of the four attention checks which were embedded in the online surveys to ensure that participants were reading the instructions. These exclusion criteria were applied after the prescreening stage, because the participants

would have to go through the experimental material and complete the online surveys to be deemed ineligible according to their responses (see Section 2.2 for the study procedure). After further excluding participants who did not complete all parts of the study, the remaining analytic sample contained 296 participants. Fig. 1 is a CONSORT diagram showing the participant flow. See Table 1 for participant characteristics.

2.2. Procedure

In both cohorts and at all study sites, recruitment started up to 2 weeks before the term start date and ended 6 weeks after the term commenced. Participants completed a brief online prescreening survey on Qualtrics to determine their eligibility. Eligible participants were invited to attend a 1-h lab session (Time 1; T1) occurring between Week 1 to Week 6 of the term. Approximately 6 weeks after the T1 lab session ($M = 6.17$ weeks, $SD = 0.52$, range = 3.86–8.29), participants were invited to attend another 1-h lab session (Time 2; T2). The participants attended the lab sessions in small groups, each led by a trained research assistant. The lab sessions took place in-person on campus during 2019, but were moved online to the Zoom videoconferencing platform in 2020 across all study sites due to the COVID-19 pandemic.

In the T1 lab session, participants completed a battery of online questionnaires on Qualtrics including three scales measuring psychological well-being and a scale measuring sexual orientation microaggression (see Section 2.3).² Participants were then randomly assigned (using a built-in Qualtrics randomization function) into either the self-affirmation condition or the control condition. Participants in the self-affirmation condition completed the following steps: (1) selecting the value that was most important to themselves from a list of 11 values (e.g., athletic ability, being good at art); (2) composing a paragraph describing why or when the chosen value was important for themselves; (3) completing questionnaires measuring internalized homophobia³; (4) changing their computer password to a phrase that summarized the paragraph's take-home message and included pronouns such as "I/my/me"; and (5) disabling any other sign-in options such as using biometrics. Participants in the control condition completed the same steps, except that they were asked to select the value (from the same list of 11) that was least important to themselves, write about why or when the chosen value might be important for someone else, and include pronouns such as "he/him/his," "she/her/her," or "they/them/their" in their new computer password. The first two steps were identical to the writing exercise used in previous studies (Cohen et al., 2006, 2009), except that "family relationships" was removed from the list of values, due to concerns of accidentally reminding the sexual minority participants of negative experiences in their family.

In the T2 lab session, participants completed the same battery of online questionnaires on Qualtrics and additionally reported their frequency of password usage. At the end of the study, participants were debriefed and received either course credits or vouchers for popular e-commerce websites as compensation.

² Participants also reported their experiences of bullying and victimization using a scale adapted from D'Augelli et al. (2002) in T1 and T2 lab sessions. However, we did not test the moderation of bullying and victimization for three reasons: (1) the measure demonstrated poor internal consistency at T2 ($\alpha = 0.58$); (2) the construct showed a floor effect (low mean levels with low variability) on a scale ranging from 0 to 100 at T1 ($M = 1.82$, $SD = 6.51$, skewness = 8.63, kurtosis = 99.56) and at T2 ($M = 1.19$, $SD = 3.54$, skewness = 4.72, kurtosis = 30.11); and (3) the two scale scores of victimization and bullying correlated only moderately across the two timepoints, $r(294) = 0.29$. These findings together suggested poor psychometric properties of the scale, which may bias hypothesis-testing.

³ We report findings on internalized homophobia in another working paper.

2.3. Measures

2.3.1. Psychological well-being

At T1 and T2, participants reported their psychological well-being in three domains: satisfaction with life, flourishing, and lack of depressive symptoms. Within each timepoint, a composite measure of psychological well-being was created by averaging the scale scores across the three domains (after reverse-coding scores from the depression scale), such that larger scores represent higher levels of psychological well-being.⁴ Cronbach's α s for the composite measure of well-being were 0.73 and 0.76 at T1 and T2, respectively, suggesting acceptable internal consistency among these three domains.

2.3.1.1. Satisfaction with life. The Satisfaction with Life Scale (Diener et al., 1985) consists of five items including "I am satisfied with my life." Responses ranged from *strongly disagree* (0) to *strongly agree* (6) on a 7-point Likert scale. Within each timepoint, a scale score was created by first averaging the item scores and then using the POMP method (Cohen et al., 1999); larger scores represent higher levels of life satisfaction ($\alpha = 0.84$ at both timepoints). The POMP method calculates the percentage that a person scored on the range of the Likert scale (e.g., a raw score of 3.5 converts to a POMP score of 50, indicating that 50% was earned on the 7-point Likert scale). The POMP method is preferred over standardization in longitudinal studies because the former produces a score that is easy to interpret and that does not rely on a reference distribution or timeframe (Moeller, 2015).

