Bridging the Social Distance: Offline to Online Social Support during the COVID-19 Pandemic

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The severe impact of COVID-19 in the United States has forced many students to replace in-person socialization with online digital contact. In this study, we investigate the mental health impacts associated with this shift by examining properties of online interactions that may affect loneliness and perceived social support. Students were surveyed (N = 827) across 97 universities across the US during their first full semester impacted by the COVID-19 pandemic (Fall 2020). Private online interactions (messaging, phone call, video call) were found to have a comparable correlation to social support as face-to-face interactions, but public online interactions (social media) were associated with more negative outcomes. Among private platforms, messaging had the strongest correlation with social support; and daily self-disclosure over messaging yielded social support levels that were 1.21x higher than rarely or never disclosing over this platform. We speculate that factors such as the level of privacy and peoples' feelings of control contributed to disclosure and perceived social support in online platforms.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; **Social content sharing**; **Social media**.

Additional Key Words and Phrases: covid-19 pandemic, college students, mental health, social support, social media, loneliness

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1 INTRODUCTION

The COVID-19 pandemic led to a fundamental change in people's social lives on a worldwide scale [72]. At times, the United States had the highest number of reported cases of any country [69], shutting down college campuses nationwide [16]. The Fall 2020 season was a complex period where colleges had unusual arrangements for the student experience. Students suffered from disruption of their formative years, loss of social belonging and community, and worries about the future [10].

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What is unique about this pandemic is that it was the first major event that discouraged *in-person socialization* while an alternative of *online digital interaction* was as widely available. These changes imposed new norms for student interactions, allowing for a timely investigation into its effects.

Over the three month period from September 24, 2020 to December 24, 2020, we distributed an online survey investigating the impact of pandemic-induced online interactions on social support and loneliness in college students across the United States. The campaign was done directly through contacting academic deans to request they help distribute the survey, as well as through social media forums for college students. The survey was continuously sent out until a stratified sample of students from diverse types of colleges had responded, resulting in 827 complete responses during the crisis.

Each student participant specified the nature of their physical and digital socializing during the pandemic, as well as completed measurements of **loneliness**, defined as the "state experienced when a discrepancy exists between the interpersonal relationships one wishes to have, and those that one perceives they currently have," [57] and **social support**, defined as the "exchange of resources between two individuals perceived by the provider or the recipient to be intended to enhance the wellbeing of the recipient" [39]. After conducting an extensive examination of social theories, we believe social support and loneliness may be particularly affected by isolation and loss of social contact as discussed later in this work.

The first section of the results report on the psychological impact of the pandemic on students, showing that loneliness and social support suffered due to changes in their lifestyle. However, students were not mere passive participants, and the remaining sections of results illustrate the efforts students made to cope, to socialize, and to seek emotional support from others both online and offline. We identify how physical isolation and the frequency of different forms of digital socialization (e.g., social media, messaging, phone calls, and video calls) correlated with loneliness and social support. This leads to a central question about the nature of online socialization in the third part: to what extent might online socialization be a substitute for in-person interaction in the context of loneliness and social support? Perhaps unsurprisingly, students with higher levels of perceived social support indeed sought and received support from their contacts online. However, interestingly, online socialization was found to have different effects on social support and loneliness. We investigate the different properties of online platforms to more closely understand how social support was fostered online at this time.

In this study we make the following contributions: (1) investigate the extent to which online interaction fosters social support and mitigates feelings of loneliness from the lens of key psychological theories during a period of intense physical isolation, (2) examine the differences in effect on social support and loneliness between public (social media) and private (messaging, phone calls, video calls) forms of online communication, (3) explore the impacts of self-disclosure across these platforms including the specific emotions shared (4) investigate the implications of group dynamics across online interactions (e.g., one-on-one chats vs. group chats) during the COVID-19 pandemic.

2 RELATED WORK

2.1 The State of Mental Health During the COVID-19 Pandemic

Numerous studies reveal a decrease in overall mental well-being throughout the world during the COVID-19 pandemic (e.g., [60, 73, 74]), often attributed to psychosocial stressors associated with unforeseen increased isolation, such as life disruption (e.g., [41, 71]) and fear of illness or uncertainty (e.g., [25, 67]), therefore calling for increased prioritization of mental health (e.g., [70, 77]). Wang et al. found 54% of individuals showed moderate to severe psychological impact from the COVID-19 pandemic, with 29% reporting moderate to severe anxiety and 17% reporting moderate to severe

depression in the population of China immediately following the first outbreak of the pandemic [74]. Furthermore, they conducted a follow-up study revealing that these symptoms persisted even a month later [75]. Tull et al. found similar trends in the United States population, revealing stay-at-home orders to be associated with increases in loneliness and decreases in social support [71]. These reports of declining mental health are replicated in studies from Australia [26], the United Kingdom [11], and among college students worldwide (e.g., [14, 25, 41, 43]). Furthermore, individuals in social isolation around the world reported lack of access to adequate mental healthcare, relying primarily on self-help techniques [22]. This matches trends in previous outbreaks, as research during SARS revealed higher levels of stress, anxiety, and depression in the general population [17], and patterns across previous pandemics reveal a lack of adequate mental health resources worldwide during or immediately following the outbreak [68].

2.1.1 Among College Students. The COVID-19 pandemic has negatively impacted college students in particular; most experienced severe disruptions to academic routine, and many were forced to evacuate dorms, lost on-campus jobs due to the remote work environment, experienced increasing financial hardships, food and housing insecurity, and reduced access to academic material [5, 78]. Moreover, many students reported a decline in feelings of social belonging and community connectedness [78]. Current studies show college students report higher levels of stress, anxiety, and depression than the general population during the COVID-19 pandemic (e.g., [14, 21, 25, 67, 76]). Immediately following the initial outbreak, one large-scale longitudinal study (164,101 college student participants) revealed increased stress, anxiety, depression, and acute stress in college students [41] and another study found similar, persistent mental health trends in college students over multiple months of the pandemic [21]. Due to the clear psychological effect of COVID-19 on this group, our study seeks to specifically examine US college students in order to better understand the impacts and potential benefits of online interaction on social support and loneliness.

2.2 Online Communication as a Coping Mechanism During the COVID-19 Pandemic

2.2.1 Movement of Communication to Online Platforms. Numerous studies in Human-Computer Interaction examine crisis informatics, the study of the "intersecting trajectories of social, technical and information perspectives during the full life cycle of a crisis" [33]. After almost every disaster we see a regional unification of communities, materials, and information, known as geographical convergence [28]. Studies have found this behavior mirrored in online interactions, as individuals gravitate towards online communities as a coping mechanism (e.g., [23, 54, 64]) creating broader social convergence without geographical barriers. This trend was found during the COVID-19 pandemic, as people around the world turn to virtual platforms for socialization while under quarantine guidelines (e.g., [29, 51, 72]). In Belgium, social media apps saw a 72% increase in usage, messaging apps saw a 64% increase, and phone calls saw a 44% increase in average time spent on each platform [51]. Similar patterns have also been found in Italy, revealing significant increases across video calls and online gaming platforms [29], and in the United States, revealing an increase in posting across public social media platforms [72].

Although some increases in online interaction were expected due to the nature of an international crisis, it is likely that online interaction was further escalated due to the global quarantine-induced isolation that impeded social interactions on a larger scale than seen in recent crises. This effect is supported by the Social Compensation Hypothesis, which suggests individuals will compensate for in-person social deficits by increasing their online interaction [47]. From this perspective, the abrupt halt in face-to-face interactions that many experience as a result of the pandemic may create inherent social deficits and draw individuals online as a mode of compensation.

In addition to online presence, online expression was amplified during the COVID-19 pandemic [6]; and the sentiment of public-facing social media posts was found to be significantly more negative [72]. Self-disclosure, "an interaction between at least two individuals where at least one intends to deliberately divulge something personal to another," [31] is associated with increased stressful life events [80] and recognized as a fundamental human need [8]. Furthermore, self-disclosure is associated with intimacy and relationship closeness, and is most frequent between dyads [66], suggesting that disclosure online may be more common in one-on-one chats, rather than in group chats or public social media.

Online disclosure is often met with reciprocated self-disclosure from others, and has been found to increase relationship strength [55] and facilitate social support [2]. Current work suggests there may be an increased likelihood of willingness to disclose during the COVID-19 pandemic [49], however, fails to examine changes in disclosure patterns across multiple online platforms. We seek to fill a gap in the literature by examining the specific emotions students disclose through online private platforms and the relationship of each of these emotions with perceived social support and loneliness during this time.

