

Loneliness in Connected Campuses: Social Disconnection in Digitally Saturated Students

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Abstract

Today's university students are the most connected and arguably one of the most lonely generations ever. This paper does not consider that to be a paradox that needs to be resolved through explaining loneliness as a problem of the digital, but rather a specification problem: the amount of social contact and the quality of social connection have become separated and the means by which they became separated are institutional, not technological. We expand on the notion of the Contact-Connection Gap (CCG) which outlines three avenues for how exposure to ambient digital contact can coexist with, and in some arrangements lead to, a perceived belonging deficit: displacement of unstructured co-presence, comparison-driven inflation of perceived social norms, and shallowing of reciprocal self-disclosure. Six propositions are drawn out, as well as individual and institutional moderators that forecast which students and which campuses are most at risk. Since the effects found in the empirical research literature on digital media and well-being are small, heterogeneous and sensitive to the specific measures studied, we have chosen not to report any invented statistics; rather we provide a clear simulation harness for simulating tie formation with different levels of co-presence opportunity and a measurement and estimation template that uses placeholder notation. The framework shifts the policy discussion from restricting screen time (largely without evidence to support the move) to shaping the structures of campus time, space and activity that result in repeated, unstructured interactions that are the basis for friendship formation. Student services implications, timetabling, residential design and implications for intervention evaluation are discussed.

Keywords: loneliness; belonging; higher education; social media; social networks; student well-being; campus design; digital saturation

1. Introduction

The modern campus of the university is surrounded by communication infrastructure. Students bring a device that connects with hundreds of others in an instant, for free; institutions have learning-management systems, cohort chat groups, and society networks; and the physical campus is layered with a rich digital community, theoretically eliminating any and all barriers to social connection. In the context of such developments, the problems of loneliness and disconnection have been a constant recurring theme in institutional surveys of well-being and in the broader national debate on higher education. The contrast begs a natural conclusion: that connection is giving way to connectivity and digital technology is creating a young people's loneliness epidemic.

That's more of an inference than a defense. Large-scale reanalyses suggest that the relationship between digital media use and adolescent and young-adult well-being is comparable in magnitude

to the relationship with variables of no substantive interest, and that the sign and size of the estimates that have been published is sensitive to the specific specification the analyst selects (Orben & Przybylski, 2019). The findings of umbrella reviews are also quite cautious and highlight that much of the heterogeneity in what individuals are doing and with whom is missed when using screen-time measures as a whole (Valkenburg et al., 2022). The increase in loneliness among young people in many countries, meanwhile, can be reasonably well supported by evidence, and the time course does not correspond to a single technological factor (Twenge et al., 2021).

In this paper, the starting point is, therefore, different. It doesn't ask if digital media make people feel lonely, but why has the volume of contact become a poor measure of connection quality? And what is it about the architecture of modern campus life that creates the space between? The framing is important, not just in theory, but in practice. Loneliness is a technology issue, and so is the policy. Where it is an issue of how contact is structured, the policy response is about time, space and the design of the settings in which repeated unstructured encounter can happen – these are directly under institutional control and not the case with student device use.

Four contributions follow. First, the concept is explained, setting apart "loneliness" from "social isolation" and "social solitude." The idea of "loneliness" is mistakenly merged with social isolation and social solitude in much of the applied literature. Secondly, we arbitrate between rival theoretical explanations for digital media and connection and demonstrate that they are not mutually exclusive, but that they can be used to explain different kinds of interactions. Third, we put forth the Contact-Connection Gap framework, which identifies three mechanisms and six testable propositions, all of which have specific moderators. Fourth, we offer analytical protocol, consisting of a simulation harness for tie formation and an estimation template, which specifies the evidence required to disconfirm the argument, but does not give illustrative numbers to replace data that we have not gathered.

2. Conceptual Clarification

2.1 Loneliness, isolation, and solitude

Loneliness is the unpleasant feeling of having a gap between the desired and actual social relationships (Perlman & Peplau, 1981). 3 aspects of that definition make significant work. It is subjective, and cannot be broken down into number of contacts. It is discrepancy-based, meaning it is based on expectation rather than circumstance, so it can be a lonely or contented experience based on the same objective social situation. And it's aversive – it's not chosen, it's not restorative – it's aversive. Social isolation, in contrast, is an objective quality of a person's network, few ties are very little contact, and participation is limited. There is only a moderate correlation between the two of them and the dissociation is the interesting analytically case. A student who has a close circle of friends but no one to whom they can turn is not isolated and could be extremely lonely.