2.3.1.2. Flourishing. The Flourishing Scale (Diener et al., 2010) contains eight items including "I am engaged and interested in my daily activities." Responses ranged from *strongly disagree* (0) to *strongly agree* (6) on a 7-point Likert scale. Within each timepoint, the item scores were averaged and converted into a POMP score as the scale score (Cohen et al., 1999); larger scores represent higher levels of flourishing ($\alpha = 0.85$ at T1 and 0.87 at T2).

2.3.1.3. Depressive symptoms. Depressive symptoms during the past week were measured using the Centre for Epidemiological Studies Depression Scale-Revised 10 (CES-D-R-10; Andresen et al., 1994). This 10-item scale contained items including "I felt hopeful about the future." Possible responses were *rarely or none of the time (<1 day)* (0), *some or a little of the time (1–2 days)* (1), *occasionally or a moderate amount of time (3–4 days)* (2), and *all of the time (5–7 days)* (3). Within each timepoint, a scale score was created by (1) averaging the item scores, (2) using the POMP method (Cohen et al., 1999) to transform the mean composite, and (3) reverse coding by subtracting the previous POMP score from 100; larger scores represent a lack of depressive symptoms ($\alpha = 0.80$ at T1 and 0.83 at T2).

2.3.2. Frequency of password usage

At T2, participants recalled the frequency of using their customized passwords during the study period on a 5-point scale: 0 = *never*, 1 = *<1 time per day*, 2 = *1–2 times per day*, 3 = *3–5 times per day*, and 4 = *6 or more times per day*.

2.3.3. Sexual orientation microaggression

At T1 and T2, experiences of microaggression due to being sexual minority was measured using the Sexual Orientation Microaggression Inventory (Swann et al., 2016), which contained 19 items such as "Someone said homosexuality is a sin or immoral." Participants reported the frequency they had encountered each event in the past month on a 5-

⁴ We adapted this averaging method from Whillans et al. (2017), except that we used the percentage of maximum possible (POMP; Cohen et al., 1999), instead of standardization, to calculate the scale scores; see Section 2.3.1.1 for more information on the POMP method.

