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Research paper

The online world as a means of connection and disconnection during the COVID-19 pandemic: A test of the interpersonal-connections-behaviour framework

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ABSTRACT

Background: The *interpersonal-connections-behaviour* framework proposes that social media is helpful/unhelpful to the individual to the extent that it facilitates/hinders satisfaction of core needs for acceptance and belonging (*connecting* and *disconnecting* pathways). However, little research has, to date, explicitly tested this framework.
Methods: Both pathways were explored in a cross-sectional sample of UK adults at the start of the pandemic (N = 632) and in longitudinal (cross-lagged) analyses (N = 227–240). Participants completed measures of online and offline socialising with friends and family (*connecting* pathway), and online and offline social comparisons (*disconnecting* pathway), anxiety, depression and loneliness.
Results: In cross-sectional analyses higher levels of online comparisons were associated with poorer mental health, an effect that survived after controlling for *offline* comparisons, and was partially mediated by loneliness. Counter to our predictions, online socialising was also associated with *poorer* mental health. Longitudinal analyses did not support predicted directions of causality.
Limitations: Limitations include a lack of testing of individual-level moderators, the use of single item questions to probe some constructs, and an inability to test for effects potentially operating at different time-scales.
Conclusions: The findings reported partially support the *interpersonal-connections-behaviour* framework in highlighting a *disconnecting* (but not *connecting*) pathway between online engagement and mental health. From a clinical perspective they highlight the importance of including people's online lives when considering mental health risk and resilience, particularly (one might argue) during periods of social isolation.

1. Introduction

Whilst discourses around the role of social media (SM), screen time and internet use in mental health (MH) have typically taken a "concern-centric" perspective (Orben et al., 2020), the COVID-19 pandemic has led to reassessment of this position. For large swathes of the world's population social distancing measures and stay at home orders meant that online technology became the primary source for staying in touch with others (Ofcom, 2021).

Although it remains to be seen to what extent these changes (and the effects thereof) persist (Thygesen et al., 2021), a growing body of evidence from this period suggests a complex picture, with SM playing positive *and* negative roles in MH depending on a range of factors, including motivations for use, online behaviours, type of app/technology used. For example, a systematic review of digital media use by adolescents during the pandemic found that whilst most studies reported a small association between higher (general) levels of SM use and poorer wellbeing, certain forms of online engagement were associated with reduced feelings of loneliness and stress; these included direct (one-to-one) communication, self-disclosure in the context of a mutual, online friendship, as well as positive or funny online experiences (Marciano et al., 2022).

A challenge in interpreting these findings is the lack of theoretical integration, which typifies SM/MH research more generally (Orben, 2018). One simple theory that (arguably) has the potential to integrate some of the findings described, is the *interpersonal-connections-behaviour*

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framework (ICBF). The ICBF proposes that SM use is helpful/unhelpful to the extent that it satisfies core needs relating to acceptance and belonging (Clark et al., 2018). Put simply, the technology is likely to be beneficial where it connects people, and detrimental where it leaves people feeling more disconnected. See Tibber and Silver (2022) also.

To our knowledge, only one study has tested the framework explicitly, and none during the pandemic. Tibber et al. (2020) tested both arms of the ICBF in a single (pre-pandemic) emerging adult population sample, and showed that whilst online upward social comparisons (OUSCs) were associated with lower self-esteem (taken as evidence for the *disconnecting pathway*), the use of SM to cultivate and consolidate social connections was *not* associated with higher self-esteem (taken as a lack of evidence for the *connecting pathway*). Whilst this represented an important step in explicitly testing the ICBF, there were a number of limitations to this study, including its relatively modest sample size ($n = 183$), cross-sectional design, and lack of control for *offline* social behaviours, which the authors acknowledged. In addition, the wording of questions used to probe a potential *connecting* pathway likely oriented participants towards their use of *social network sites*, sometimes referred to as *mass-personal* media because of their capacity to connect users with large audiences, rather than *inter-personal* SM forms such online texting, video-messaging or video-chatting, which facilitate more direct, one-to-one or small group communication and greater intimacy (Choi and Choung, 2021; Fumagalli et al., 2021).

In the present study a number of predictions to emerge from the ICBF were tested in a larger sample of UK adults during the early stages of the pandemic and associated lockdown, a period during which, we reasoned, the potential risks *and* benefits of online engagement would be elevated because of the increased dominance that digital technologies came to play in people's lives (Ofcom, 2021). Specifically, we tested four hypotheses relating to the disconnecting pathway, three based on cross-sectional analyses, and a fourth based on a (smaller) sample of participants for whom follow-up data permitted longitudinal analyses, and five parallel hypotheses relating to the connecting pathway. With respect to the *connecting* pathway, in light of the limitations of our previous study (Tibber et al., 2020), we focused on the use of *inter-personal* SM forms, explicitly asking participants about their use of technologies such as voice, video or instant messaging to connect with friends and family.

Considering the disconnecting pathway first (Clark et al., 2018), we predicted that (H1) higher levels of OUSCs would be associated with poorer MH, specifically symptoms of (H1a) anxiety and (H1b) depression. Thus, social comparisons theory (Festinger, 1954) proposes that people's sense of worth is derived, in part, from comparisons with others, with upward social comparisons (i.e. comparing oneself to others perceived as better off in some way) often being associated with negative self-evaluation and poorer wellbeing (Samra et al., 2022). More recent research has shown that such processes commonly operate in the online environment (Verduyn et al., 2020), and may be exacerbated in the digital sphere (Nesi et al., 2018a, b).