The additional distinction provided by Weiss (1973) provides a basis for much of the subsequent literature. Emotional loneliness is characterized by the absence of a close attachment figure and is not eased by more casual contact while social loneliness is characterized by an absence of an interesting social network and is not eased by intimacy with one attachment figure. The difference may have direct diagnostic utility on campus as it presents a similar appearance in survey

aggregates and needs different responses. The constructs along with their characteristics and the measurement traditions are defined in Table 1.

Table 1. Distinguishing loneliness from adjacent constructs

Construct	Defining feature	Nature of the deficit	Typical measurement	Implication for institutional response
Emotional loneliness	Absence of a close attachment or confidant	Qualitative: depth of a single tie	Multidimensional loneliness scales; confidant-name generators	Not remediable by increasing contact volume; requires conditions for deep disclosure
Social loneliness	Absence of an engaging network or community	Structural: breadth of belonging	UCLA Loneliness Scale (Russell, 1996); short-form measures (Hughes et al., 2004)	Remediable by group membership and shared activity settings
Social isolation	Objectively few ties or infrequent contact	Objective network property	Network size, contact frequency, participation counts	Detectable administratively; not equivalent to distress
Solitude	Voluntary and self-regulated time alone	No deficit; often restorative	Time-use measures with volition items	Should not be treated as a target for intervention
Perceived belonging	Sense of fit and acceptance within an institution	Evaluative and comparative	Belonging scales; sense-of-fit items (Walton & Cohen, 2007)	Highly responsive to brief attributional interventions

2.2 Why loneliness matters institutionally

The case is not a difficult one because of distress. Loneliness has been related to poor executive function, sleep disturbances and increases in physiological stress response (Cacioppo & Hawkley, 2009; Hawkley & Cacioppo, 2010); and meta-analytic findings indicate that loneliness and social isolation have been associated with higher mortality risk across all populations (Holt-Lunstad et al., 2015). In higher education, perceived belonging is one of the more stable predictors of persistence and attainment and belonging-based interventions have proven to have lasting positive impacts on the academic and health outcomes of students from groups that are socially questioned as to their fit (Tinto, 1993; Walton & Cohen, 2011). Loneliness is thus a social issue and a factor in the outcomes which are formally measured, on which institutions are judged.

Another is issues of self-maintenance. Loneliness is not one-off, but a cognitive process with consequences for cognition: lonely people exhibit attentional and interpretative biases of social

threat that lead to behaviour that helps them protect themselves against social rejection, which in turn decreases the chances of connection (Spithoven et al., 2017). This hypervigilance mechanism accounts for the greater stability of loneliness over time, compared with what one might expect from a description of circumstances (Mund et al., 2020), and for why interventions that simply provide more opportunities for contact are often unsuccessful: it's not that opportunities are being squandered, it is that they are not being perceived as valuable. This is reflected in meta-analytic studies, which show that interventions that address maladaptive social cognition seem to be more effective than interventions that provide social contact, social support, or social skills (Masi et al., 2011).

2.3 The transitional context of the first year

Loneliness in higher education is not uniformly spread across the student career and any approach that lumps it together will miss its temporal dimension. On the one hand, there's the need to break up an existing network and on the other, to put one up together within tight deadlines, in a situation where all peers are doing the same thing and social churn is high. Belongingness is a basic motive whose thwart signals predictable psychological and physiological consequences (Baumeister & Leary, 1995) and the transition phase focuses this thwart—from a settled position in one network to an unsettled one in another, where the ultimate outcome is yet to be known, given the lack of prior evidence to predict the eventual outcome.

Two of these are significant for the argument: These two are significant for the argument: To begin with, network formation is highly homophilous, meaning that students with unusual demographic, educational, or linguistic traits have fewer potential links and will require a longer time to form the network (McPherson et al., 2001). This is because the loneliness of international, first-generation, mature and commuting students is correlated with various factors on average, and the aggregate measures of cohorts mask the concentration of risk. Second, in this period, students have little first-hand information on what their peers are actually experiencing, further increasing their need to infer information from what they can see and hear, leading to the maximization of exposure to the comparison mechanism, described below. Adolescence and emerging adulthood are times of heightened vulnerability as suggested by longitudinal work on loneliness throughout the lifespan; this is in keeping with the developmental logic of a life stage that involves renegotiating social identity (Qualter et al., 2015). What this means practically is that, "Time matters just as much as targeting, an intervention that happens in week two is somewhat in a different state of the population than one that happens in week twenty.