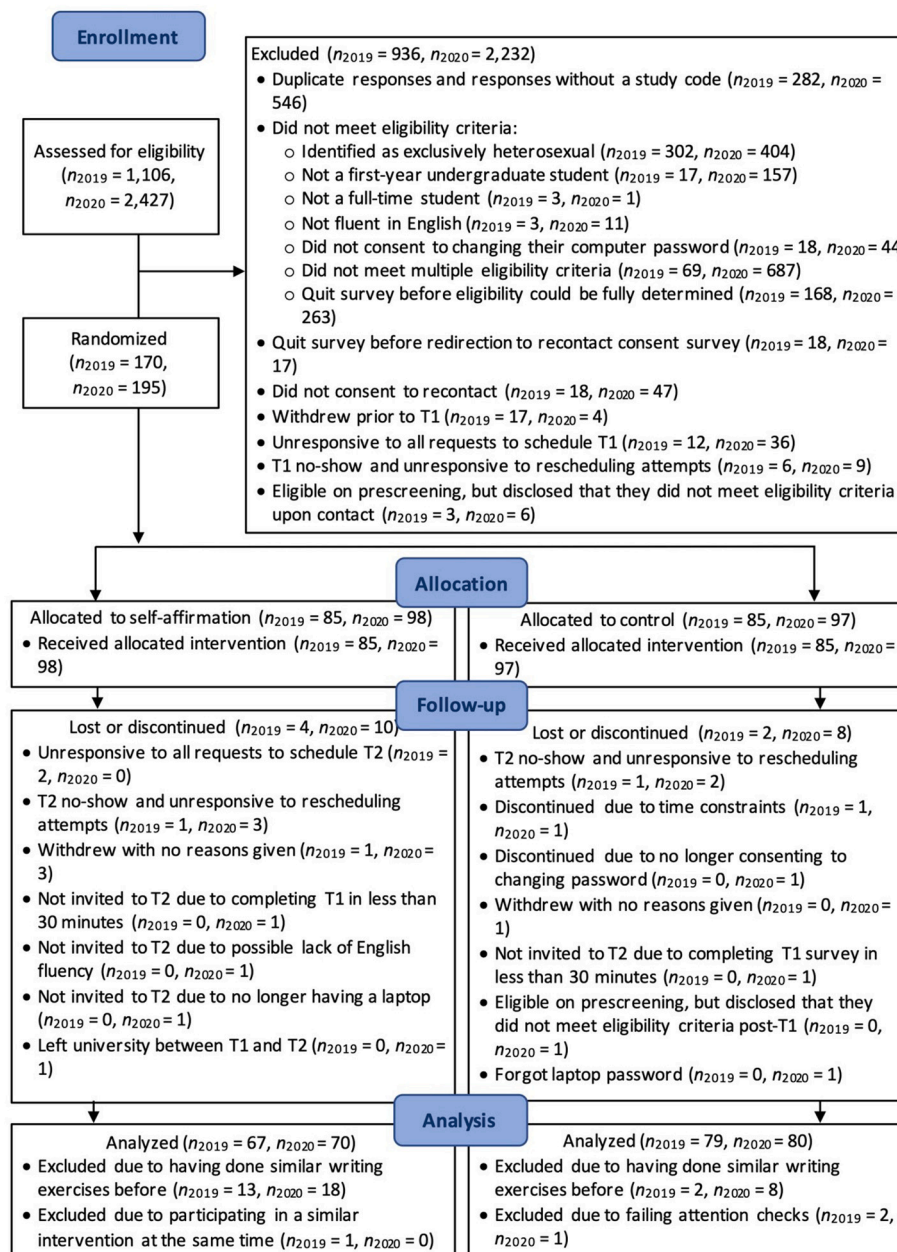


Fig. 1. CONSORT flowchart of participants.

point Likert scale ranging from *never* (0) to *always* (4). Within each timepoint, the item scores were averaged and converted into a POMP score as the scale score (Cohen et al., 1999); larger scores represent more experiences of microaggression due to being sexual minority ($\alpha = 0.89$ at both timepoints). These POMP scores across the two timepoints were averaged, $r(294) = 0.70$, $p < .001$; larger composite scores represent higher levels of sexual orientation microaggression 1 month before the start and the end of the study.

2.4. Data analysis

Prior to hypothesis-testing, we conducted a manipulation check of the writing exercise. A primary coder who was blind to the group assignment read all 296 participants' essays (see Section 2.2) and answered one question for each participant ("Was this participant self-affirmed?") with *no* (0) or *yes* (1). A secondary coder who was also blind to the group assignment read a random selection of 60 (20%) essays and

independently answered the same question for each essay to validate the primary coder's coding. No communications were allowed between the two coders. We calculated the proportion of agreement and Cohen's κ to determine interrater reliability. In addition, a 2 (group assignment: self-affirmation vs. control) \times 2 (the primary coder's coding: self-affirmed vs. not self-affirmed) chi-square test was conducted for the manipulation check.⁵

⁵ We were unable to conduct parallel manipulation check of the password manipulation, because although 86.5% of participants voluntarily reported their study passwords at the end of the study, many of these passwords were undecipherable. Nevertheless, we checked for compliance and found that only 2.4% of participants reported having changed their study passwords (away from the one that they created for the study) prior to the end of the study. Removing these participants along with those who did not pass the manipulation check of the writing exercise (see Section 3.1) did not change the study conclusions.

Table 1
Participant characteristics at prescreening.

Prescreening characteristic	Self-affirmation (n = 137)		Control (n = 159)		Comparison
Age in years, <i>M</i> (<i>SD</i>)	18.23	(1.92)	18.03	(1.37)	$t(294) = 1.05, p = .294$
Sex assigned at birth ^a , n (%)					$\chi^2(1, N = 296) = 0.55, p = .460$
Male	26	(19.0)	25	(15.7)	
Female	111	(81.0)	134	(84.3)	
Sexual orientation and gender identity, n (%)					$\chi^2(4, N = 296) = 3.35, p = .501$
Cisgender mostly heterosexual	43	(31.4)	61	(38.4)	
Cisgender bisexual/pansexual	42	(30.7)	38	(23.9)	
Cisgender lesbian/gay	25	(18.2)	23	(14.5)	
Cisgender other	18	(13.1)	25	(15.7)	
Transgender	9	(6.6)	12	(7.5)	
Race/ethnicity, n (%)					$\chi^2(3, N = 296) = 0.72, p = .869$
White	45	(32.8)	48	(30.2)	
East Asian	49	(35.8)	60	(37.7)	
South/Southeast Asian	19	(13.9)	19	(11.9)	
Other/multiracial	24	(17.5)	32	(20.1)	
Relationship status, n (%)					$\chi^2(1, N = 296) = 0.34, p = .559$
Single	102	(74.5)	123	(77.4)	
Dating/long-term relationship/other	35	(25.5)	36	(22.6)	
Religion, n (%)					$\chi^2(1, N = 296) = 1.67, p = .196$
None	100	(73.0)	105	(66.0)	
Any religion	37	(27.0)	54	(34.0)	
Parental education level ^b , <i>M</i> (<i>SD</i>)	3.73	(1.16)	3.72	(1.10)	$t(290) = 0.13, p = .899$
Cohort, n (%)					$\chi^2(1, N = 296) = 0.02, p = .893$
2019	67	(48.9)	79	(49.7)	
2020	70	(69.4)	80	(50.3)	
Study site ^c , n (%)					$\chi^2(1, N = 296) = 0.41, p = .523$
UBC	120	(87.6)	143	(89.9)	
NYU Shanghai	17	(12.4)	16	(10.1)	

^a The imbalanced sex ratio may have resulted from (a) the female preponderance of a sexual minority identification (including “mostly heterosexual”) in the general population (a female-to-male ratio of 1.94:1; Bailey et al., 2016) and (b) the female preponderance in volunteer samples in mental health research (a female-to-male ratio of 2.85:1; Thornton et al., 2016).