2.2.2 Social Support Compensation Through Online Interaction. Perceived social support has been found to improve resilience to trauma due to neurobiological factors as well as its inherent promotion of stress-regulating behaviors [63]. During the COVID-19 pandemic, increased social support was also shown to decrease crisis-related stress symptoms such as anxiety and depression [50].

Studies reveal online communities to be an effective method for receiving social support [2], however it is unclear whether online interactions can generate similar levels of social support derived from in-person interactions. During periods of physical isolation brought on by COVID-19, research shows college students report using online communication intentionally as a means of gaining support [76], and digital platforms were effective in truly increasing perceived social support during this time [29, 43]. Despite the positive effects of online interactions, other studies have found participants tend to believe virtual platforms are inadequate substitutes for in-person conversation [58]. The physical isolation during the COVID-19 pandemic thus provides us with an opportunity to investigate whether online interactions are truly an effective substitute for receiving in-person social support.

2.2.3 The Potential for Mitigating Loneliness Online. Prior to and during the COVID-19 pandemic, studies have revealed inconsistent patterns between online interactions and loneliness. Some studies suggest technology is helpful for fostering feelings of social connection in isolated individuals [48], yet others reveal associations between increased public social media usage and increased feelings of loneliness [43, 59]. More recent research has also found increased levels of support seeking behavior on public social media platforms [43] and have found individuals are likely to be using public platforms as a coping mechanism to compensate for existing feelings of loneliness [48, 56], rather than social media causing feelings of loneliness [72]. This raises question to whether online interactions are truly mitigating feelings of loneliness. Our study seeks to better understand the factors influencing loneliness, specifically the differing effects of online and in-person communication as well as the impact from properties of separate online platforms (i.e., social media, messaging, phone call, video call).

2.2.4 Effect of Interaction Type and Intent. Individuals across the world appear to be using online platforms as a coping mechanism, however, it is unclear whether these platforms truly combat feelings of loneliness or provide social support during periods of isolation. Previous research has revealed public social media to be correlated with increased feelings of loneliness [72]; however, other research has found social media to promote coping techniques and the use of technologies to

increase well-being (e.g., self-care, meditation videos) [62].These contrasting patterns may be due to the way in which an individual is using the social platform.

The Interpersonal-Connection-Behaviors (ICB) Framework suggests that the use of online platforms in active relationship building leads to positive outcomes, whereas more passive usage yields fewer benefits [18]. This framework proposes categorizing usage within the platforms: (A) active, meaning engaging in interactions that promote user's active building of relationships (e.g., commenting, having a conversation), or (B) passive, meaning without any inherently relational engagement (e.g., scrolling without engagement) [18]. Active interactions are associated with greater positive outcomes, whereas passive interactions present negative associations such as increased feelings of loneliness [19]. Similarly, research conducted during the COVID-19 pandemic has also found that the total time spent interacting has less bearing on well-being than the amount of satisfaction one derives from interacting online [58], however, has not considered the active or passive nature of the interaction.

Recent work has challenged the active and passive categorization, suggesting that behavior previously classified as passive usage can still have relational qualities [9]. As a result, our study seeks to further investigate the passive and active comparison made in the ICB framework by more closely examining various factors and behaviors that may contribute to social support and loneliness outcomes associated with online interaction during the COVID-19 pandemic.

2.2.5 Online Platform Differences. The majority of previous research examines online communication by investigating only public social media platforms, without differentiating between other, private platforms [45, 81]. However, these platforms are different in nature: public platforms, which encompasses social media such as Facebook, Twitter, Reddit, and other public online groups, may reach a wide audience - often with bounds the user is unaware of, whereas private platforms (e.g., messaging, video calls, and phone calls) are intended only for those deliberately included in the interaction [45, 81]. Even fewer studies on mental health have differentiated between platforms [25, 29, 35, 42], despite previous work showing different interaction types between public and private communications [12]. Of the few studies that differentiate, private platforms have emerged as more beneficial for loneliness than public platforms [48]. Their benefits are often credited to the greater perception of anonymity and privacy [81]. Furthermore, there are differences within private platforms that may impact user behavior and should be accounted for. Private platforms allow for a variety of group dynamics, as they enable one-on-one communication (i.e., direct communication between two people) and group communication (i.e., communication between more than two people), which has been shown to impact offline interactions [66]. Thus there is a gap in the literature as few studies have examined the impacts of one-on-one communication [42, 52], and even fewer have examined private group communication [3].

2.3 Research Objectives

Through this study, we hope to bridge a gap in the literature by distilling the varied dimensions of online interactions we believe may play a role in affecting feelings of social support and loneliness during periods of intense physical isolation. For each of these dimensions, we examine the relationship with user behavior and outcome. We formulate the following research questions to guide our analysis of this topic:

> **RQ1:** *While it is clear that college students are gravitating towards online interactions during the COVID-19 pandemic, for what reasons are they doing so?*
> **RQ2:** *Are there differences in perceived social support or loneliness between public (social media) and private (messaging, phone call, video call) online platforms?*

RQ3: *How do one-on-one communications (e.g., direct messaging with one person) and group communications (e.g., group chats) differ in effectively mediating feelings of loneliness or compensating for social support perceived from typical in-person interactions?*
RQ4: *To what extent does the impact on social support and loneliness differ when individuals engage in passive as opposed to active online interaction?*
RQ5: *Is self-disclosure more effective at cultivating positive social support and loneliness outcomes than simply spending more time generally interacting on these platforms?*

In summary, this study aims to identify the specific properties of online communication that have the strongest relationship with social support and loneliness during a period of intense physical isolation.

3 METHODS

To better understand the psychosocial effects of the COVID-19 pandemic as well as investigate the implications of various online platforms on US college students, we distributed an online survey assessing students' daily life, online interaction patterns, and critical aspects of their mental health, namely loneliness and social support. Upon completion of the survey, participants were given the opportunity to enter in a raffle to receive one of ten $25 digital gift cards.

All participants were US college students, comprising a group of people who were immediately disrupted by the pandemic, with many being forced to relocate out of their dorms and away from their primary social support groups within just a few days [78]. Moreover, research shows this age group uses online platforms more than any other age group in the US [15], allowing us to examine its implications during this time. Additionally, participants were limited to students actively enrolled in accredited US universities as countries around the world elected varying methods of crisis management and were at different stages of the COVID-19 crisis while the survey was distributed.

3.1 Survey Design

A qualitative questionnaire was drafted, refined and then underwent two rounds of pilot testing and a cognitive field test. In the first pilot test, the broader survey was evaluated for potential insights on 11 graduate and undergraduate student researchers. Experimenters then discussed the impact of online interactions and self-disclosure through various platforms with these researchers. Based on their feedback, we identified self-disclosure patterns as an area of potential impact and therefore included the Emotional Self-Disclosure Scale (ESDS) [65] to assess disclosure of specific emotions.

After incorporating feedback from student researchers, the survey was tested a second time through a pilot test with 26 college students across five U.S. universities, with additional qualitative follow-up questions in order to improve the pilot survey. Based on the findings, we reordered our quantitative survey questions to fit conversational conventions. The range for potential responses for usage of online platforms was also expanded in response to feedback. We also tested questions assessing trust across each platform (e.g., Please rate how much you trust the following communication platforms – Twitter). Students reported significant difficulty in answering this due to many confounding factors (e.g., data privacy, company scandals, misconceptions, etc), thereby increasing survey fatigue. As a result, all questions assessing trust of these platforms were removed.

Finally, we conducted a cognitive pretest and follow-up interview with a college student who had previously never seen the questionnaire. We observed the student participant as they filled out the questionnaire and gathered insights on their experience. The student expressed feelings of survey fatigue given the length of the questionnaire. In order to ensure accurate results, we incorporated validation questions (e.g., "What is the name of the current global pandemic?") and reverse wording. Any responses that failed to correctly answer validation questions were removed.

3.2 Survey Questions

The distributed questionnaire was quantitative in nature, and demographic questions included self-identification of gender, university, and level of study (i.e., graduate or undergraduate student). Additional demographic data such as age and degree major was not collected to preserve participant privacy. The remaining part of the questionnaire can be separated into three sections: physical isolation, online interaction behavior, and scales to measure social support and loneliness.