Building on this work, we predicted that (H2) the association between OUSCs and MH symptoms would persist after controlling for *offline* upward social comparisons. Few studies of OUSCs have controlled for equivalent *offline* processes. Without this analytic step, however, it is unclear whether there is anything particular about *online* comparisons per se, or whether in fact, they merely serve as a proxy for social comparisons more generally. Thus, according to the *transformation framework* (Nesi et al., 2018a, 2018b), online spaces have the potential to transform interpersonal/social processes. For example, the *publicness* (i.e. access to large audiences), *quantifiability* (i.e. inclusion of social metrics such as "likes" and "shares") and *visualness* (i.e. inclusion of photographs and videos) of online communication (Nesi et al., 2018a, b) may create a context in which individuals have near-constant/immediate access to a wide range of heavily curated (and hence idealised) comparison targets that are likely to trigger more negative self-evaluations.

Third (H3), we predicted that loneliness would *partially* mediate the association between OUSCs and higher MH difficulties, i.e. that social comparisons would be correlated with loneliness, and that loneliness would – in turn – be correlated with higher mental difficulties. Thus, the ICBF proposes that OUSCs are associated with poorer MH outcomes *because* they leave the user feeling disconnected, reducing feelings of acceptance and belonging (Clark et al., 2018).

Finally in longitudinal analyses (H4), we hypothesised that OUSCs at baseline (T1) would predict (H4a) anxiety and (H4b) depression six months later (T2). Thus, if the ICBF (Clark et al., 2018) is correct, there should be a *causal* relationship running from OUSCs to MH symptoms. The advantage of longitudinal analyses is that they allow one to establish temporal precedence, i.e., determine that a cause precedes an effect (in this case: OUSCs precede symptomatology, respectively), and test for correlations between these across time. These conditions are necessary (though not sufficient) to establish a causal relationship. Note: whilst some have proposed a *reciprocal* (i.e. bidirectional) relationship between OUSCs and MH [see Frison and Eggermont, 2016 for example], we made no prediction about the potential for anxiety and depression at T1 to predict OUSCs at T2, since the ICBF does not lend itself to any predictions of this kind.

As noted, we also tested four (parallel) hypotheses relating to the *connecting* pathway proposed by the ICBF (Clark et al., 2018). The first (H5), predicted that online/remote socialising using *inter-personal* SM functionalities such as voice, video or instant messaging would be associated with better MH, i.e. lower symptoms of anxiety and depression. We reasoned that this would represent a major source of social connection during the lockdown, with positive links to MH (Choi and Choung, 2021; Ruggieri et al., 2021). Thus, there is abundant evidence as to the protective effects of social connections and social connectedness on MH, which seem to operate in a causal manner, including during the COVID-19 pandemic (Morina et al., 2021).

Following the structure (and underlying reasoning behind) hypotheses (H2-H4), we also predicted that this basic effect would remain significant after controlling for (H6) offline socialising, thereby testing the *transformation framework*'s proposal that online behaviours do not merely replicate offline processes, but are transformed in some way (Nesi et al., 2018a, 2018b). As *per* OUSCs, we also tested (H7) the mediating role of loneliness in the association between online socialising and MH symptoms. Finally, we explored longitudinal associations between online socialising and (H8a) anxiety and (H8b) depression, hypothesizing an underlying direction of causality running from technology use to MH.

2. Material and methods

The data presented were gathered May/June 2020 (T1) and February/March 2021 (T2) as part of the UCL COVID Impacts Study (Tibber et al., 2023). Participants were recruited through SM posts, advertisements and author-held participant databases. Informed consent was obtained and the survey presented online using the Qualtrics survey environment. Participation was voluntary, conferred eligibility for a £10 prize draw, and was open to anyone in the UK 18 or over. Ethical approval was obtained through the UCL Research Ethics Committee (18335/001) and ethical standards stated in the 1964 Declaration of Helsinki (and associated amendments) adhered to. The study and analyses were not pre-registered. All analyses were undertaken using STATA Release 17 (TX: StataCorp LLC.).

2.1. Measures

In addition to basic demographic information (age, gender and ethnicity) gathered at T1, data were gathered about MH, socialising and social comparisons (on- and offline) at T1 and T2.

2.1.1. Psychological constructs

Anxiety, depression and loneliness were measured using the

following well-established self-report measures: the Patient Health Questionnaire (PHQ-9) (Kroenke et al., 2001), Generalised Anxiety Disorder Scale (GAD-7) (Spitzer et al., 2006), and the Three-Item Loneliness Scale (3iLS), which was developed from the Revised UCLA Loneliness Scale (Hughes et al., 2004).

2.1.2. Socialising

Time spent socialising (putative *connecting pathway*) was assessed using the following single-item questions: "On a typical weekday in the last two weeks, approximately how many hours did you spend doing the following activities?": (i) "talking with friends or family remotely (e.g. via voice, video or instant messaging)" (*online socialising*), (ii) "talking with friends or family from another household in-person" [*offline socialising* (*out*)], and (iii) "spending quality time with members of your household" [*offline socialising* (*in*)]. For these items free responses were encouraged using the prompt: "e.g., for half an hour, please enter 0.5".