^b Averaged between maternal and paternal education levels. Scale anchors: 1 = high school or less, 2 = some college or university, 3 = college-level certificate/diploma, 4 = completed a university degree, 5 = completed a graduate or other professional degree.

^c UBC’s Vancouver campus and Okanagan campus were collapsed into one category due to the small sample size from Okanagan campus ($n = 7$). Most participants came from UBC because (1) recruitment was limited to UBC in 2019; (2) UBC is a large, public university with an annual enrollment of over 13,000 undergraduate students across its two campuses, whereas NYU Shanghai only had approximately 800 first-year undergraduate students (including “Go Local” students) enrolled in 2020; and (3) recruitment methods at NYU Shanghai were limited by regulations of the University’s Institutional Review Board.

We then conducted a series of preliminary analyses. These include a randomization check using independent-samples t -tests for continuous dependent variables and chi-square tests for categorical dependent variables to compare participant characteristics between the self-affirmation condition and the control condition. Next, considering the potential impacts of COVID-19 on the study outcomes, we conducted two independent-samples t -tests to determine whether participants’ psychological well-being varied by cohort. Moreover, we performed two additional independent-samples t -tests to compare psychological well-

being by study site. Variables that showed statistically significant results ($\alpha = 0.05$, two-tailed) in these preliminary analyses were accounted for in subsequent analyses for hypothesis-testing. Finally, we performed descriptive statistics and correlations for the focal variables by group assignment.

We then constructed four regression models to test each hypothesis. For H1 on the main effect of self-affirmation, we used psychological well-being at T1 and group assignment to predict psychological well-being (Model 1). For H2 on the interaction effect of password usage and self-affirmation, we added frequency of password usage (mean centered) and its interaction with group assignment to the first model (Model 2). For H3 on the interaction effect of sexual orientation microaggression and self-affirmation, we added sexual orientation microaggression (mean centered) and its interaction with group assignment to the first model (Model 3). For H4 on the joint interaction of frequency of password usage and sexual orientation microaggression on the self-affirmation effect, we added both terms (mean centered) and their two-way and three-way interactions with group assignment to the first model (Model 4). We probed interactions that were statistically significant ($\alpha = 0.05$, two-tailed) with simple slope analysis and paired-samples t -tests.

3. Results

3.1. Manipulation check

The two independent coders reached a high level of agreement (96.7%) on whether a participant was self-affirmed in the random sample of 60 (20%) participants’ writing, corresponding to an almost perfect interrater reliability, Cohen’s $\kappa = 0.93$. Among all 296 participants, those assigned to the self-affirmation condition (95.6%) were substantially more likely than those assigned to the control condition (2.5%) to be coded as “self-affirmed,” $\chi^2(1, N = 296) = 257.15, p < .001$, Cramér’s $V = 0.93$, suggesting successful manipulations in the writing exercise. Removing the participants who did not pass this manipulation check (i.e., the six participants in the self-affirmation condition who were not coded as “self-affirmed” and the four participants in the control condition who were coded as “self-affirmed”) did not change the significance levels of the findings in the hypothesis testing Sections 3.3–3.6.

3.2. Preliminary analysis

We found no statistically significant differences in participant characteristics between the self-affirmation condition and the control condition, $ps > 0.19$, suggesting successful randomization between the two conditions (Table 1). Next, two independent-samples t -tests on psychological well-being revealed no statistically significant differences at T1 (Cohort 2019: $M = 63.65, SD = 14.79$; Cohort 2020: $M = 61.59, SD = 16.49$), $t(294) = 1.13, p = .259, d = 0.13$, or at T2 (Cohort 2019: $M = 61.66, SD = 16.17$; Cohort 2020: $M = 59.59, SD = 16.68$), $t(294) = 1.08, p = .280, d = 0.13$. Moreover, two additional independent-samples t -tests revealed no statistically significant differences at T1 (UBC: $M = 62.30, SD = 15.62$; NYU Shanghai: $M = 65.05, SD = 16.21$), $t(294) = 0.95, p = .342, d = 0.18$, or at T2 (UBC: $M = 60.27, SD = 16.72$; NYU Shanghai: $M = 63.31, SD = 13.89$), $t(294) = 1.00, p = .318, d = 0.19$. Therefore, we combined the cohorts and study sites in hypothesis-testing. Table 2 shows descriptive statistics and correlations of the study variables.