3.2.1 Assessing Amount of Physical Isolation from Others during the COVID-19 Pandemic. In the first part of the questionnaire, we address the level at which participants are physically isolated from other people during the pandemic by examining the number of in-person interactions they had. Questions first examined their behavior during the pandemic, through multiple-choice responses asking participants to indicate their adherence to standard government social distancing guidelines and select the level of quarantine that best matches their behavior, such as: (a) "*I am in mandatory quarantine (mandated by government to stay home)*", (b) "*I am in voluntary self-isolation (not completely mandatory by government, but I am staying home)*", (c) "*I am going about my daily business like usual (going to work, school, etc) but avoid restaurants, cinemas, etc*", (d) "*I am going about my daily business like usual (going to work, school, etc) AND visit restaurants, cinemas, etc*", (e) "*My work requires me to go out (e.g. medical, delivery, public transport) while others are recommended to stay home.*" Moreover, participants were asked to specify their in-person interactions from the previous week: including the number of days one spent self-isolating (not leaving the house), and the number of days one had face-to-face contact with another person for 15 minutes or more (including someone living in the same space). Furthermore, self-report questions asked participants to indicate the number of people they live with, the number of people they talk to, and their keyworker status. We also assess COVID-19 impacts through self-report questions such as relationship changes and whether the participant is located in a COVID-19 hotspot.

3.2.2 Measuring Online Interaction During the Pandemic. The second part of the questionnaire examined college student online interactions during the COVID-19 pandemic. This seeks to gain insights into whether students are building community or socializing through online platforms. Multiple choice questions assessed online behavior prior to and during the COVID-19 pandemic, including the amount of time spent per week interacting on each platform (specific options included: *"Social media (Twitter, Facebook, Reddit, etc.)", "Messaging (SMS, Facebook Messenger, DMs, etc.)", "Videochat" and "Phone call"*). Participants reported how frequently they disclose across private platforms, based on the number of people in the interaction (i.e., *"How often do you discuss your emotional state with friends/family over... Phone call with 1 person, Phone call with 2+ people,"...* across phone calls, messaging and video calls).

Furthermore, we measured how willing participants were to self-disclose eight specific emotions online, then analyzed the differences between these emotions in order to better understand self-disclosure and its effect on perceived social support and loneliness at this time. We include a modified version of the Emotional Self-Disclosure Scale (ESDS) [65] to measure participant comfort when sharing emotions to another person during the COVID-19 pandemic. The ESDS is a popular assessment of how often individuals share certain emotions to a given person (e.g., friend, family, etc) and was modified for this study to specifically reflect only one-on-one messaging during the pandemic (as in-person communication was not an option for many in quarantine). Participants respond on a 1–5 scale of the willingness they are to disclose each of the given 40 emotion topics (i.e., How comfortable are you disclosing – "Times when you felt depressed"). We include all of the original 40 emotion topics of the original ESDS but request "the extent to which you discuss these

feelings and emotions through private messaging". The McDonald's ω for this scale in this study was 0.98, indicating this scale had good reliability.

3.2.3 Understanding Perceived Social Support and Loneliness. The final part of the questionnaire seeks to assess specific mental health trends. This included the short form of the University of California, Los Angeles Loneliness Scale (ULS-8), which includes 8-items and is scored continuously, with higher scores indicating higher levels of loneliness [34]. This measurement, as well as the 20-item long form scale, has been widely used in the research community as a measurement of loneliness [61]. The McDonald's ω of this scale for this study was 0.70, indicating this scale had good reliability.

We also included the Multidimensional Scale of Perceived Social Support (MSPSS), a 12-item measurement of social support from three collectives: family, friends, and significant others [82]. Participants indicate agreement with questions such as, "I can count on my friends when things go wrong," with higher mean scores indicating higher perceived social support. Previous research indicates that this measure has adequate psychometric properties for adults [13] and it is a popular tool for measurement during the COVID-19 pandemic specifically [41, 71]. The McDonald's ω of this scale in this study was 0.90, indicating this scale had good reliability. Scores were cross-analyzed to consider the context of physical and online interaction.

3.3 Participant Recruitment

Recruitment targeted students above the age of 18 actively enrolled in accredited colleges in the United States during the Fall 2020 semester (September–December, 2020). Schools targeted held varying profiles, including small liberal arts colleges, large urban research universities, and rural universities with a high proportion of commuting students. Participants were recruited using three methods: emails from university administrators, Reddit posts, and Facebook advertisements. Instagram, which displays Facebook advertisements, and Facebook were chosen as avenues for recruiting as they were the most widespread methods of communication among college-age people [15]. Reddit was also chosen as a recruitment avenue as it allowed us to more directly target students from specific schools.

For the first of our three recruitment methods, we contacted about 200 administrators (e.g., academic deans, directors of student affairs, etc) at academic institutions directly by email to advertise this study to their students. Academic administrators then passed along this advertisement through the appropriate channels, depending on their institution. At least 58% of responses were gathered through this method.

Secondly, we posted advertisements using Reddit, a popular social media platform often used by other researchers to gather data during the COVID-19 pandemic [6, 79]. University-specific subreddits gave us the rare opportunity to target students across a variety of universities. Targeted universities were randomly selected from accredited schools from the US Department of Education's Database of Postsecondary Institutions and Programs [24]. We then determined if there was a subreddit for the institution, contacted the subreddit moderators for approval, and posted accordingly. In order to ensure well-rounded responses, schools were later narrowed down based on size and university COVID-19 response status [16], then randomly selected. Advertisements were posted on 80 university-specific subreddits, accounting for at least 30% of the responses gathered.

Finally, approximately 3% of participants were recruited through Facebook advertising. Using stratified sampling, participants were grouped based on university COVID-19 regulations in order to ensure adequate representation in our sample. As there were comparatively few responses from universities with fully or primarily in-person status, the goal of this final round of recruitment was to target students from universities in this sub-group. The advertisement audience was limited to

students (age 18-30) who identified on Facebook as currently attending universities who had been reported as having fully in-person or primarily in-person courses over the Fall 2020 semester [16].

This study intended to collect data from a wide variety of participants for reliability purposes (i.e., $N > 500$). A total of 1,328 individuals accessed the survey, however, 288 did not complete the survey, 122 declared they were not above the age of 18, 26 did not attend an accredited university in the US and 1 did not pass the validation question. We also monitored the amount of time responses took; as this survey took an average of 20 minutes, the 56 individuals who completed the survey under 5 minutes and the 8 individuals who took over 3 hours were removed for reliability purposes. After filtering, the final sample included a total of 827 participants.

Previous studies have examined the correlation between online interactions and social support outside of the COVID-19 pandemic [46], finding a medium correlation ($r = 0.36$) between social support and number of hours interacting online. A power analysis was conducted for correlation sample size [36] with power β set at 0.10 and $\alpha = 0.05$, two-tailed. Results revealed that in order to receive a similar effect size ($r = 0.36$), any sub-populations that we use should consist of at least 77 participants to reach statistical significance at the .05 level.

4 RESULTS

Completed online survey results were collected from 827 actively enrolled college students across 97 accredited US institutions during the Fall 2020 semester (September–December, 2020). The majority of participants were undergraduate students (87.34%), and participants attended institutions across a wide variety of student body population sizes with 20.2% small (< 5,000), 10.2% medium (5,000–15,000), 32.7% large (15,000–30,000), 36.9% huge (30,000+). Across the 97 institutions, there were an average of 24 participants per school ($SD = 28.28$). Participants attended institutions across 34 states, with the majority of participants attending schools in the south (44%) and midwest (29%), followed by the west (17%) and northeast (12%) United States. 62% of students identified as female, 33% as male, and 3% identified as nonbinary. When asked about their household, 10.5% of students reported living completely alone, 81% lived with 1–4 people, and 9% of students lived with 5 people or more. The majority of participants (82%) did not identify as a government keyworker at the time of survey completion and 58% of students identified as living in a hotspot at some point during the pandemic.

Analysis using JASP and python scripts examined the linear relationship among various interaction variables with perceived social support and loneliness, as outlined in the sections below. Normality was checked using the Shapiro-Wilk test, showing all instruments followed a normal distribution. Descriptive analysis was determined for frequencies and percentages, Pearson's and Spearman's correlations were examined for linear relationships, and one-way analysis of variance (ANOVA) analyzed the differences between select groups. Tukey post-hoc tests determined the honest significant differences between groups.