2.1.3. Social comparisons

Social comparisons (putative *disconnecting pathway*) were assessed using the following single-item questions: "How much do you focus on people who are better off than you when comparing yourself to people:" (i) "online", and (ii) "offline (i.e. in day-to-day interactions)". Responses were provided using a five-point Likert scale ranging from "Not at all" to "A great deal".

2.2. Regression analyses

To test connecting and disconnecting pathways, PHQ-9 and GAD-7 scores were regressed on OUSCs and *online socialising* scores. Data were analysed using univariate linear regression analyses, assessing for zero-order associations (H1 & H5), and subsequently with offline processes, i.e. *offline upward social comparisons* and *offline socialising,* included as covariates (H2 & H6).

Separate models were run with social comparison items included as ordinal and as continuous data. Since findings were almost identical, for ease of interpretation data are presented with variables modelled as continuous only. Assumptions of linearity, normality of residuals, low multicollinearity, and homoscedasticity were tested. All were met, with the exception of normality; however, linear regression analyses are deemed to be robust to such violations for large sample sizes (>10 observations per variable) (Schmidt and Finan, 2018).

2.3. Mediation analyses

To test the proposed mediating role of loneliness in the association between OUSCs/online socialising and anxiety/depression, path analyses were undertaken (H3 & H7). This allowed us to test whether there was a serial association between these variables, as we would expect if OUSCs and online socialising were affecting MH *through* their effects on loneliness. It is important to note, however, that mediation analyses do not determine the underlying *direction* of causality, even if significant serial associations are found. For example, a significant association between variables A, B and C of the form of A → B → C cannot be distinguished from a reversed direction of causality (C → B → A). Nonetheless, if a *casual* path of the form A → B → C *does* exist, one would expect to see this reflected in a cross-sectional mediation analysis; thus, our analyses represent a test of a prediction to emerge from a hypothesised process, rather than definitive proof thereof. Models were estimated using the asymptotic distribution free estimator (adf) in STATA, a form of weighted least squares estimation that makes no assumptions about normality or symmetry of variables.

2.4. Cross-lagged panel modelling

To test predictions emerging from proposed directions of causality (SM → MH) a series of cross-lagged analysis models were run (H4 & H8). Cross-lagged paths allow one to evaluate the association between a variable and another across time whilst controlling for the stability of these variables. Specifically, it allowed us to test whether OUSCs and online socialising at T1 predicted symptomatology at T2, and/or whether the reverse is true, i.e. whether symptomatology at T1 predicted OUSCs and online socialising at T2. As noted, whilst such associations do not prove a causal relationship, they do indicate temporal precedence and an association *across time*. Model 1 included: (i) cross-lagged paths between OUSCs and depression at T1 and T2, (ii) stability paths for these variables between T1 and T2, in addition to (iii) covariance between variables and error terms *within* time-points. Model 2 was identical to Model 1 except that anxiety was included instead of depression. Models 3 & 4 were identical to Models 1 & 2 except that online socialising was included instead of OUSCs.

3. Results

Data were available for a total of 632 participants at T1. Missing responses (see Table 1), meant that regression and mediation analyses were undertaken with data from 513 and 475 participants, respectively. Whilst this represented a substantial loss of data (18.83 % and 24.84 %) complete case analyses were undertaken with the reduced data-sets in order to equate power across sub-tests. For longitudinal analyses, since there was considerable attrition between T1 and T2 (288 participants initiated the T2 questionnaire), to avoid reducing available sample sizes further cross-lagged analyses were run using all available data (n = 277 for PHQ-9 and n = 240 for GAD-7 analyses).

Due to the high level of missing data, sensitivity analyses were also run, with all analyses described above executed with multiple imputation (MI) of missing data. MI was run using the 'mi estimate' command (STATA). Ten inputed data-sets were generated using the multivariate normal regression (MVN) imputation algorithm and all key variables included. Findings from analyses with MI did not differ from the main analyses (described above). Consequently, only the main analyses are reported.

3.1. Regression analyses

Regression analyses indicated that higher levels of OUSCs were associated with higher PHQ-9 and GAD-7 scores, even after controlling for *offline* upward social comparisons [PHQ-9 (coefficient = 1.82, CI = 1.28;2.36, $p < 0.001$), GAD-7 (coefficient = 1.28, CI = 0.79;1.77, $p < 0.001$)], with multivariate models describing 15.38 % [$F_{(2,510)} = 46.33$, $p < 0.001$; $R^2 = 0.15$] and 15.13 % [$F_{(2,510)} = 45.46$, $p < 0.001$; $R^2 = 0.15$] of the variance, respectively (Table 2).

In addition, higher levels of online socialising were associated with *higher* (not lower) PHQ-9 and GAD-7 scores, even after controlling for *offline* socialising (inside and outside the home) [PHQ-9 (coefficient = 0.46, CI = 0.18;0.74, $p < 0.001$), GAD-7 (coefficient = 0.39, CI = 0.14;0.64, $p < 0.01$)], with multivariate models describing 2.43 % [$F_{(3,509)} = 4.23$, $p < 0.01$; $R^2 = 0.02$] and 1.81 % [$F_{(3,509)} = 3.13$, $p < 0.05$; $R^2 = 0.02$] of the variance, respectively (Table 3).