3. Competing Accounts of Digital Media and Connection

The literature can be organized around four theoretical standpoints and they are not only interpretive as they clash in terms of empirical evidence. The displacement hypothesis states that time spent online displaces time spent in richer face-to-face interactions, and, therefore, decreases the quality of the interaction (cf. Kraut et al., 1998, their classical statement on early panel data evidence of a link between use of the internet and decreases in social involvement and well-being). However, the opposite theory, the stimulation hypothesis, has been embraced by the same research group's subsequent research, which discovered that the earlier negative effects of online

communication were mostly gone as the medium and its users evolved (Kraut et al., 2002; Valkenburg & Peter, 2007). The Goldilocks hypothesis states that there is a non-monotonic relationship between the two; that is, there is a moderate level of use that is linked to the best outcomes, whereas abstaining from use and engaging in heavy use are linked to worse outcomes (Przybylski & Weinstein, 2017). The differential-susceptibility and interaction-type position suggests that the unit of analysis is inappropriate (aggregate use), and that effects depend on what is done (directed, personalised, and close interaction associated with positive effects; passive interaction associated with the opposite).

These accounts, with discriminating predictions, and evidence bearing on each are stated in table 2. The most plausible interpretation of the field is that they are not players at the same level of abstraction. The interaction-type position is a specification of conditions where displacement occurs, or where stimulation occurs, and the Goldilocks pattern is the pattern that would be seen in aggregate data if the underlying process is interaction-type dependent, and if the heavy users tend to be passive consumers. The causal claim gains more credence than the correlational mass of the literature, as evidenced by two experimental design types that have been conducted and found to have effects in the hypothesized direction, although limited in magnitude in recent studies when compared to popular claims: staggered-rollout designs that take advantage of the natural expansion of a social platform over university campuses, and randomised deactivation designs, which have generated mental health and well-being effects in the hypothesized direction, albeit small (Allcott et al., 2020; Braghieri et al., 2022).

Table 2. Competing theoretical accounts, discriminating predictions, and evidentiary status

Account	Core claim	Discriminating prediction	Principal supporting evidence	Principal weakness
Displacement	Online time substitutes for richer offline interaction	Negative association strengthens with total use; mediated by reduced face-to-face time	Early panel studies (Kraut et al., 1998)	Later replications by the same team did not sustain the effect
Stimulation	Online communication extends and maintains existing ties	Positive association concentrated in directed communication with close ties	Kraut et al. (2002); Valkenburg and Peter (2007)	Cannot account for passive-use findings
Goldilocks	Moderate use is optimal; abstention and heavy use are both worse	Inverted-U functional form	Przybylski and Weinstein (2017)	Aggregate form may be an artefact of composition rather than a causal shape
Interaction-type /	Effects depend on activity type, tie	Directed communication and	Burke and Kraut	Demanding measurement

Account	Core claim	Discriminating prediction	Principal supporting evidence	Principal weakness
differential susceptibility	strength, and person characteristics	passive consumption show opposite signs within the same individual	(2016); Verduyn et al. (2017)	requirements; limited external validity
Quasi-experimental and experimental	Exogenous variation identifies causal effects	Staggered rollout and deactivation produce detectable well-being changes	Allcott et al. (2020); Braghieri et al. (2022)	Effects are modest; generalisability across cohorts and platforms uncertain

One of the not-so-obvious reasons for the instability of the field is measurement. Self-reported retrospective usage of technologies is only modestly related to logged usage and the direction of error fluctuates with mood, salience of recent use, and the respondent's beliefs about excess use. In addition, there is plausible evidence that both loneliness and low mood affect recall of screen time, meaning that there is an error component shared between the two that exaggerates their relationship. The problem is compounded by the use of aggregate duration, which adds behaviours of opposing predicted effects together into a single number, ensuring that they will all be dampened towards an average of the mixture. The methodological implication is that a large proportion of the disagreement in this literature can be due to the measurement artifact and studies involving log use, activity-type resolution, and within-person designs are significantly underrepresented in the literature.