4.1 Impact of Physical Isolation on College Students

4.1.1 Social Impacts of Physical Isolation. Participants reported the impact of COVID-19 on their relationships: friendships seemed to suffer heavily, as 64% of students felt COVID-19 had a negative impact on their friendships, whereas only 36% of students felt COVID-19 had a negative impact on their familial relationships. In general, close personal relationships (e.g., best friend, close relatives) did not suffer as much as distant relationships (e.g., acquaintances), with 44% of students reporting a negative impact on close relationships, and 63% reporting a negative impact on distant relationships.

4.1.2 Emotional Impacts of Physical Isolation. We also investigated behavioral patterns to gauge how physical quarantine during the COVID-19 pandemic impacted perceived social support and

Correlations with Social Support and Loneliness

	In-Person Interaction	Hours Interacting Online	Disclosure Online
Loneliness	-0.23***	0.05	-0.10**
Social Support	0.20***	0.073*	0.29***

Table 1. Correlations for social support and loneliness by frequency of self-disclosure were examined across each one-on-one and group platforms. Note that *higher* levels of social support and *lower* levels of loneliness are the desired outcomes. Online disclosure has a larger effect on both social support and loneliness than hours interacting online. Furthermore, self-disclosure had a stronger relationship specifically with social support than loneliness across all platforms. *p<0.05, **p<0.01, ***p<0.001.

loneliness. Participants self-reported their behavior in one of five groups: mandatory quarantine (1.67%), voluntary quarantine (25.24%), normal life but avoiding select public areas (47.98%), completely normal life (21.43%), and keyworkers going to public areas as part of a condition for employment (3.57%). In our study, when we compare across quarantine levels, we do not include individuals who identify as keyworkers, as keyworkers have been found to have higher levels of loneliness and lower levels of social support during the pandemic compared to the rest of the population [37].

A one-way ANOVA examining the differences between loneliness across quarantine levels showed a small significant variation among groups $F(21.8, 793) = 9.67, p < 0.001, n^2 = 0.02$. Post-hoc Tukey tests revealed an honest significant difference ($p < 0.001$) between loneliness, as those living under strict quarantine (voluntary or mandatory) reported higher levels of loneliness ($Mean = 3.14$, $SD = 1.11$) than those living in normal life without quarantine ($Mean = 2.68$, $SD = 1.06$). An honest significant difference was almost found ($p = 0.06$) as those living under strict quarantine reported higher levels of loneliness ($Mean = 3.14$, $SD = 1.11$) than those living under some quarantine restrictions ($Mean = 2.95$, $SD = 1.03$). An honest significant difference ($p = 0.02$) was also found as those living under some quarantine restrictions reported higher feelings of loneliness ($Mean = 2.95$, $SD = 1.03$) than those living in normal life without quarantine ($Mean = 2.68$, $SD = 1.06$).

Interestingly, a one-way ANOVA revealed no differences in perceived social support between quarantine groups, as the effect size was zero $F(6.85, 793) = 3.23, p = 0.04, n^2 = 0.00$, however those under stricter quarantine groups reported slightly lower social support ($Mean = 3.57$, $SD = 1.12$), followed by those under some restrictions ($Mean = 3.75$, $SD = 0.94$), and finally those living their life normally without quarantine reported the highest social support ($Mean = 3.82$, $SD = 1.12$). It appears that individuals under stricter quarantine are experiencing increased levels of loneliness, but do not exhibit differences in social support. As individuals in stricter quarantine are spending more time physically distant from others, it is possible they are receiving social support digitally.

In addition to quarantine status, we also ran Pearson's correlations to examine the linear relationship between the actual number of people participants interacted with during the pandemic (including both online and in-person interactions) and both perceived social support and loneliness. We found a very weak positive correlation ($r = 0.11, p < 0.001$) between an increase in the number of people interacted with and perceived social support. Moreover, a Pearson's correlation for the number of people interacted with and reported loneliness showed a weak negative correlation ($r = -0.17, p < 0.001$).

As 84% of students reported feeling a large difference between online and in-person conversations, the implications of each on perceived social support and loneliness were examined individually.

We compare each of amount of in-person interaction, amount of online interaction, and frequency of disclosure in private communication online with feelings of social support and loneliness, as shown in Table 1. In-person interaction was classified as the self-report number of days over last week in which a participant had a physical, face-to-face interaction with another person for at least 15 minutes (including someone living with them). It appears that both social support and loneliness have moderate correlation with in-person interactions, however, social support has much stronger correlations with online interaction, specifically self-disclosure (i.e., the frequency of discussing one's emotional state online). Although we find social support and loneliness to be moderately correlated with each other ($r = -0.41$, $p < 0.001$), this suggests they may be impacted by different factors. This may point to loneliness being an emotion that can be more effectively mitigated through in-person contact than online interactions.

4.1.3 Demographic Differences. As our study includes various demographic groups, we also check for differences in feelings of social support or loneliness and in online platform usage between demographic groups. For participant privacy we only collected gender and undergraduate/graduate student status for demographic measures. A one-way ANOVA found a very weak significant difference in loneliness between undergraduates and graduate students $F(1, 823) = 11.18, p < 0.001, n^2 = 0.01$, with a post-hoc Tukey test revealing an honest significant difference ($p < 0.001$). Although undergraduates ($Mean = 2.97, SD = 1.06$) reported feeling 14% more lonely than graduate students ($Mean = 2.59$, $SD = 1.1$) a one-way ANOVA revealed no significant differences for social support $F(1, 823) = 2.35, p = 0.13, n^2 = 0.003$. Furthermore, when considering online social interactions, no significant differences were found between these groups for the number of hours spent online $F(1, 823) = 16.33, p = 0.21, n^2 = 0.002$.

Next, we considered the differences in perceived social support and loneliness between male and female participants. Interestingly, a one-way ANOVA found no significant difference for social support $F(1, 788) = 1.25, p = 0.26, n^2 = 0.002$ or loneliness $F(1, 788) = 0.093, p = 0.76, n^2 = 0.00$. However, one-way ANOVA's revealed significant differences in their online behavior. A very weak significant difference was found for the amount of time spent online $F(1, 788) = 6.05, p = 0.01, n^2 = 0.008$, with a post-hoc Tukey test revealing an honest significant difference ($p = 0.01$), as women ($Mean = 8.76, SD = 3.35$) reported spending more time communicating online than men ($Mean = 8.17, SD = 2.88$). Similarly, a very weak significant difference was found for the amount of time spent self-disclosing online $F(1, 788) = 26.4, p < 0.001, n^2 = 0.03$, with a post-hoc Tukey test revealing an honest significant difference ($p < 0.01$), as women ($Mean = 12.10$, $SD = 5.7$) reported spending more time than men ($Mean = 10.01$, $SD = 4.91$) disclosing online. For both of these genders, Spearman's correlations revealed strong relationships between increased online self-disclosure and perceived social support (female: $r = 0.31, p < .001$; male: $r = 0.25, p < .001$).

4.2 Changing Trends in Online Platform Usage

We next examined changes in platform usage during the pandemic to understand the effects of communicating with a greater number of people online. For the purpose of our study, we consider public online interactions as posts made on social media platforms (e.g., Facebook, Twitter, Reddit, etc.), that allow for a diverse audience of recipients; we consider private online interactions as messages sent directly to an individual or group of specific recipients (e.g. DMs, texts, phone calls, etc.).

We compare the average self-reported frequency of platform usage and self-disclosure across online platforms before and during the COVID-19 pandemic in Figure 1. We saw an increase in time spent across each online platform surveyed, in line with previous research showing general increases in student online activity during the pandemic [43]. Students spent at least 4 hours on average on each platform and spent the most amount of time on public social media.

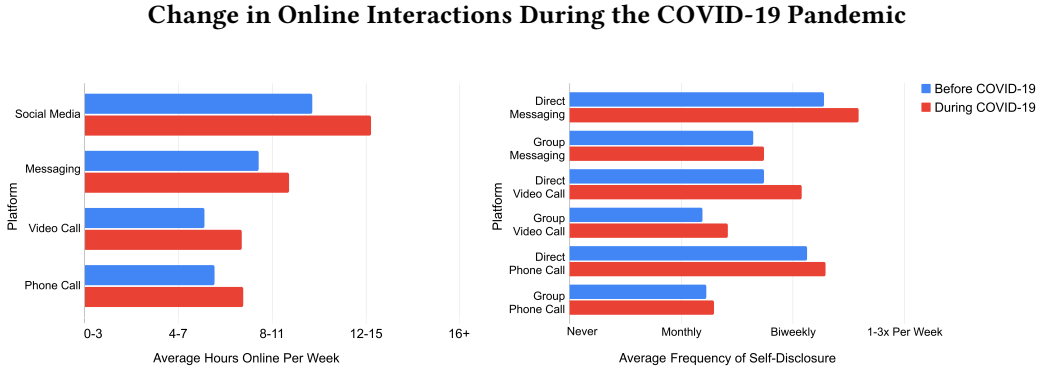

Fig. 1. The average self-reported online interaction frequency was compared before and during the COVID-19 pandemic. The average hours spent interacting on each platform per week (left), as well as frequency of self-disclosure (right) on each platform was calculated. College students saw an increase in usage across all platforms, with the largest being social media. A greater increase was found in frequency of self-disclosure across these platforms, and students on average spend more time disclosing over one-on-one platforms instead of group platforms, with the most being one-on-one messaging.