3.2. Mediation analyses

The potential mediating role of loneliness in both the *disconnecting* and *connecting* pathways was explored for symptoms of depression and anxiety in separate sets of path analyses (see Fig. 1 and Supplementary Material).

Considering the *disconnecting* pathway first, indirect/mediating paths (through loneliness) were significant for both PHQ-9 and GAD-7 ($\beta = 0.1$, $p < 0.001$; $\beta = 0.1$, $p < 0.001$). Further, effects persisted after addition of *offline* upward social comparisons as a covariate. The percentage of the effect that was mediated was 26.19 % for PHQ-9, and 25.54 % for GAD-7.

With respect to the *connecting* pathway, indirect/mediating paths

Table 1
Summary of variables. Includes scores on mental health measures (PHQ-9 and GAD-7) as well as demographic and (online/offline) social/social comparison variables. Data are presented for the whole sample (n = 632) as well as the regression (n = 513; CC Regression) and path/mediation (n = 475; CC Mediation) complete case analysis samples. In addition, the number and percentage (in brackets) of items missing for each variable are shown. 3iLS = three item loneliness scale.

Variable		Missing from whole sample N (%)	Whole sample N (%), mean (STDEV)	CC regression N (%), Mean (STDEV)	CC Mediation N (%), Mean (STDEV)
Mental health					
PHQ-9		47 (7.444)	6.7 (5.91)	6.76 (5.72)	6.94 (5.79)
GAD-7		30 (4.75)	6.4 (5.3)	6.31 (5.14)	6.31 (5.21)
3iLS		64 (10.13)	4.97 (1.8)	4.86 (1.71)	4.89 (1.72)
Demographic					
Age		0 (0)	–	–	–
	18–21	–	11 (1.74)	9 (1.75)	9 (1.89)
	22–29	–	70 (11.08)	60 (11.7)	55 (11.58)
	30–39	–	127 (20.09)	105 (20.47)	99 (20.84)
	40–49	–	218 (34.49)	173 (33.72)	160 (33.68)
	50–59	–	132 (20.89)	110 (21.44)	98 (20.63)
	60–69	–	62 (9.81)	48 (9.36)	47 (9.89)
	70–79	–	11 (1.74)	7 (1.36)	6 (1.26)
	80+	–	1 (0.16)	1 (0.19)	1 (0.21)
Gender		0 (0)	–	–	–
	Female	–	534 (84.49)	429 (83.63)	401 (84.42)
	Male or Other	–	98 (15.51)	84 (16.37)	74 (15.58)
Ethnicity		0 (0)	–	–	–
	White	–	544 (86.08)	444 (86.55)	416 (87.58)
	Mixed	–	26 (4.11)	24 (4.68)	22 (4.63)
	Black	–	17 (2.69)	14 (2.73)	14 (2.95)
	Asian	–	38 (6.01)	28 (5.46)	22 (4.63)
	Other	–	7 (1.11)	3 (0.58)	1 (0.21)
Social & technology					
Online socialising (h)		32 (5.06)	1.9 (2.14)	1.82 (2.1)	1.87 (2.1)
Offline socialising (out) (h)		72 (11.39)	0.96 (1.65)	0.87 (1.48)	0.89 (1.52)
Offline socialising (in) (h)		41 (6.49)	3.51 (2.8)	3.51 (2.8)	3.6 (2.82)
Online upward social comparisons		30 (4.75)			
	Not at all	–	253 (42.03)	211 (41.13)	195 (41.05)
	Very little	–	185 (30.73)	156 (30.41)	140 (29.47)
	Somewhat	–	104 (17.28)	93 (18.13)	88 (18.53)
	Quite a bit	–	48 (7.97)	41 (7.99)	41 (8.63)
	A great deal	–	12 (1.99)	12 (2.34)	11 (2.32)
Offline upward social comparisons		32 (5.06)			
	Not at all	–	226 (37.67)	192 (37.43)	183 (38.53)
	Very little	–	217 (36.17)	188 (36.65)	165 (34.74)
	Somewhat	–	109 (18.17)	92 (17.93)	88 (18.53)
	Quite a bit	–	40 (6.67)	34 (6.63)	32 (6.74)
	A great deal	–	8 (1.33)	7 (1.36)	7 (1.47)

Table 2
Disconnecting pathway. Regression of PHQ-9 and GAD-7 on (online and offline) upward social comparisons.

Predictor/covariate	Univariate		Controlling for offline	
	Coefficient (95 % CIs)	*p* value	Coefficient (95 % CIs)	*p* value
(a) PHQ-9				
Online upward social comparisons	**2.1 (1.65;2.53)**	**<0.001**	**1.82 (1.28;2.36)**	**<0.001**
Offline upward social comparisons	**1.69 (1.2;2.18)**	**<0.001**	0.48 (−0.12;1.07)	0.12
(b) GAD-7				
Online upward social comparisons	**1.77 (1.38;2.17)**	**<0.001**	**1.28 (0.79;1.77)**	**<0.001**
Offline upward social comparisons	**1.73 (1.3;2.17)**	**<0.001**	**0.88 (0.35;1.42)**	**0.001**

Values in bold denote statistical significance.