There are two consequences to this for the argument to follow below. First, a policy based on digital media as a single-causal agent will be certainly be underperforming because the tech is actually not uniform. Second, the reconnection pathway is not to be underestimated: The association between use and loneliness is partly reverse-causal – lonely people use social technology more, and not less – and for some students, digital contact partly compensates for a lack of contact, rather than being a substitute for it (Nowland et al., 2018).

4. The Contact-Connection Gap Framework

4.1 Structure

Digital saturation is defined as ambient contact abundance, which is an asynchronous state of many contacts being available at low frequencies and high depths, as illustrated in Figure 1. Ambient contact does not necessarily pose a threat, and is actually known to maintain weak ties that are informational and psychologically beneficial (Granovetter, 1973; Sandstrom & Dunn, 2014). The claim of the framework is more limited: Ambient contact is not a substitute for the face-to-face interactions that are fundamental to the development of close ties, and three mechanisms transform ambivalent contact into a sense of belonging deficit.

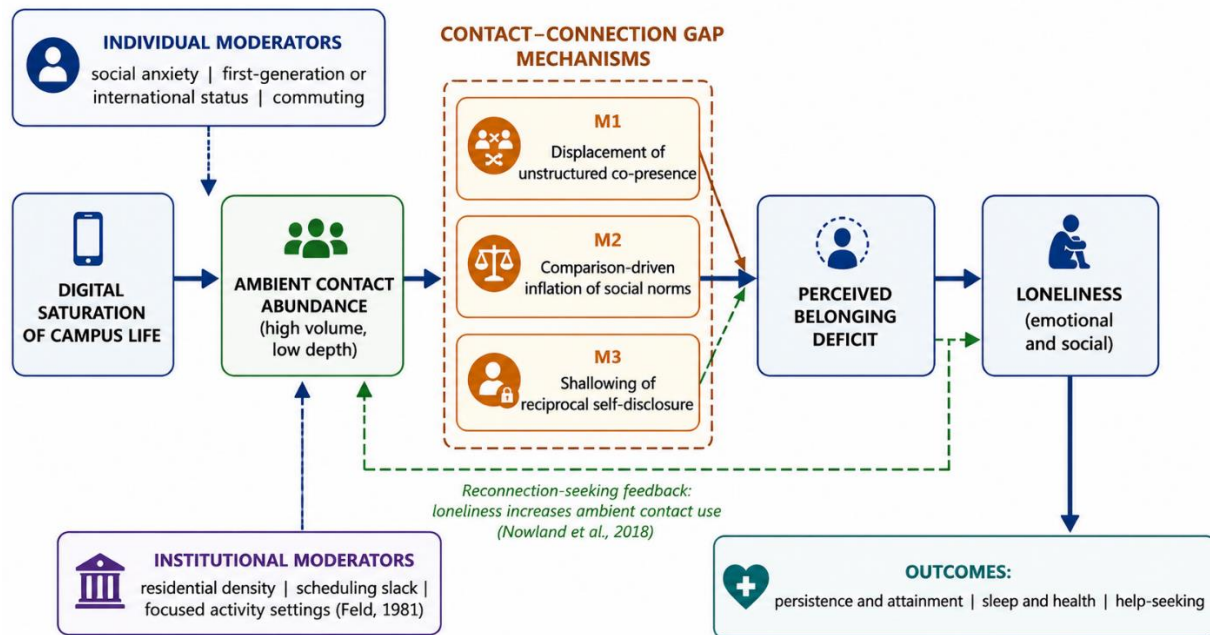


Figure 1. The Contact-Connection Gap framework, showing three mediating mechanisms linking ambient contact abundance to perceived belonging deficit and loneliness, with individual and institutional moderators and the reconnection-seeking feedback pathway.

M1: Displacement of unstructured co-presence. The amount of unplanned, low-stakes time in the same physical space is the key to friendship formation. According to classic propinquity research, the physical closeness and incidental encounter of others is an important predictor of the formation of ties (Festinger et al., 1950), and there is an explanation why: ties form around foci, that is, activity settings that repeatedly bring the same people together for activities without requiring either to initiate (Feld, 1981). An analysis of the time that must pass between stages of acquaintance and friendship has revealed that there is a considerable amount of cumulative time between the various levels of acquaintance and friendship (Hall, 2019). No ambient contact can be added to this currency. It has short, directed, and delayed interactions, which can displace the unstructured co-presence that still exists, both because it takes attention in shared physical space (Dwyer et al., 2018; Misra et al., 2016) and because it is able to remove the coordination difficulty that used to produce incidental encounter (Dwyer et al., 2018). If a student can confirm plans immediately, the unplanned contact that often occurs due to students waiting, drifting and loitering is taken away from the day.