Although students spent the most time on public social media, this was the only platform to show negative consequences with perceived social support and loneliness. More specifically, increased loneliness (Pearson's $r = 0.15$, $p < 0.001$) and, although insignificant, decreased social support (Pearson's $r = -0.06$, $p = 0.10$) was found to be associated with increased time spent interacting on social media. Interestingly, all other private platforms (messaging, video calls and phone calls) saw the opposite effect, and were associated with decreases in loneliness and increases in social support. As a result, we sought to better understand the positive effects of private platforms as well as investigate properties of these interactions that affect feelings of loneliness and perceived social support in the following section.

4.3 Patterns in Self-Disclosure in Private Online Interactions

As previously mentioned, we saw an increase in usage across all private platforms during the pandemic (Figure 1). Of all the private platforms examined, users spent the most time messaging, and the least time communicating over video call. Overall, while we saw an increase in self-reported frequency of self-disclosure across all private platforms, trends between platforms seemed to stay consistent between the time before and during the pandemic. Similarly, it appears students most frequently self-disclose over messaging, and least frequently disclose over video call. Furthermore, students more frequently disclose their emotional state across one-on-one platforms ($Mean = 2.32$, $SD = 1.43$, indicating biweekly disclosure on average) than group platforms ($Mean = 1.49$, $SD = 1.04$, indicating monthly disclosure on average), with one-on-one messaging being the most frequent ($Mean = 2.59$, $SD = 1.45$), as shown in Figure 1.

Upon closer examination, we found the frequency of self-disclosure to have much stronger relationships with both social support and loneliness than the hours spent generally interacting online, as shown in Table 1. As a result, we compared self-disclosure across different private online platforms to see effects on social support. As shown in Table 2, Pearson's correlations revealed all one-on-one platforms ($0.19 \leq r \leq 0.25$, $p < 0.001$) to have a stronger relationship with perceived social support and loneliness than group platforms ($0.09 \leq r \leq 0.13$, $p < 0.001$). Moreover, frequency of disclosure had a stronger relationship with social support than loneliness across all

platforms, with the strongest being one-on-one messaging ($r = 0.25, p < 0.001$). In line with previous findings, social support has stronger relationships with self-disclosure than loneliness across each platform. One-on-one communication appears to have stronger ties than group communication, and specifically one-on-one messaging seems to have the strongest connection to social support.

4.4 Case Study Insights: Students Who Shifted All Interactions Online

We analyzed a small group of students ($N = 3$) who most extremely represented very little in-person interaction but had a very high increase in their public online interaction. We sought to examine the effects of complete isolation and determine if online interaction was an effective substitute for face-to-face interaction in this edge case population. The individuals in this sample were in mandatory or voluntary quarantine, living completely alone (no roommates or pets), and reported having absolutely no in-person interaction for 15 minutes or more with another person in the past week. In terms of online interaction, this group consisted only of individuals with the lowest (25^{th} percentile and below) prior public social media experience and those who were in the 75^{th} percentile and higher for their change in online interaction due to COVID-19.

We expected the effects of online interactions on feelings of loneliness and social support to be reflected especially strongly in this group, as these individuals had both a lack of physical interactions and a large increase in online interactions. Thus, results from this group were used as justification to further investigate whether the findings held for the entire participant population.

The three members of this group consisted of the following:

- P1, a female undergraduate student at a large institution conducting hybrid instruction, located in a COVID-19 hotspot in the southern United States. P1 reported the highest level of loneliness ($score = 4.75$), and the mid-range level of social support ($score = 3.50$) of this group.
- P2, a male graduate student at a large institution conducting online instruction, located in the midwestern United States. P2 reported the mid-range level of loneliness ($score = 4.125$), and the lowest level of social support ($score = 2.75$) of this group.
- P3, a female undergraduate student at a medium sized institution conducting hybrid instruction, located in a COVID-19 hotspot in the southwestern United States. P3 reported the lowest level of loneliness ($score = 3.00$), and the highest level of social support ($score = 4.33$) of this group.

All three members reported practicing social distancing in either voluntary or mandatory quarantine since at least April 2020, and were above the 75^{th} percentile for prioritizing physical distancing during the COVID-19 pandemic. None of the three members were categorized as keyworkers under the COVID-19 CDC guidelines [27].

Self-Disclosure Across Online Private Platforms

	Social Support			Loneliness		
	Messaging	Phone Call	Video Call	Messaging	Phone Call	Video Call
One-on-one	0.25***	0.23***	0.20***	-0.05	-0.12***	-0.12***
Group	0.13***	0.10**	0.09**	-0.09**	-0.09**	-0.06

Table 2. Correlations for social support and loneliness by frequency of self-disclosure were examined across each one-on-one and group platforms. Self-disclosure had a stronger relationship with social support than loneliness across all platforms. Furthermore, disclosure across one-on-one platforms had a stronger relationship than disclosure across group platforms, with one-on-one messaging having the strongest correlation. *p<0.05, **p<0.01, ***p<0.001.

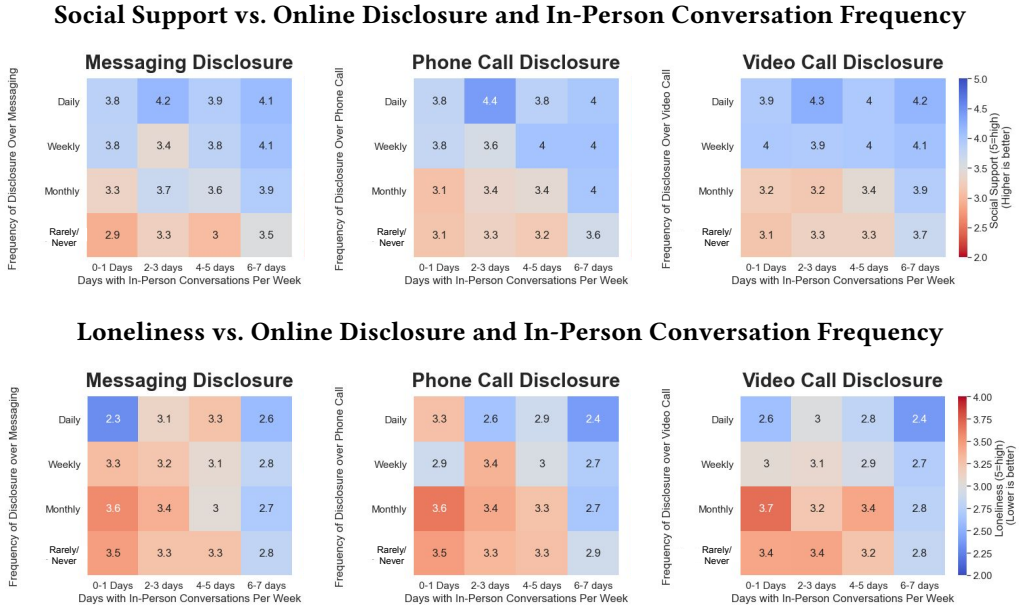

Fig. 2. The average social support and loneliness is plotted against the days with in-person interactions (x-axis) and the frequency of emotional disclosure across each private online platform (y-axis). The more frequent disclosure occurs online, regardless of in-person interactions, is associated with increased social support across all three platforms. Those with daily in-person interactions still benefit slightly from online disclosure across each platform. Conversely, those having fewer than 2 days of in-person interaction per week and overall no online contact are associated with the least amount of social support. In contrast, there does not seem to be a clear association between frequency of online disclosure and loneliness. Though users who disclose daily over video call seem to report lower levels of loneliness, daily disclosure over messaging and phone call does not consistently relate to lower loneliness.