Table 3
Connecting pathway. Regression of PHQ-9 and GAD-7 on (online and offline) socialising.

Predictor/ covariate	Univariate		Controlling for offline	
	Coefficient (95 % CIs)	*p* value	Coefficient (95 % CIs)	*p* value
(a) PHQ-9				
Online socialising	**0.25 (0.01;0.48)**	**<0.05**	**0.46 (0.18;0.74)**	**0.001**
Offline socialising (out)	−0.06 (−0.39;0.28)	0.74	−0.21 (−0.58;0.16)	0.26
Offline socialising (in)	−0.14 (−0.31;0.04)	0.13	**−0.25 (−0.45;-0.06)**	**<0.05**
(b) GAD-7				
Online socialising	**0.26 (0.05;0.47)**	**<0.05**	**0.39 (0.14;0.64)**	**<0.01**
Offline socialising (out)	−0.04 (−0.34,0.26)	0.78	−0.23 (−0.56;0.1)	0.18
Offline socialising (in)	−0.02 (−0.18, 0.14)	0.84	−0.11 (−0.28;0.07)	0.23

(through loneliness) were not significant for PHQ-9 or GAD-7 ($p > 0.05$), although they *were* after controlling for offline covariates (i.e. socialising face-to-face inside and outside the home) ($\beta = 0.09$, $p < 0.001$; $\beta = 0.09$, $p < 0.001$). All direct effects were insignificant after inclusion of indirect paths ($ps > 0.05$), suggesting that any effects of online socialising on MH were weak, and completely mediated by loneliness.

3.3. Cross-lagged panel analyses

Since the regression and mediation analyses did not provide evidence for a connecting pathway, planned cross-lagged analyses between online socialising and MH were not run (see Fig. 2 and Supplementary materials).

With respect to the longitudinal models involving social comparisons, for both models, model fit was good (Model 1: $\chi^2_{(5)} = 79.414$, $p < 0.001$, CFI = 1, RMSEA = 0; Model 2: $\chi^2_{(5)} = 85.57$, $p < 0.001$, CFI = 1, RMSEA = 0), and *all* stability paths (i.e. associations *within* the variables across time, e.g., PHQ-9 and T1 and T2) were highly significant ($ps < 0.001$). However, OUSCs at T1 did not predict PHQ-9 (Model 1: $\beta = 0.14$, CIs = −0.00,0.27, $p = 0.06$) or GAD-7 ($\beta = 0.07$, CIs = −0.05,0.19, $p = 0.24$) scores at T2. Interestingly however, the path between GAD-7 scores at T1 and OUSCs at T2 was significant ($\beta = 0.14$, CIs = 0.03,0.26, $p < 0.05$).

Finally, given the high level of attrition between T1 and T2, we explored whether our variables of interest (i.e. GAD-7, PHQ-9 and OUSCs) might predict withdrawal of participation between the two time-points (see Supplementary Materials). We found that for Model 2, individuals who were retained at T2 tended to be *less* anxious (OR = 0.96, CIs = 0.92, 1, $p = 0.03$). Consequently, we must be cautious in interpreting longitudinal analyses relating to GAD-7, since these are

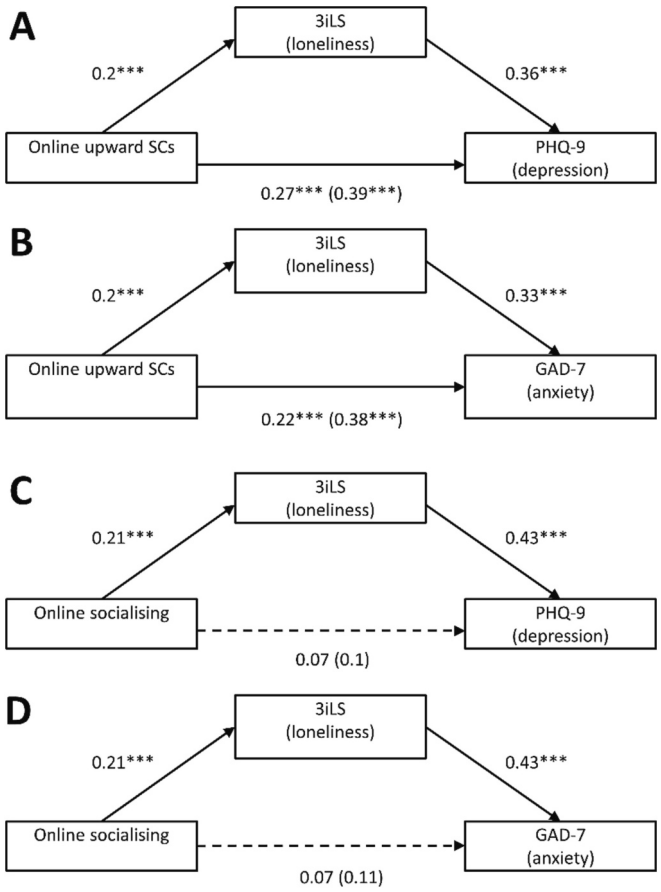

Fig. 1. Mediation analyses. Models exploring the potential mediating role of loneliness in the association between (A & B) online upward social comparisons and PHQ-9/GAD-7 scores, and (C & D) online socialising and PHQ-9/GAD-7 scores. Models shown are those run with *offline* upward social comparisons (for A & B) and *offline* socialising (C & D) as covariates (not shown in path diagrams for simplicity, however). Values in brackets denote direct paths in non-mediational models. SCs = social comparisons; ***$p < 0.001$.

biased by the retention of less anxious individuals.