M2: Comparison-driven inflation of perceived social norms. Students make inferences based on what they see, and what they see on the saturated campus is systematically biased upwards in terms of social life. Social media content is edited for positive and social self-presentation, thus the observed distribution of peer sociality is right-shifted in comparison to the true distribution as described by Festinger (1954) and Vogel et al. (2014). This bias is exacerbated by another: the friendship paradox, which says that people who have more friends on a social network tend to have

more friends than those who do not, meaning that people with more friends in the sample are likely to have more friends in general than people without more friends in the sample (Feld, 1991; Zuckerman & Jost, 2001). Since loneliness is based on discrepancy, an upward-biased norm generates loneliness in the absence of any changes in the actual relationship. The mechanism is similar to the classic pluralistic ignorance situations in which students systematically overestimate how comfortable they are with prevailing norms on campus (Prentice & Miller, 1993).

M3: Shallowing of reciprocal self-disclosure. Self-disclosure coupled with the responsiveness it elicits is a process that unfolds across a series of cycles (Laurenceau et al., 1998; Reis & Shaver, 1988). The other side of that cycle is inhibited in ambient contact environments: content is long-lived, audiences are large and not necessarily well-defined, and the reputational liability for misjudged self-disclosure is great. Students, therefore, regulate themselves toward performance and not disclosures. In face-to-face contexts, a barrier is active, people systematically underestimate the amount of others like them they can talk to after conversation (Boothby et al., 2018), overestimate how awkward it would be to have a deeper conversation (Kardas et al., 2022), and thus settle for shallow conversation that is not desired by either party. They are each minor, but they all make a difference, working when the right handshake could seal the deal to a friendship of a lifetime.

4.2 Propositions

Table 3 states six propositions with their theoretical warrant and focal constructs. They are formulated to be falsifiable with data that institutions could realistically collect.

Table 3. Propositions of the Contact-Connection Gap framework

Proposition	Statement	Theoretical warrant	Focal constructs
P1	Loneliness is predicted by the ratio of ambient contact to unstructured co-presence, not by the volume of either alone.	Focused organisation; time-accumulation account of friendship	Contact volume; co-presence hours; loneliness
P2	Directed communication with close ties reduces loneliness, whereas passive consumption of broadcast content increases it, within the same individual across occasions.	Interaction-type account	Communication type; tie strength; daily loneliness
P3	The gap between perceived and actual peer sociality mediates a substantial share of the association between platform use and loneliness.	Social comparison; friendship paradox	Perceived norm; true norm distribution; loneliness

Proposition	Statement	Theoretical warrant	Focal constructs
P4	Emotional loneliness is unresponsive to interventions that increase contact opportunity, whereas social loneliness responds to them; both respond to interventions targeting social cognition.	Weiss's typology; loneliness-intervention meta-analysis	Loneliness subtype; intervention class; effect size
P5	Institutional scheduling slack and residential density moderate the contact-connection gap, such that identical digital exposure produces different loneliness across campuses.	Proximity; focused organisation	Timetable density; residential arrangement; commuting status
P6	Loneliness increases subsequent ambient contact use, producing a reciprocal relationship that biases cross-sectional estimates of the effect of use on loneliness.	Reconnection-seeking pathway	Lagged loneliness; subsequent use; estimation bias

4.3 Who is most exposed

The framework does not anticipate uniformity of concentration but it does show where—with the moderators shown in Figure 1. For the socially anxious student, the advantages of ambient contact are especially appealing because it allows them to participate without the risk of being judged by human interaction; it is thus highly likely to be used to replace the aversive human presence they crave the most. A commuter student is not as likely to have unplanned encounters from having close proximity to resident peers, and his or her time spent on campus is limited to scheduled activity so that there is no opportunity for unplanned drift. International and first generation students are subject to the same homophily constraint outlined above, but may have a greater likelihood of appraising early social difficulty as evidence of "not belonging" (Walton & Cohen, 2011), which belongs interventions seek to address.