4.4.1 *Impacts of Living Alone During the COVID-19 Pandemic.*

In case study: All three members were completely isolated from in-person interactions and lived alone. As P3 had higher social support ($score = 4.33$) than the general population average of this study ($Mean = 3.73$, $SD = 1.03$), we examined the impacts of living with others on the entire participant population.

In study population: The entire dataset was divided into two groups: those living alone ($N = 87$) and those living with other people ($N = 740$). A one-way ANOVA revealed a small significant variation in loneliness between these groups $F(1, 825) = 10.47$, $p = 0.001$, $n^2 = 0.01$ and a Tukey post-hoc test revealed an honest significant difference ($p < 0.001$). Students living with other people were significantly less lonely ($Mean = 2.91$, $SD = 1.07$) than those living alone ($Mean = 3.25$, $SD = 1.09$). This matches the findings of current research studies during the COVID-19 pandemic [32], where living alone was found to double the odds of one feeling lonely in the UK general population during the pandemic. Interestingly, a one-way ANOVA and Tukey post-hoc test revealed students living with other people had no honest significant difference in social support than those living alone ($p = 0.12$). This indicates that although students living alone are likely to be lonelier, they do not necessarily feel less socially supported. It is possible that these students are receiving social support through other means, or perhaps loneliness has stronger ties with in-person interactions.

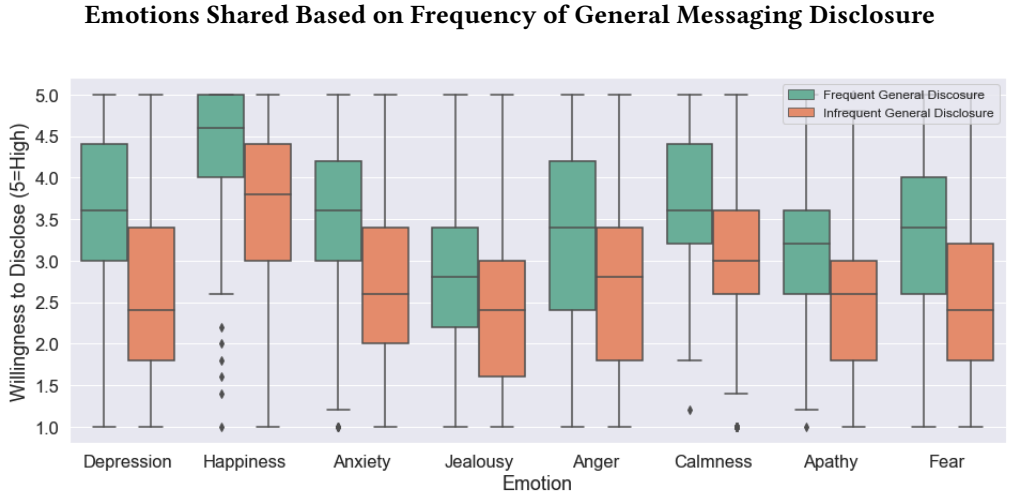

Fig. 3. Data is grouped by those disclosing over messaging platforms at least weekly (frequent) or those disclosing monthly or less (infrequent). The specific emotions shared are plotted, revealing significant differences between groups across all emotions, with greater increases for more negative emotions (depression, anxiety, fear), with the exception of anger. It appears that those who are more willing to disclose are specifically referring to negative emotions, not disclosure of positive emotions. It appears that students who share negative emotions more frequently may perceive added benefits to social support.

4.4.2 *Comparing Online and In-Person Interaction for Social Support.*

In case study: Despite all three group members being completely physically isolated, with no in-person interaction, their perceived social support ($Mean = 3.52$) was still within one standard deviation of the general population ($Mean = 3.78$). As we know that these participants had a large increase in their online communication during the COVID-19 pandemic, we look more closely into the relationship between social support, frequency of self-disclosure over private messaging, and frequency of in-person interactions.

In study population: Figure 2 displays a comparison of social support across in-person interactions and online self-disclosure for each platform. Online self-disclosure across all platforms was shown to be associated with increased social support, even when individuals were more physically distant. Specifically, students who only interacted in-person and never disclosed their emotions over messaging reported roughly the same level of perceived social support ($Mean = 3.52$) as individuals who also disclosed their emotions frequently, but rarely interact in-person ($Mean = 3.84$). This indicates that regardless of the number of in-person interactions, self-disclosure across messaging has similar ties to social support. Furthermore, of individuals who do not interact in person, those who also did not self-disclose over messaging reported far lower levels of social support ($Mean = 2.92$) than those who frequently self-disclose over messaging ($Mean = 3.84$). This suggests that the practice of self-disclosure online could serve as an effective means of fostering social support even without in-person interactions.

4.4.3 *Social Support in Messaging: Perception and Disclosure by Emotion.*

In case study: We noticed that the individual in this group reporting the least amount of loneliness and highest social support (P3) also reported the highest agreement with messaging helping them

cope (score=4), whereas P2 and P3 reported messaging not helping at all or only slightly (score=1, score=2, respectively).

In study population: On average, we found the general population to be unsure of whether messaging was helping them cope ($Mean = 3.17, SD = 1.22$). This, in conjunction with our finding that frequency of disclosure over messaging is moderately correlated with feelings of social support calls for a deeper dive into disclosure over messages.

We sought to understand the specific emotions shared by those with increased willingness to disclose. Pearson's correlations analyzed student willingness to disclose a fixed set of emotions surveyed on the ESDS Scale (depression, happiness, jealousy, anxiety, anger, calmness, apathy, fear) [65] and perceived social support and loneliness. Increased willingness to disclose each emotion surveyed had moderate significant positive correlations with perceived social support ($0.27 \leq r \leq 0.33$, $p < .001$), as well as weak significant negative correlations with feelings of loneliness ($-0.010 \leq r \leq -0.007$, $p < .001$).

We examined the specific emotions disclosed by those who reported disclosing over messaging platforms at least weekly (frequent) or those disclosing monthly or less (infrequent), as shown in Figure 3. One-way ANOVAs were conducted across each emotion, revealing significant differences between groups across all emotions. However, we find that participants who disclose more frequently had greater increases in willingness to disclose for more negative emotions (depression, anxiety, fear) than more positive emotions (e.g. happiness, calmness), with the exception of anger, as shown in Appendix A, Table 3.As increased disclosure was found to be associated with increased perceived social support, this may indicate that negative emotions play a larger role than positive emotions in how individuals perceive social support online.

4.5 Main Takeaways

Overall, our results reveal the role of online interaction during periods of physical isolation during the COVID-19 pandemic (RQ1). We find that during this period, college students in stricter quarantine have experienced higher levels of loneliness, but have appeared to maintain their levels of social support. We similarly find that increased feelings of social support and decreased feelings of loneliness both correlated moderately with amount of in-person interaction. In contrast, social support correlated with frequency of emotional disclosure online ($r = 0.29, p < 0.001$) much more strongly than loneliness did ($r = -0.1, p < 0.01$). Students who engaged more over public social media also reported higher levels of loneliness and, though not statistically significant, lower levels of social support. Meanwhile, students who engaged more over private communication channels reported lower levels of loneliness and higher levels of social support (RQ2). Additionally, we find that among these private online platforms, one-on-one interactions appear to be more conducive to self-disclosure than group interactions (RQ3). We find that the act of self-disclosure on private interaction platforms (messaging, phone, video calls) is associated with higher levels of perceived social support (RQ4), and that among these, users self-disclose most frequently over messaging and least frequently over video call (RQ5). Finally, we find that students who self-disclose daily over online platforms show similar levels of social support as students who interact daily with others in person.

5 DISCUSSION

Our study sought to investigate (1) whether online interactions during the COVID-19 pandemic were allowing college students to compensate for the loss of in-person interactions, and (2) how different dimensions of online interactions (i.e. public/private, group/one-on-one, active/passive, and self disclosure) impact feelings of perceived social support and loneliness during the COVID-19 pandemic.

Below, we emphasize four implications of our work. First, we investigate the lack of apparent benefit between public online interactions and individuals' perceived social support and loneliness. Next, we highlight the unexpected benefits associated with private messaging that we do not see in phone or video calls. Third, we analyze the differences between one-on-one and group communication methods and why the latter appears to be less conducive to providing social support. Lastly, we consider the divergent effects of online communication on perceived social support and loneliness.