4. Discussion

With respect to stated hypotheses, for cross-sectional analyses those relating to the disconnecting pathway were supported, whereas those relating to the connecting pathway were largely not. In terms of *disconnection*, higher levels of OUSCs were associated with higher symptoms of anxiety and depression (H1a & b), survived after controlling for *offline* comparisons (H2), and were partially mediated by loneliness (H3). In contrast, higher levels of online socialising were not associated with poorer MH (H5a & b); in fact, higher online socialising correlated with *higher* symptoms of anxiety and depression, and survived after controlling for offline socialising (H6). This effect of online socialising on anxiety and depression disappeared, however, with the addition of a mediational path through loneliness, which was itself found to be significant when offline covariates were included (H7).

With respect to longitudinal analyses, our hypotheses were not supported. No significant associations were seen between (H4) OUSCs or (H8) online socialising at T1 and anxiety/depression at T2. Interestingly however, an association *was* seen between anxiety symptoms at T1 and OUSCs at T2. However, as noted, it is important to interpret this finding with caution, since additional analyses (helpfully requested by a reviewer), indicated that higher levels of anxiety were associated with participant drop-out, likely introducing biases into the data.

Taken together these findings only partially support the ICBF (Clark et al., 2018), consistent as they are with a disconnecting pathway of online engagement linked to negative outcomes, but not with a connecting pathway linked to *positive* outcomes. These findings are also in close correspondence with the only other study (to our knowledge) to have explicitly tested both arms of the ICBF in a single population sample (Tibber et al., 2020), which also found evidence for the disconnecting, but not connecting, pathway. It is interesting that the findings of these two studies converge, since the data presented here represent a unique snapshot during a particular moment in history, i.e. the COVID-19 pandemic, whereas Tibber et al. (2020) was undertaken pre-pandemic, arguing for the stability of core underlying processes.

With respect to the disconnecting pathway, the finding that upward social comparisons were associated with poorer MH is consistent with a growing body of evidence that has linked online *and* offline (upward) social comparisons to a range of indicators of poor MH and wellbeing (Meier and Reinecke, 2020; Verduyn et al., 2020; Yang et al., 2021). Our findings extend the literature, however, in a number of ways. First, we show that OUSCs predict variance in MH symptoms after controlling for *offline* social comparisons, which is critical if we are to make any claims as to the specificity of documented associations to the online environment. These findings are thus consistent with the *transformation framework* in suggesting that social comparisons are transformed (qualitatively and/or quantitatively) in their move online. Thus, certain features of online communication, particularly those that characterise "performative" SM platforms may be particularly conducive to social comparisons, e.g. the *publicness*, *quantifiabilty* and *visualness* of communication (Nesi et al., 2018a, b; Tibber et al., 2022).

Our findings also extend the literature on OUSCs in showing that loneliness partially mediates its association with anxiety and depression. This adds to our understanding of the underpinning mechanisms, and in support of the ICBF (Clark et al., 2018), suggests that OUSCs may operate – at least in part – by driving feelings of isolation and disconnection, impeding satisfaction of core needs relating to acceptance and belonging (assuming a particular direction of causality, although more on this below). See Yang (2016) and Lee (2020) for related findings.

With respect to our longitudinal analyses, the finding that OUSCs at T1 were not predictive of anxiety or depression symptoms at T2 was counter to our predictions, and potentially (though not necessarily), represents a threat to the disconnecting pathway of SM proposed by Nesi and colleagues' ICBF (Nesi et al., 2018a, b). Thus, the ICBF makes no claims as to the time-scale of any effects it describes (more on this below). However, it is possible that such longitudinal effects do exist, but we were simply underpowered to find them. Further, it is possible that selective attrition amongst those who were more anxious (described above), may have reduced the likelihood of finding an effect, e.g., by compressing the range of available T2 GAD-7 scores.

An alternative explanation of our findings is that OUSCs may exert positive *and* negative effects on MH (either varying *within* the individual across time and/or *between* individuals), which tend to cancel one another out when explored in between-participants, group-level designs. Whilst research has shown that experimental manipulation of OUSCs may lead to a (near-immediate) fall in self-esteem and increase in negative self-evaluations in laboratory conditions (Vogel et al., 2014), and an ecological momentary assessment (EMA) approach to data collection has been used to link moment-by-moment fluctuations in OUSCs (*within* the individual) with repetitive negative thinking and feelings of insecurity (Faelens et al., 2021), one recent study (undertaken during the COVID-19 pandemic) found that OUSCs predicted *improvements* in levels of anxiety, stress, loneliness and life satisfaction across an 18-day period (Ruggieri et al., 2021). See Meier et al. (2020) also. The authors proposed a number of possible reasons, including the potential for OUSCs to foster a sense of sharing a common struggle, as well as a tendency for individuals to try to elevate their wellbeing to the level of their peers.