3.3. Intervention effect on psychological well-being

A first multiple regression model did not show evidence supporting H1; the main effect of self-affirmation intervention was not statistically significant, $b = 0.43, SE b = 1.23, 95\% \text{ CI } [-2.00, 2.85], p = .729, r_{sp} = 0.01$ (Table 3, Model 1).

Table 2
Descriptive statistics and correlations for study variables by group assignment.

Variable	1	2	3	4	<i>n</i>	<i>M</i>	<i>SD</i>	Range
1. Psychological well-being at Time 1	–	0.81***	0.05	–0.29***	137	62.77	16.99	19.31–94.17
2. Psychological well-being at Time 2	0.71***	–	0.14†	–0.21*	137	60.98	18.15	0.69–96.67
3. Frequency of password usage	0.10	0.03	–	–0.03	136	3.23	0.84	1–4
4. Sexual orientation microaggression	–0.04	–0.07	–0.00	–	137	14.25	10.71	0–55.26
<i>n</i>	159	159	159	159				
<i>M</i>	62.46	60.30	3.01	14.61				
<i>SD</i>	14.52	14.85	0.92	13.59				
Range	16.25–95.97	20.28–100	0–4	0–87.50				

Note. Values above the diagonal are from the self-affirmation condition; values below the diagonal are from the control condition. The absolute range of the variables are: psychological well-being at Time 1 and Time 2, 0–100; frequency of password usage, 0–4; sexual orientation microaggression, 0–100.

† *p* < .10.
* *p* < .05.
*** *p* < .001.

Table 3
Multiple regression models predicting psychological well-being at Time 2.

Predictor	<i>b</i>	<i>SE b</i>	95 % CI		<i>p</i>	<i>r_{sp}</i>
			<i>LL</i>	<i>UL</i>		
Model 1						
Psychological well-being at Time 1	0.81	0.04	0.73	0.88	< 0.001	0.77
Self-affirmation ^a	0.43	1.23	–2.00	2.85	0.729	0.01
Model 2						
Psychological well-being at Time 1	0.80	0.04	0.73	0.88	< 0.001	0.77
Self-affirmation ^a	0.25	1.24	–2.19	2.69	0.841	0.01
Frequency of password usage ^b	–0.68	0.91	–2.47	1.11	0.456	–0.03
Self-affirmation x Frequency of password usage ^b	2.94	1.41	0.17	5.71	0.037	0.08
Model 3						
Psychological well-being at Time 1	0.81	0.04	0.73	0.89	< 0.001	0.75
Self-affirmation ^a	0.42	1.23	–2.01	2.85	0.731	0.01
Sexual orientation microaggression ^c	–0.05	0.06	–0.17	0.08	0.459	–0.03
Self-affirmation x Sexual orientation microaggression ^c	0.07	0.11	–0.14	0.28	0.517	0.02
Model 4						
Psychological well-being at Time 1	0.81	0.04	0.73	0.89	< 0.001	0.75
Self-affirmation ^a	0.26	1.24	–2.18	2.70	0.836	0.01
Frequency of password usage ^b	–0.62	0.91	–2.42	1.18	0.498	–0.03
Sexual orientation microaggression ^c	–0.05	0.06	–0.17	0.07	0.417	–0.03
Self-affirmation x Frequency of password usage ^b	2.94	1.41	0.15	5.72	0.039	0.08
Self-affirmation x Sexual orientation microaggression ^c	0.07	0.11	–0.14	0.29	0.493	0.03
Frequency of password usage ^b x Sexual orientation microaggression ^c	–0.12	0.07	–0.26	0.02	0.096	–0.06
Self-affirmation x Frequency of password usage ^b x Sexual orientation microaggression ^c	0.17	0.14	–0.10	0.43	0.214	0.05

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

^a 0 = control condition, 1 = self-affirmation condition.
^b Mean centered at 3.11.
^c Mean centered at 14.44.

3.4. Moderation effect of frequency of password usage

A second multiple regression model revealed that, after controlling for psychological well-being at T1, there was a statistically significant interaction between frequency of password usage and self-affirmation predicting psychological well-being at T2, *b* = 2.94, *SE b* = 1.41, 95 % CI [0.17, 5.71], *p* = .037, *r_{sp}* = 0.08 (Table 3, Model 2). To probe this interaction, we first conducted a simple slope analysis within each condition. Supporting H2, after controlling for psychological well-being at T1, higher frequency of password usage predicted a higher level of psychological well-being at T2 in the self-affirmation condition, *b* = 2.20, *SE b* = 1.08, 95 % CI [0.07, 4.34], *p* = .043, *r_{sp}* = 0.10, but not in the control condition, *b* = –0.57, *SE b* = 0.91, 95 % CI [–2.37, 1.22], *p* = .527, *r_{sp}* = –0.04 (Fig. 2).