At an institutional level, the model suggests that campuses with the same amount of student digital use will systematically vary in their loneliness—a rarely predicted and testable claim. Dense timetables that create free time which is broken up into too short and too brief periods, modular curricula that change peer groupings every term, and estates strategies that try to squeeze the last bit of free space out of the estate all reduce the denominator for co-presence in P1 without affecting contact volume. These are pursued by every individual for reasons, which are mostly efficiency based and assessed by criteria, which do not use Social Formation. The framework does not imply that such decisions are bad; it implies only that they have a social cost, that cost is currently unmeasured, and that it is in principle measurable.

5. Institutional Design Implications

If the framework is correct, the leverage available to universities lies less in regulating student technology use, which is neither feasible nor evidently effective, than in restoring the conditions under which unstructured co-presence accumulates. Table 4 sets out design levers organised by the mechanism they address, with the institutional owner and a candidate indicator for each.

Table 4. Institutional design levers by targeted mechanism

Lever	Targeted mechanism	Description	Institutional owner	Candidate indicator
Timetable slack and cohort synchrony	M1	Schedule shared free periods within cohorts so that unstructured time coincides rather than fragments	Registry and timetabling	Overlapping free-hour minutes per cohort per week
Third-place provision	M1	Provide unprogrammed, low-cost, lingerable settings between formal spaces (Oldenburg, 1989)	Estates and facilities	Seat-hours of informal dwell space per enrolled student
Small stable groupings	M1	Keep seminar, lab, and residential groupings stable across a term to generate repeated encounter with the same peers	Academic programme design	Proportion of contact hours spent with a stable group
Norm-correction communication	M2	Publish accurate distributions of peer social experience, including how common early-year loneliness is	Student services and communications	Gap between perceived and measured peer sociality
Structured disclosure settings	M3	Facilitated small-group formats with graduated disclosure prompts and trained facilitators	Student services; peer mentoring	Participation rate and reciprocal-disclosure ratings
Belonging-attribution interventions	M2, M3	Brief interventions reframing early social difficulty as common and transient rather than diagnostic (Walton & Cohen, 2011)	Induction and first-year programmes	Belonging-scale change; persistence differentials

Lever	Targeted mechanism	Description	Institutional owner	Candidate indicator
Commuter and non-residential provision	M1, moderator	Compensate for absent residential propinquity with anchored on-campus time and storage, study, and social bases	Student experience	On-campus dwell hours among commuting students

Identifying the recommendations that the framework does not recommend is also crucial. It is not feasible and is not supported to have technology restriction at the campus level. The evidence of deactivation and limitations is mixed; some randomized studies find that limitations lead to better loneliness and depression outcomes (Hunt et al., 2018), and large-scale deactivation experiments find some improvements in some measures of well-being, but also find that there is significant welfare value in having the ability to use the platform (Allcott et al., 2020). Ambient contact is essential for the reconnection process for lonely students (Nowland et al., 2018); therefore, eliminating it without addressing the co-presence deficit could lead to a loss of contact as well. The framing of a digital-detox also has a rhetorical price tag – it places the blame on student behaviour, and avoids questioning how institutions can be designed in order to address the issues Table 4 outlines.

There are three design concepts that cross the table. The first is that opportunity cannot be an alternative; it has to be built into the system. There are interventions that require students to opt in, and when students are most in need of the help, they are most likely to be socially threatened, and thus most likely to be turned off by volunteering (Spithoven et al, 2017), this is an identical selection problem to what has been documented as occurring for workplace provision of well-being. Design that alters the default distribution of encounter reaches does so this population, design that provides an optional event does not.

The second is that it's repetition, not intensity, that's important. Large one-off social events are an exception in that they cause contact, but it does not build up over time, and the time-accumulation account shows that a single high-intensity encounter creates substantially less contact than would the same number of hours of contact spread across repeated encounters with the same people (Hall, 2019). Systematic over-investment by institutions in the former, which is visible, schedulable and easily reported.

The third one is that norm correction is very inexpensive. However, if a significant proportion of student loneliness was a misjudgement of the level of peer sociality – rather than a real lack of it – then giving accurate information about the reality of the distribution of sociality is a low-cost intervention that is plausibly testable with a clear mechanism. It is particularly useful in the first term when students have the least amount of straightforward evidence of other students, and the most amount of reliance on inference based on observable signals.