5.1 Public Posting does not seem to have a Positive Effect on Perceived Social Support and Loneliness

In contrast to private online interactions, which encompass more intimate interactions on private messaging, phone, and video calls, public online interactions include engagement within social media platforms (e.g., Facebook, Twitter) which allow for a diverse audience of recipients that, in many cases, may be unknown to the poster. We questioned the effect of public and private online interactions on feelings of social support and loneliness, and found that, while private messaging is associated with benefits to social support and reducing loneliness, the same does not hold for public online interactions.

By nature, public online interactions typically allow users to reach a wider number of people than private platforms. Similar to other studies conducted during the pandemic (e.g., [4, 29, 51]), our results show an increase in online interaction, particularly on social media. Participants reported spending more time on public social media than any other platform (e.g., messaging, phone call, video call), again matching previous findings in the US during the pandemic [72].

Given the large body of contrasting literature into the implications of social media use on various constructs related to mental health (e.g., [29, 48, 59, 62, 72]), including social support and loneliness; our findings that time spent on public platforms is correlated with higher levels of loneliness would seem to support the idea that public social media use has a negative effect on feelings of social support and loneliness. However, given the positive associations we find for private communication platforms, this explanation appears insufficient. While our analysis is not exhaustive, we propose a few considerations for why this pattern may exist.

We already expect to see a shift online with the beginning of the COVID-19 crisis, based on known behavioral patterns such as geographical convergence and its online equivalent [54, 64]. However, if this were the only factor, then we would expect to see similar social support and loneliness patterns across all online platforms. That we see differing patterns in public and private communication platforms indicates that other factors may be impacting college students.

Previous work has tied increases in online interaction to the Social Compensation Hypothesis [48], which suggests people gravitate towards online interactions to compensate for in-person social deficits [47]. Some people may attempt to increase their popularity online to compensate for their perceived lack of offline popularity [83] or increased introversion in offline social settings [47]. In the context of the COVID-19 pandemic, we may see students moving online to compensate for a lack of in-person interaction due to quarantine and social-distancing efforts.

Public social media platforms inherently enable users to interact with more people at once. They may therefore be the natural place for students to go to for companionship when they are feeling lonely or in need of support from a variety of perspectives. This would mean that it is the *existence of those negative feelings* that drives the correlation with social media use, rather than social media being the cause of negative feelings. However, what this does not explain is why we still see high levels of perceived social support associated with significant amounts of use and emotional disclosure across private platforms.

We can also examine this disparity between public and private messaging from the perspective of the Interpersonal Connection Behaviors (ICB) Framework. This Framework theorizes that outcomes of online platforms depend on whether users are actively using them for relationship building [18, 19]. Public social media usage in general does not inherently imply either active or passive use, and indeed some recent work has shown that traditionally "passive" activities could also be relational in nature [9]. However, traditional passive activities (e.g., reading/scrolling without commenting) are primarily associated with public platforms.

If we make the assumption that most time spent on public platforms is passive interaction, while a relatively large percentage of private online interaction (particularly when self-disclosing) is active, then our findings are aligned with the approach of the ICB Framework. We would expect to see negative outcomes associated with public platform usage in this case, along with more positive associations with private platform usage. This would also tie with previous work that theorized that private online interactions are more indicative of true emotion as they encourage communication more similar to in-person conversational patterns [45].

Finally, as social support and loneliness are, by their nature, emotions affected by interaction, maybe the lack of positive outcomes over platforms is a result of lack of interaction. That is to say, it may be that students gain less reciprocation and response over public platforms than in private communication. While it is possible to direct a public social media post towards a particular person (for example, Tweeting "at" another user), this is not the intended type of interaction for those platforms. Thus when a student posts on a public platform, there may not be significant or sufficient responses to elicit a positive outcome. In contrast, when a student communicates over a private platform, there is a specific person or group of people who are being contacted to engage, increasing the likelihood of a response.

This interaction pattern is reminiscent of known psychological phenomena, first being "diffusion of responsibility", where as the number of bystanders increases, an individual bystander shares the moral responsibility of intervening to assist the victim [40], bringing about nonintervention known as the "bystander effect" [30]. Recent work suggests this phenomena is linked to social media behavior and online victimization [44]. In the context of online interactions, this becomes more apparent when we look at an example: Say a user is feeling particularly negative and wants to reach out for support. Consider an identical message, say "I am feeling very sad today, please help cheer me up", posted on a public and private platform. In a public space, other users see the message but, knowing that there are many other people also seeing the same message, may believe that they do not have a satisfactory response, and that someone else would take up that emotional burden. In a private space, a user seeing this message is singled out, and is more likely to respond and engage.

5.2 Private Interactions and Self-Disclosure Benefits

In comparison to public platforms, each private platform (messaging, phone call, video call) showed significant correlations with both increased social support and decreased loneliness. We also found self-disclosure over private platforms to be the strongest predictor of perceived social support, even when compared to frequency of in-person interactions. As shown in Figure 2, the more time one spends disclosing online, regardless of the frequency of face-to-face conversations, is associated with greater social support when done so across private platforms.

In the past, private online interactions have been theorized to facilitate interpersonal connections more often than public online interactions because they more closely resemble in-person conversation [45]. Specifically, the inherent privacy provided by direct conversation itself, the perceived control that results from that privacy [81], and the relative speed of conversation that leads to a lack of revision—and subsequently less emotional filtering [45] are credited with providing an

experience closer to spoken conversation. Self-disclosure over private platforms is also perceived as more appropriate than disclosure over public platforms [7].

5.2.1 Unexpected Benefits of Messaging as Opposed to Phone or Video Calls. Intuitively, it makes sense that the closer an online platform feels to face-to-face interaction, the more it would be used for self-disclosure. As mentioned previously, previous work has attributed more frequent and more accurate disclosure in private platforms over public platforms to similarities between private platforms and spoken conversation. We would expect this pattern regardless of whether the platform is intentionally selected to be used for the purpose of disclosure, or whether the platform is already in use and provides a comfortable space for self-disclosure.

With this in mind, there are several auditory features often found during face-to-face conversation that are not captured by messaging but are present in phone calls, most obviously tone and verbal pauses. Video call takes this a step further and also provides facial expression and body language. We would therefore expect students to disclose most frequently and effectively over video call as it is most similar to face-to-face interaction. However, as shown in Table 2, amount of self disclosure over *messaging* was actually found to correlate most strongly with feelings of social support, with students who reported disclosing daily over one-on-one messaging reporting 1.21x higher social support than those who disclosed rarely or never.

We speculate this may be due to the added control that messaging provides as well as perceived privacy in the self-disclosure, which previous work suggests facilitates social support [1]. In many ways, messaging could be considered more private than face-to-face interactions, phone calls, and video calls. The lack of spoken responses means that people outside of the direct conversation cannot overhear anything shared. The addition of message disappearing times (such as those seen in Snapchat or Signal) also reduces the chance of messages being screenshot and shared, providing even more confidence. The lack of auditory and visual cues also allows users to present their thoughts without emotional tells, something that may also be privacy-protecting. While this may seem counter-intuitive, if we consider situations where emotional responses can hamper ability to communicate, we can see that messaging may be the most effective method of communication. For example, at times a speaker may begin to cry when upset, making it difficult to effectively verbalize their thoughts, and potentially leading listeners to ignore or dismiss their words. However, typing avoids this by allowing users to effectively convey their thoughts over text. Furthermore, where phone and video calls may allow for more unfiltered conversations and shows of emotion, private messaging may allow users to tailor their responses and share information in a more selective manner. This may allow for more thoughtful responses, and more consideration of any meaningful messages sent.

Private messaging is the only platform in this study that is both textual communication and extremely private. This difference could lead to higher levels of reciprocated disclosure and intimacy, which may in turn contribute to stronger feelings of social support across messaging platforms. We suggest future research look into the qualitative differences between the content and information shared by individuals over both in-person and private online interactions.

Additionally, previous work has shown people are more likely to reciprocate actions of self-disclosure over methods that are least expected for self-disclosure [38]. As common intuition tells us that disclosure is more expected over phone calls or video calls, it follows that disclosure is less expected over messaging. This would make any disclosure over messaging seem more meaningful and a symbol of a closer relationship, something that is suggested by the Hyperpersonal Interaction Model [38]. It is likely additional reciprocation may also be tied to higher feelings of social support.