To further probe and understand the benefit of frequent password usage for participants in the self-affirmation condition, we split participants in the self-affirmation condition into two halves by the median frequency of password usage. This resulted in participants who used the self-affirming password five times or less per day (the “self-affirmation, low password usage” group; *n* = 73) and participants who used the self-affirming password more than five times per day (the “self-affirmation, high password usage” group; *n* = 63). We then conducted paired-samples *t*-tests on these two groups, as well as on the control group (*n* = 159), to compare changes in psychological well-being over time. We found a small but statistically significant decrease in psychological well-being from T1 to T2 in the control group, *t*(158) = –2.45, *p* = .015, *d* = 0.19,⁶ and in the “self-affirmation, low password usage” group, *t*(72) = –2.39, *p* = .019, *d* = 0.28. However, we found no statistically significant change in psychological well-being in the “self-affirmation, high password usage” group, *t*(62) = –0.27, *p* = .791, *d* = 0.03. These findings suggest that frequent use of self-affirming passwords buffered the decreases in psychological well-being that was seen in other students over the first months of university (Fig. 3).

⁶ To test the alternative hypothesis that frequent use of passwords or computers protects against the decrease in psychological well-being, we further split the control group by the median of password usage frequency; “low password usage” was quantified as usage frequency of five or fewer times per day and “high password usage” was quantified as usage frequency of more than five times per day. Results suggested that participants in the “control, low password usage” group and the “control, high password usage” group both had small decreases in psychological well-being, paired *t*(103) = –1.46, *p* = 0.148, *d* = 0.14 and paired *t*(54) = –2.17, *p* = 0.013, *d* = 0.29, respectively. These findings suggest that the protective effect on well-being was not produced by highly frequent password or computer usage in general, but rather specifically by highly frequent usage only of self-affirming passwords.

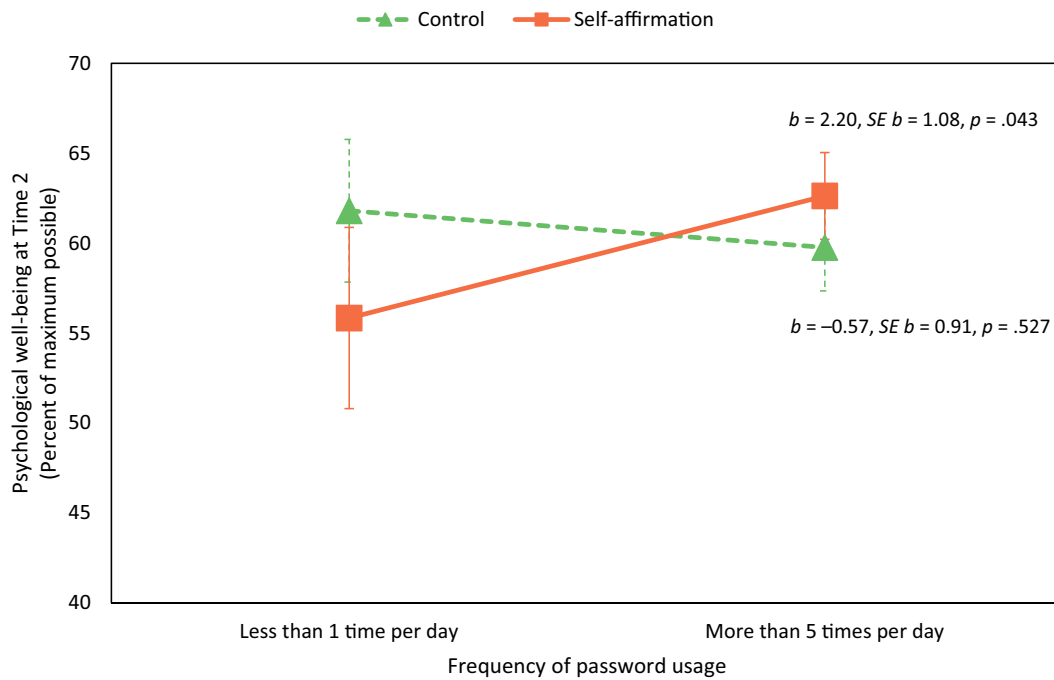


Fig. 2. Interaction plot predicting psychological well-being at Time 2

Note. Regression models were conducted separately for each of the two experimental conditions, using frequency of password usage to predict psychological well-being at Time 2, while controlling for psychological well-being at Time 1. Unstandardized regression coefficients, standard errors, and significance levels of frequency of password usage are reported. Error bars represent 95 % confidence intervals. For ease of interpretation, frequency of password usage was fixed at *< 1 time per day* (1) and *>5 times per day* (4), instead of $\pm 1 SD$.