6. Analytical Protocol

6.1 A simulation harness for tie formation

The structure of encounter opportunity is argued to cause loneliness, not the number of contacts. There are quantitative implications of that that aren't immediately clear from a verbal statement, so we formalise it. They gain interaction hours with candidate alters as a result of co-presence opportunities that occur according to a Poisson process with rate ρ per week, and interaction time has a variable duration; if the interaction hours exceed a threshold h , chosen from the time-accumulation literature, it is considered a strong tie. Panel (b) of Figure 2 presents the results of a simulation of the proportion of students with fewer than two strong ties at the end of a thirty week school year, for various values of h and ρ . The three competing functional forms from Section 3 are plotted in panel (a) as a comparison with the results. The parameters are not estimated, but are declared and recorded in Table 5, and the figure shows the behaviour of the model, but does not claim to represent any actual student population.

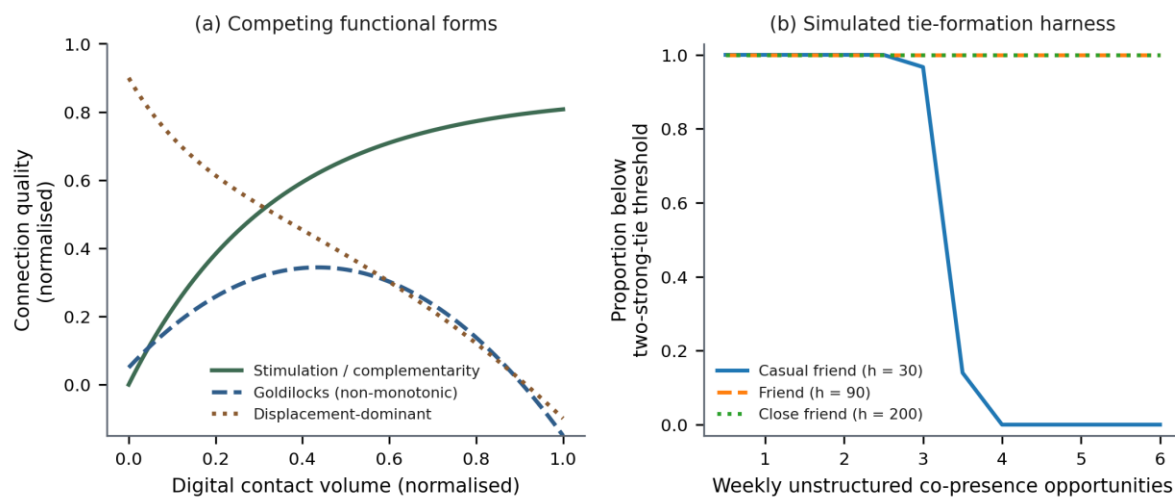


Figure 2. Panel (a) competing functional forms relating digital contact volume to connection quality. Panel (b) simulated proportion of students below a two-strong-tie threshold as a function of weekly unstructured co-presence opportunities, at three tie-formation thresholds. All values are generated from declared parameters and are illustrative of model behaviour only; they are not empirical estimates.

Table 5. Simulation harness parameters and estimation template with placeholder notation

Element	Specification	Declared value or placeholder	Role
ρ	Weekly unstructured co-presence opportunities student	0.5 to 6.0, swept	Primary structural lever (M1)
h	Cumulative hours required for a strong tie	30, 90, 200 (Hall, 2019, as declared thresholds)	Determines conversion of encounter into tie
Encounter duration	Uniform draw scaling each encounter	0.4 to 1.2 hours	Introduces realistic heterogeneity

Element	Specification	Declared value or placeholder	Role
Horizon; population	Academic year; simulated cohort	30 weeks; 300 students; replicated runs	Determines simulated distribution
P1 test	Ambient contact hours divided by co-presence hours, predicting loneliness	Coefficient [b1], expected sign positive	Within-person panel with individual fixed effects
P2 test	Directed communication and passive consumption entered jointly	Coefficients [b2d] negative, [b2p] positive	Experience sampling; within-person estimation
P3 test	Perceived minus measured peer sociality as mediator	Indirect effect [b3]	Mediation with measured true distribution as benchmark
P4 test	Intervention class by loneliness subtype	Interaction contrast [b4]	Randomised or stepped-wedge trial
P5 test	Timetable slack and residential density at campus level	Cross-level interaction [b5]	Multi-campus multilevel design
P6 test	Lagged loneliness predicting subsequent use	Cross-lagged coefficient [b6]	Random-intercept cross-lagged panel model