5.2.2 Disclosure was Less Frequent across Group Chats. Just as we found a difference in interaction patterns for public and private platforms, we also investigate differences in self-disclosure between

one-on-one communication and group communication (i.e., one-on-one messaging vs. group chats). As shown in Table 2, we found self-disclosure across private one-on-one interactions to have stronger ties to social support than self-disclosure across private group interactions. This begs the question of how group dynamics affect the benefits of active platform usage.

Previous work on face-to-face conversations has shown that in-person self-disclosure most frequently occurs in one-on-one conversations, and is much less likely in larger group sizes due to the inherent association self-disclosure has with intimacy and relationship closeness [66]. This, in conjunction with our previous insights about aspects of private messaging that may encourage disclosure, may indicate that the similarities shared between public platforms and private group conversations are the reason for this difference. Compared to one-on-one, group interactions are less private, and may suffer from the same diffusion of responsibility that we speculated may impact public posting. Prior work has similarly shown that disclosure within in-person groups often suffers from inherent limitations, such as disclosure fears, reservations, and diffusion of responsibility compared to disclosure among dyads [20].

Coming from the perspective of the ICB Framework, we then argue that online group interactions, especially group messaging, may take on a more passive form, especially as group size increases. Similarly, public social media posting can be considered a group interaction at a large scale, and therefore represents a far more passive version of online communication than one-on-one private interactions, potentially explaining the original assumption that public platforms encourage passive interaction. Given this, we make the argument that the passive/active dichotomy presented in the ICB Framework is heavily affected by privacy of a platform and a user's willingness to self-disclose.

5.3 Divergent Effects of Online Communication on Loneliness and Perceived Social Support

Through our analysis of several factors that seem to influence the behavior and outcomes of online interactions during COVID-19, we found that levels of perceived social support and loneliness are not necessarily affected by the same factors during periods of physical isolation. Therefore, this section analyzes the differences in how online communication seems to impact social support versus loneliness. In particular, we note that while perceived social support seemed to be positively associated with factors such as private online interactions, one-on-one communication, and self disclosure, the same factors did not result in subsequent decreases in feelings of loneliness. This matches previous findings of persistent levels of loneliness across a seven week lockdown period [11] despite evidence of increased online communication during this time [29, 51, 72]. In comparison, our findings show that in-person factors seemed to have a much greater effect on loneliness than social support. While individuals living alone reported being significantly lonelier than those living with others, we find no significant difference in perceived social support between those living alone and those living with others. This is consistent with the work of Elmer et al., which found that although students reported increased loneliness, there were no significant shifts in social support during the COVID-19 pandemic [25]. However, the causal relationship behind these patterns is still unclear. It is possible that persistent levels of loneliness may stem from loneliness being a shorter-term feeling based on current experiences, whereas perceived social support is a measure of an individual's existing support and community network. Therefore, an individual's perceived social support prior to the COVID-19 pandemic may serve as a deterministic factor in the level of social support they feel even during physical isolation. Individuals with large existing support networks may simply have a larger network of people with whom they feel comfortable interacting and self-disclosing, whether that is in person or online. On the other hand, as loneliness is an emotion that can change from moment to moment, it may simply be difficult to mitigate online without in-person interaction.

As our study was limited to correlation data surrounding these factors, future research should take a causal approach to investigate the impact of online interactions on social support and loneliness.

6 LIMITATIONS

There were a few areas where this study was limited. First, there is a potential limitation in the recruitment method used. As we advertised exclusively through online channels (e.g., university email services and social media), it is possible that students without regular internet access would be under-represented in this study. Furthermore, our social media reach was limited by our use of Facebook advertisements (including on Instagram) and Reddit posts, so students that do not use those platforms were under-represented in this study. Online recruitment allows researchers to get a large reach of participants, including those under strict quarantine restrictions, however, individuals who do not use social media at all or are unresponsive to email prompts may be excluded from this sample.

In addition, we filtered participants based on the question, "Are you currently enrolled in a college/university in the United States?". Filtering based on this criteria includes all active students in our sample. This entails that our sample may have included remote international students who are enrolled in US colleges and universities, but live abroad. These students may live under varying COVID-19 regulations depending on their home countries, so their experiences may differ from students living in the US. Furthermore, the sample may include students who are enrolled part-time, another group whose experiences may differ from full-time university students. Regardless, all participants in our study are active members of the student body, and are affected by the regulations imposed by US universities.

Another limitation to this study was the inability to determine causation between the variables analyzed. Due to the observational nature of this study, we were only able to identify correlations between variables. For example, findings that correlate higher levels of social support with higher levels of messaging cannot be generalized to say that messaging causes students to feel more socially supported. To determine causality, future work should consider randomized controlled trials to better understand the causal relationships between online interactions and mental state.

Lastly, as with all voluntary survey-based studies, responses to this study were all self-reported, which could lead to self-selection biases or inaccuracies in survey responses. Participants willingly elected to complete the survey online and their decision to participate could reflect inherent, biased characteristics. Furthermore, self-report affords the possibility that participants might exaggerate their scores or struggle to introspectively assess their behavior accurately. In order to combat this, the questionnaire underwent several rounds of pilot testing, and incorporated validation questions (e.g., "What is the name of the current global pandemic?") and reverse wording to ensure accurate results. Survey-based studies of this form are very common methods of measurement in modern research, and the mental health scales distributed all showed a high level of internal consistency.

7 CONCLUSION

The COVID-19 pandemic caused a major upheaval in the lives of college students, a group that already has been found to have high levels of mental health challenges [53]. The severe impact of COVID-19 in the United States has forced many of its colleges and universities to adopt remote instruction policies that confine students to various states of physical isolation, resulting in increased psychological challenges [14, 41].

Previous research reveals young adults interact on social media more than any other age group in the US [15], and an increase in usage across online platforms during the COVID-19 pandemic [29, 51, 72], as echoed in our results. With this in mind, the increased physical isolation during the COVID-19 pandemic provided the unique opportunity to investigate whether online interactions

are truly an effective substitute for in-person interactions in mitigating loneliness and fostering social support. Online interactions were found to have stronger, positive ties with perceived social support than loneliness. Although we cannot prove causation, digital platforms showed promise for fostering social support in physically isolated individuals.

In this study, we investigate and reveal the positive relationship between private online communications on student social support during the COVID-19 pandemic. Private platforms were found to have greater positive ties to social support than public social media. We find self-disclosure across private platforms held the strongest ties to perceived social support, specifically on messaging platforms as opposed to phone and video calls, perhaps due to the privacy and flexibility messaging provides. We also examined group dynamics online, revealing one-on-one communication to have much stronger ties with social support than group communication. Overall, we see clear ties between online communication and feelings of social support, and suggest further study into private platforms and self-disclosure specifically.

Despite the psychological challenges of the COVID-19 pandemic, it appears that students are using advanced technologies to find new ways of receiving the support they need while in physical isolation. As online interactions were not found to mediate loneliness as much, interventions are needed for physically isolated individuals so that all students can feel connected and effectively bridge the social distance.

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A EMOTIONS DISCLOSED BASED ON FREQUENCY OF MESSAGING

Differences In Emotions Shared Between Frequency of General Messaging Disclosure

Emotion	df	Mean Difference	SE	Mean Square	F	p	n^2	p_{tukey}
Depression	1	-1.01	0.10	152.58	106.61	<.001	0.15	<.001
Fear	1	-0.86	0.10	110.728	77.46	<.001	0.11	<.001
Anxiety	1	-0.89	0.10	118.07	84.40	<.001	0.12	<.001
Anger	1	-0.66	0.10	65.58	41.46	<.001	0.06	<.001
Happiness	1	-0.65	0.10	61.94	38.80	<.001	0.06	<.001
Jealousy	1	-0.57	0.09	48.90	43.37	<.001	0.06	<.001
Calmness	1	-0.62	0.09	57.46	44.72	<.001	0.07	<.001
Apathy	1	-0.64	0.09	60.51	51.70	<.001	0.08	<.001

Table 3. Differences in the specific emotions disclosed by those who reported disclosing over messaging platforms at least weekly (frequent) or those disclosing monthly or less (infrequent) were examined. One-way ANOVAs were conducted across each emotion, revealing significant differences between groups across all emotions. The mean difference above represents the (mean of frequent)-(mean of infrequent), indicating greater differences for more negative emotions (depression, anxiety, fear), with the exception of anger. This suggests that students reporting higher willingness to disclose online are likely referring to more negative emotions. As increased self-disclosure online was found to be associated with increased perceived social support, it is likely that negative emotions play a larger role than positive emotions in students' perceived social support online during the COVID-19 pandemic.

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