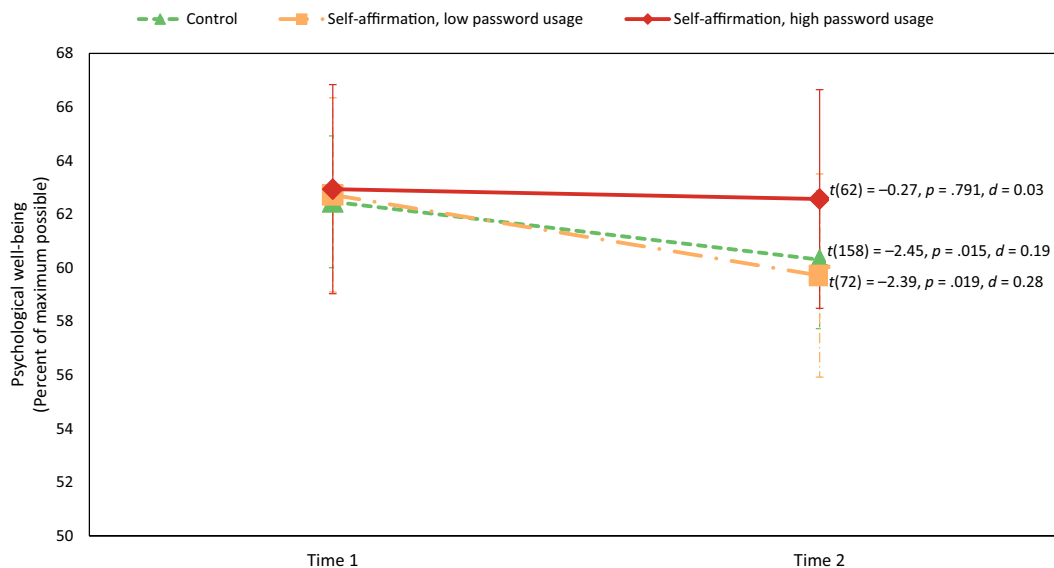


Fig. 3. Interaction plot predicting psychological well-being over time

Note. The “control” group includes all participants in the control condition ($n = 159$). The “self-affirmation, low password usage” group includes participants in the self-affirmation condition who used their password five or fewer times per day ($n = 73$). The “self-affirmation, high password usage” group includes participants in the self-affirmation condition who used their password more than five times per day ($n = 63$). The statistics are from three paired-samples t -tests, conducted separately for the three groups. Error bars represent 95 % confidence intervals.

3.5. Moderation effect of sexual orientation microaggression

We did not find evidence supporting H3; multiple regression did not reveal a statistically significant interaction between self-affirmation and sexual orientation microaggression, $b = 0.07$, $SE b = 0.11$, 95 % CI $[-0.14, 0.28]$, $p = .517$, $r_{sp} = 0.02$ (Table 3, Model 3). No other predictors in Model 3 were statistically significant, $ps > 0.45$, apart from psychological well-being at T1.

3.6. Joint moderation effect of frequency of password usage and sexual orientation microaggression

We did not find evidence supporting H4; multiple regression demonstrated that the three-way interaction between self-affirmation, frequency of password usage, and sexual orientation microaggression was not statistically significant, $b = 0.17$, $SE b = 0.14$, 95 % CI $[-0.10, 0.43]$, $p = .214$, $r_{sp} = 0.05$ (Table 3, Model 4). However, in the same

model, the two-way interaction between self-affirmation and frequency of password usage remained robust, $b = 2.94$, $SE b = 1.41$, 95% CI [0.15, 5.72], $p = .039$, $r_{sp} = 0.08$. No other predictors in Model 4 were statistically significant, $ps > 0.09$, apart from psychological well-being at T1.

4. Discussion

This study investigated the effects of a self-affirmation intervention on the psychological well-being of sexual minority first-year undergraduate students over 6 weeks. We further tested potential moderators of these effects, including user-customized passwords as timely boosters to maintain the self-affirmation effects and sexual orientation microaggressions as recurrent psychological threats that trigger the self-affirmation effects. Our sample size ($N = 296$) is among the largest of existing psychological interventions on sexual minority people (Bochicchio et al., 2020), which was sufficient to detect small effects ($\eta^2 = 0.02$) when $\alpha = 0.05$ and $\beta = 0.80$.