With respect to the *connecting* pathway, whilst – as noted – the lack of

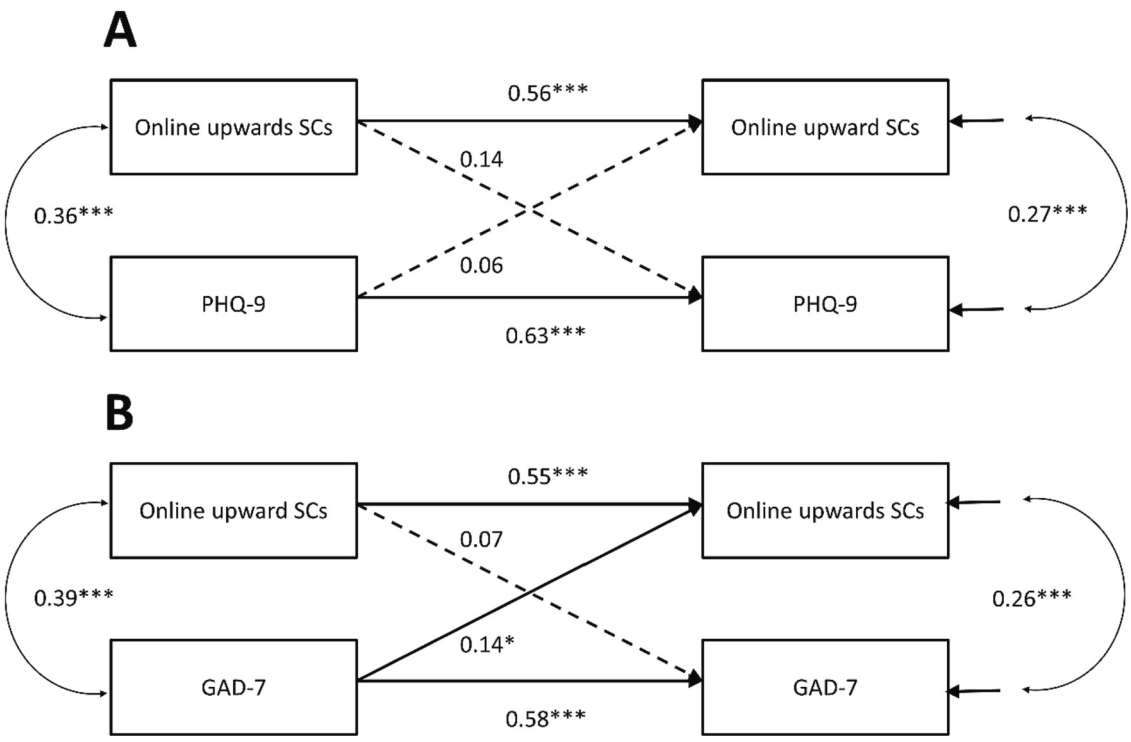

Fig. 2. Cross lagged panel analyses. Models explore the longitudinal associations between (A) PHQ-9 scores and (B) GAD-7 scores and upward social comparisons. Solid arrows denote significant paths, whereas dashed arrows denote non-significant paths ($p > 0.05$). SCs = social comparisons. $p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

support for such a route between online engagement and positive MH is consistent with previous testing of the ICBF (Tibber et al., 2020), it was still counter to our predictions. As noted, there is a relatively rich literature on the potential benefits of SM use and online engagement more generally (alongside risks), which has tended to focus on its potential to foster and build social connection and capital (Yang et al., 2021). Whilst such benefits are far from ubiquitous in the literature, we expected the online world's potential to foster social connection (and hence positive MH) to be particularly evident in our sample, collected as it was at the start of pandemic and national lockdown, when so much connection was likely dependent on the online environment (Ofcom, 2021). Further, as noted, we specifically asked participants about the use of *inter-personal* SM forms (e.g. voice, video or instant messaging) for the purpose of communicating with friends and family (Choi and Choung, 2021; Fumagalli et al., 2021).

Nonetheless, our findings are broadly consistent with systematic reviews and meta-analyses of the literature, which suggest that the risks of the online world, whilst typically small, are nonetheless more common and reproducible than the benefits, particularly when studying between-participants group average effects (Orben, 2020). This raises the question as to why this should be the case. One possibility is linked to the cross-sectional nature of the data, which prohibits disentangling the direction/s of causality: thus, whilst feelings of disconnection may drive greater online engagement (predicting one sign of association), time spent online may lead to feelings of connection (predicting the opposite sign of association). In at least one study this has led to seemingly contradictory findings, *within the same data-set* (Sheldon et al., 2011).

Another possible contributor to the seemingly elusive nature of the connecting pathway, is that the potential benefits of online engagement may be highly context dependent. For example, in relation to our own construct of time spent remote socialising, whilst this captures (in a limited sense) "how" the online world is being used (i.e. what purpose it is being put to), it does not adequately capture the "what" or the "who", i.e. *what* app, platform or functionalities are being used, and *who* is being connected to (i.e. family, close friends, peers known exclusively online, or online *and* offline, etc.), some of which might mediate and/or moderate the relationship.