6.2 Measurement and inference cautions

There are four cautions for any empirical test. Avoid aggregating screen-time, as there is only weak correlation between self-reported and logged use, and aggregation loses just the one form of variability that the framework identifies as causally relevant: interaction-type. The assessment of loneliness should be done using validated instruments and, if possible, using a subtype resolution as otherwise P4 is untestable (Hughes et al., 2004; Russell, 1996). Common-method variance is a potential problem when all three variables – use, perceived norms, and loneliness – are measured with the same instrument: Multiple measures of one variable are required (Podsakoff et al., 2012). Last, the reciprocal relationship claimed in P6 obscures the fact that any design in which the within-person ordering of events is not from cause to effect would be guilty of incorrect causal inference of compensatory use as a causal effect, suggesting that a part of the alarming cross-sectional associations that proliferate in public debate may be due to this.

7. Discussion

7.1 Theoretical implications

Its main contribution to the framework is the shift of the explanation from the medium to the ecology. Contrary to the idea that students' behaviours on their devices explain loneliness, there is no satisfactory explanation of this; and looking for a dose-response relationship between the amount of time spent on screens and distress has led to estimates that have been small and unstable for two decades. This is more easily understood in light of the fact that the two factors involved in friendship formation, repeated encounter and reciprocal disclosure, have both decreased as contact has increased; and the abundance of contact actively masks the scarcity by providing a plausible alternative to it. This reframing also overcomes the apparent contradiction in the literature: digital communication really does enable weak ties and really does not enable close ties – and both sides of the equation are right about different components of the network.

The second implication is of the loneliness as a comparative judgement. If P3 is true, there is an informational gap in the students' experience of loneliness that can be filled with informational intervention and predicts that the same social experience will create different informational experience of loneliness depending on the informational context. This does not diminish the sense of loneliness, rather it makes it more manageable.

The third implication is related to the restrictions on substitution. Cognitive constraints on the number of close relationships one can maintain at any given level of closeness are plausible and found for online media: the structure of network size and layered closeness found online seems to be similar to that found offline (Dunbar, 2016). When capacity is limited, it is not accumulation, it is allocation that is the strategic question. If a student has a lot of low intensity relationships, they have less capacity to do a few high intensity relationships, and the environment of "ambient contact" allows for an easy way to do the low intensity relationships. On this reading, digital saturation is not a decrease in sociality, but a shifting of sociality to the lowest point in the network that students feel the need for.

Lastly, the framework is linked to a larger discovery of the incongruent social expectation. People tend to underestimate how enjoyable it is to interact with strangers, and so they opt not to do so when they might have liked to have done so (Epley & Schroeder, 2014), underestimate how enjoyable it is to interact with conversation partners like themselves (Boothby et al., 2018), and expect such conversations to be more awkward than they actually are (Kardas et al., 2022). All these errors are obstacles to the kinds of interactions the framework specifies are rare, and all are potentially correctable by information. This makes the third design principle below exceptionally appealing, attractive compared to its price, and makes the framework mechanisms manipulable, not just observable.

7.2 Limitations

Three constraints are to be clearly acknowledged as such. This is a conceptual paper, where the propositions are not tested, but rather they are derived; and the simulation demonstrates internal consistency, not correspondence, with any empirical population. It has parameters that are declared and should NOT be read as a finding in Figure 2. Second, the evidence characterisations as given in Section 3 provide a summary of the direction and general strength of the published evidence, but do not provide numerical estimates of evidence; the reader should refer to the cited sources for numerical estimates and intervals, and remember that this literature is particularly specification-sensitive. Third, the framework is grounded primarily in research conducted in the context of

higher education institutions focused on residential, high-income students, and so whilst transferable to commuter-dominated, distance, and/or lower-resource contexts, it will need to be examined instead of assumed. The moderators in P5 make the boundary condition explicit but do not resolve it.

8. Conclusion

Students who attend connected campuses are not lonelier than they need to be as they are connected. They are lonely, there, because there is a great deal of contact available to them, but it is not the kind of contact that leads to close relationships, because there is a lot of what it looks like that is visible, but isn't real, and because there is a lot of what looks like that, but it is not real, and because there are institutional structures that used to produce unplanned repeated encounter that have been systematically optimized out of existence in the name of efficiency and choice. All of these are design issues, and all of these are easier to institute than technology that has been locked in. The following Contact-Connection Gap framework and the six propositions are therefore meant to make the argument testable and not just plausible, that is, refutable.

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