Contradicting H1, self-affirmation intervention did not demonstrate a statistically significant main effect. However, this finding converged with accumulating evidence to suggest that self-affirmation effects, like the effects of many other psychological interventions, are weak and heterogeneous in the real world (Bryan et al., 2021). Various factors could have contributed to the weak main effect of this study: First, it is possible that the study duration was not long enough for the intervention effect to emerge for some students, as a previous meta-analysis found that the self-affirmation effect does not appear until 1–2 years after the first intervention (Borman et al., 2018). Second, it is possible that there are insufficient resources to support sexual minority first-year students (e.g., Caxaj et al., 2018), especially during the COVID-19 pandemic (Fish et al., 2020), thereby blocking the “channels” in self-affirmation for adaptive change (Ferrer and Cohen, 2019).

Our second hypothesis concerned the interaction between the experimental condition and password usage. Supporting H2, sexual minority students who were in the self-affirmation condition but used the self-affirming passwords infrequently, and those who were in the control condition, both experienced a statistically significant decrease in psychological well-being over the first few weeks into university; in contrast, sexual minority students who were in the self-affirmation condition and used the self-affirming password frequently did not report a similar decrease. In addition, among the students in the self-affirmation condition, the benefits of self-affirmation on psychological well-being increased with the frequency of password usage. These findings suggest that self-affirming passwords, when frequently used, can act as a protective factor for first-year undergraduate students, who often report increasing mental health problems during the first semester of university (Bewick et al., 2010). One possible explanation for the amplifying effect of the frequency of password usage is that frequent use of self-affirming passwords might have increased the timeliness of the intervention relative to threat and resources, thereby enhancing the intervention effects (Ferrer and Cohen, 2019).

The final series of analyses examined the moderation effect of sexual orientation microaggression (Swann et al., 2016), which is considered a form of daily minority stress facing sexual minority individuals. According to the “trigger and channel framework” (Ferrer and Cohen, 2019), people experiencing pervasive and constant psychological threat are likely to benefit from self-affirmation intervention. For example, a large-scale longitudinal study found that self-affirmation impacts were larger for racial/ethnic minority students in schools where racial/ethnic identity threats were higher (Borman et al., 2018). However, this hypothesis was not supported by our study, which revealed no statistically significant moderation effects of sexual orientation microaggression, either on the main effect of self-affirmation (H3), or on the moderation of frequency of password usage (H4). One reason for this null finding may be that the sexual minority students in our intervention group experienced relatively low levels of sexual orientation microaggression (Table 2), and therefore the moderation effects might have been

suppressed by the restricted range of sexual orientation microaggression. It remains possible that self-affirmation exerts a greater influence in places where sexual stigma is more prevalent (Pachankis et al., 2020).

The current study had several limitations. First, we used retrospective reports of password usage frequency, which might have contributed to self-recall bias; it would be ideal to have an objectively measured variable, such as screen lock/unlock data (Kim et al., 2021), or to use daily diary methods (Gunther and Wenzel, 2012) to sample self-reports of daily password usage on different days during the study period. Second, password usage frequency was self-reported rather than manipulated, constraining our ability to draw causal inferences; it is possible, for example, that high levels of psychological well-being led to higher productivity and therefore an increased use of self-affirming passwords to unlock the computers. Future research could use ecological momentary assessment (Bolger and Laurenceau, 2013) to manipulate the frequency of password usage, by pushing surveys at different frequencies and requiring participants to type in their study passwords in every survey. Third, our participants were predominantly female; therefore, the extent to which the current findings generalize to males remains unclear. Fourth, the participants in our study only used the passwords for 6 weeks; future research should extend the duration of usage to determine whether and when habituation would occur and whether creating new passwords would maintain the intervention effects. Fifth, because this study was not preregistered, future research will be necessary to confirm the current findings.

5. Conclusions

Despite these limitations, our study demonstrates the promise of user-customized passwords as boosters for the effects of writing-based interventions. In addition to the self-affirmation intervention examined in this study, passwords can also be used in other social psychological interventions such as growth mindset interventions (e.g., creating a password to remind people that intelligence can grow) or in positive psychological interventions such as gratitude intervention (e.g., creating a password that reminds an individual of the things or people to be grateful for). Passwords carry many advantages as an intervention booster, including low cost, low burden, and timeliness. Although biometrics have been gradually gaining in popularity as a more secure and convenient means for user authentication on computers (O’Gorman, 2003), passwords are unlikely to die out (Siddique et al., 2017) and are still widely used in online logins such as to email accounts, online management systems, etc. Finally, despite the small effect size of frequent use of self-affirming passwords ($r_{sp} = 0.10$, which converts to Cohen’s $d = 0.20$), the practical effects—when taking into account feasibility, cost, social impact, etc. (Greenwald et al., 2015)—could still be large. In conclusion, password interventions have the potential to benefit many people, especially those with limited access to other more costly or administratively complex interventions. We hope that future research will continue to explore and document the potentially powerful effects of using passwords to encapsulate intervention messages.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data that support the findings in this manuscript are available from the corresponding author upon reasonable request.

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