In terms of the clinical implications of this study, there are several. However, in view of the limitations (described below), we offer these tentatively. First, directions of causality aside, the findings clearly suggest that social comparisons are intimately related to multiple indices of psychopathology and ill-health, including loneliness, anxiety and depression, with links to eating disorders, body dissatisfaction and body dysmorphia described in the literature (Hamel et al., 2012; Myers and Crowther, 2009). This reinforces the notion that upward social comparisons may represent a key trans-diagnostic feature or maker of psychopathology, which should be explored when individuals are assessed for psychological interventions (Tibber and Silver, 2022).

Second, consistent with the transformation framework (Nesi et al., 2018a, b), the findings suggest that such social comparison processes (and their psychological sequelae) may be transformed by the online environment, arguing for the importance of integrating a consideration of individuals' online (as well as offline) lives when undertaking psychological assessment (Tibber and Silver, 2022), particularly given the growing prevalence of SM use. Finally, the findings highlight social comparison processes (online and offline) as potential foci for psychological intervention (Andrade et al., 2023).

With respect to the limitations of this study, there are several. First, we did not explore individual differences in user characteristics or behaviours that might have moderated some of the effects seen (Beyens et al., 2020), e.g., substance use. Second, convenience sampling was used, with participants recruited through multiple routes, including online advertisement as part of a wider study into the impacts of COVID-19 (Tibber et al., 2023), without weighting of data (i.e. to the target population). As a result, the sample was biased towards younger, female respondents, potentially limiting the generalizability of the findings. Nonetheless, we note that this particular demographic may be disproportionately affected both by OUSCs (Nesi and Prinstein, 2015; Papageorgiou et al., 2022) as well as the social impacts of the pandemic (Wickens et al., 2021), and as such, represents an important focus for

research of this kind.

Third, the use of single-item questions to probe social comparisons potentially threatens measurement reliability, validity and sensitivity (Nunnally and Bernstein, 1994). Nonetheless, a decision was made to include single-item measures because there was pressure to limit questionnaire length in the broader study, the association between OUSCs and MH has been shown to be highly robust and reliable (Verduyn et al., 2020), and a number of studies have highlighted the acceptable reliability and validity of a number of single-item measures, including in the study of MH; see (McKenzie and Marks, 1999) for example. Further, we (and others) have previously used (very closely) worded single-item measures of the kind used here, in several different population samples/age groups, and found robust and significant associations with measures of MH and wellbeing; e.g., Vogel et al. (2014), Green (2021) and Tibber et al. (2020).

Fourth, as noted, the cross-sectional (mediational) analyses undertaken cannot prove underlying direction/s of causality. Thus, where (for example), we show a serial correlation running from OUSCs through loneliness to depression, it is equally possible that this reflects a direction of causality opposite to that proposed (depression → loneliness → OUSCs), or even a bidirectional causal link; see Vogel et al. (2014, 2015) however. Relatedly, whilst we used longitudinal analyses to explore predictions emerging from our presumed direction of causality (SM → MH), it is important to note that cross-lagged panel analyses are unable to *definitively* prove causality; for this, true experimental manipulation is necessary.

Fifth, our lack of *within*-participant data of the kind seen with EMA, means that we may have missed associations detectable at shorter timescales. Sixth, our measures of *connecting* and *disconnecting* pathways did not map on to identical technologies/functionalities. Thus, for the *connecting* pathway we asked participants about socialising on *inter-personal* SM forms, whereas for the *disconnecting* pathway we asked about OUSCs more generally.

Finally, whilst our sample size was larger than that described in Tibber et al. (2020), it was still relatively modest, particularly given that effects sizes in SM/MH research are typically quite small; consequently, effects could have been missed. Relatedly, however, though we did not correct for multiple comparisons, we note that all of the significant findings reported from the regression and mediation analyses were significant at the more stringent alpha criterion of $p < 0.01$ (and all but one at $p < 0.001$), and hence would remain significant after *Bonferroni* correction.

In conclusion, this study tested the predictions of the ICBF (Clark et al., 2018) in a relatively large sample of the UK population during the pandemic when people were increasingly reliant on digital technology (Ofcom, 2021). Whilst we found support for a *disconnecting* pathway driven by OUSCs, we did *not* find evidence for a *connecting* pathway through remote socialising (Tibber and Silver, 2022). Nor were our findings consistent with a causal relationship running from OUSCs to MH difficulties, at least across the time-scale studied. The main strengths of the study were its inclusion of parallel offline social process to assess the specificity of documented effects, the inclusion of longitudinal analyses, as well as its firm embedment in theory. Future research is needed, however, in order to further characterise the contextual factors that influence documented effects, and explore these across multiple time-scales.

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CRediT authorship contribution statement

Marc S. Tibber: Conceptualization, Methodology, Formal Analysis and investigation, Writing – original draft presentation, Supervision; Georgia Milne: Conceptualization, Methodology, Formal Analysis and investigation, Writing – review and editing; Peter Fonagy: Conceptualization, Writing – review and editing; Tessa M. Dekker: Conceptualization, Methodology, Writing – review and editing; Supervision; Funding acquisition.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2023.12.006.

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