Measuring Online and Offline Social Rejection Sensitivity in the Digital Age

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Abstract

Social rejection sensitivity has been proposed as a central risk factor for depression. Yet its assessment has typically been limited to offline contexts. Many of today's social interactions, however, take place online. Here, we developed a measure to assess social rejection sensitivity in both online and offline environments. Across four separate samples including a total of 2381 individuals (12-89 years), the Online and Offline Social Sensitivity Scale was shown to offer a reliable measure of social rejection sensitivity. The study provides evidence that rejection sensitivity across online and offline social environments shows a strong association with depressive symptoms and maladaptive ruminative brooding. We also found age-related differences in social rejection sensitivity in online and offline contexts with rejection sensitivity decreasing from early adolescence to older age. The scale has the potential to advance future research on the role of social rejection sensitivity in mental health in a digital age.

Keywords: Social Rejection Sensitivity; Depression; Adolescence; Digital Age; Rumination

Social rejection sensitivity and depression

As a social species, humans experience distress when rejected in social situations (Eisenberger, 2011). The distress is caused by a fundamental violation of the evolutionarily adaptive human need to belong (Baumeister & Leary, 1995). Excessive social rejection sensitivity, however, has emerged as a risk-factor for depression (Gao et al., 2017). Depression is currently the leading cause of disability worldwide and rates of depression are increasing (Patel et al., 2018), especially in young women (*Adult Psychiatric Morbidity Survey*, 2016). To slow and ultimately reverse this trend through effective prevention and intervention, the aetiology and maintaining mechanisms of depressive symptoms need to be understood and targeted (Hagan et al., 2015).

The social risk hypothesis of depression by Allen and Badcock (2003) proposes that individuals at-risk for and those experiencing depression view their “social investment potential” as critically low. The social investment potential refers to the ratio between an individual’s social value and burden to others. Low social investment potential is associated with a risk of rejection and even exclusion from one’s social grouping (Allen & Badcock, 2003). To prevent evolutionarily and emotionally costly rejections, those at-risk and individuals suffering from depression demonstrate three behavioural and cognitive patterns: 1) reduced risk taking in social contexts due to heightened expectations of failure and undervaluing positive outcomes; 2) signalling to conspecifics through withdrawal, submissive behaviour and eliciting care from allies; and 3) vigilance to indicators of social threat (Allen & Badcock, 2003). These cognitive and behavioural patterns, reduced social risk taking – engaging in a decision or action that could lead to rejection (Blakemore, 2018; Dunn et al., 2012; Girard et al., 2013) and increased cognitive bias in social situations (Normansell & Wisco, 2017) have been associated with

depressive symptoms in offline contexts. However, less is known whether and how they are expressed in online social interactions.

Recent years have seen a major shift in the social domain, with the advent of digital information technologies introducing a new plane of social interaction. While there is robust longitudinal and population-based evidence showing that time spent on smartphones and other digital devices is not related to increases in mental health problems (Orben et al., 2019; Orben & Przybylski, 2019; Przybylski & Weinstein, 2017), less is known about their impact on individuals who have social risk factors for depression (George & Odgers, 2015). These changing social environments may bare novel and additional risks for at-risk individuals to develop the disorder earlier or maintain it for longer. Research in the area has been limited, in part due to a lack of measurement instruments that assess social risk factors for depression in a digital area. In the current study we address this gap by developing a novel measure assessing social rejection sensitivity, a key social risk factor for depression, for use in online and offline contexts.

Social rejection sensitivity in the digital age

Understanding the impact of social rejection sensitivity in the context of online social interactions is critical, as a significant proportion of today's social interactions, especially between young people, take place online. For example, adolescents spend nearly 6 hours of their day online (Jensen, George, Russell, and Odgers, 2019), with almost 3 of them dedicated to social media. Adolescence (10-24 years; Sawyer et al., 2018) is also a period of heightened social rejection sensitivity (Fuhrmann et al., 2015; Pfeifer & Blakemore, 2012). Rejection sensitivity in this age group has been associated with emerging depressive symptoms (Beeri &

Lev-Wiesel, 2012; Platt et al., 2013). For these individuals high on social rejection sensitivity, the digital age may have extended the threats and risks of social interaction into every facet of their lives. One of the mechanisms may be through high anticipatory and post-event rumination about social encounters (Kashdan & Roberts, 2007), which may become continuously activated as there is ongoing potential for engaging in social interactions online. Indeed, offline rejection sensitivity has been prospectively associated with increased rumination (Pearson et al., 2011). Currently, it is unknown whether individuals who have high sensitivity to rejection in offline contexts show a similar profile of sensitivity in online contexts, and indeed how these may differentially relate to depressive symptoms. To address these and related questions, a measure of social rejection sensitivity that includes online social interactions is needed.

The Online and Offline Social Sensitivity Scale – O²S³

Current measures of social rejection sensitivity have either used offline scenarios (e.g., asking a friend for a favour; Downey & Feldman, 1996) or use a trait-based approach requiring respondents to evaluate the extent to which they endorsed statements relating to social rejection sensitivity (e.g., I worry about what others think of me; Boyce & Parker, 1989; Horowitz, 1979). Trait-based measures, such as the Interpersonal Sensitivity Measure (Boyce & Parker, 1989), use more categorical (i.e., less specific) scenarios compared to scenario-based measures such as the Rejection Sensitivity Questionnaire (e.g., “I avoid saying what I think for fear of being rejected” vs. “After graduation, you can’t find a job and ask your parents if you can live at home for a while”). Whilst trait-based measures of social rejection sensitivity have been associated with depressive symptoms prospectively (Boyce et al., 1992; Rizzo et al., 2006; Wilhelm et al., 2004)

and cross-sectionally (Luty et al., 2002), no current measure has explicitly incorporated questions specific to online contexts.

For our novel measure assessing social rejection sensitivity in online and offline contexts: the Online and Offline Social Sensitivity Scale (O²S³), we opted to create a trait-based measure as a scenario-based measure would likely become outdated given rapid changes in the context of online social environments. A set of novel items were created by the research team and commented on by young people 11-30 years, across three separate workshops. The items were designed to tap into the different facets of social rejection sensitivity: social evaluation (perceived low social investment potential), biased perception of the social self, and social risk taking. Like the Interpersonal Sensitivity Measure, individuals indicate for each statement on the O²S³ how much they feel it describes them on a four-point Likert-scale ranging from “Strongly Disagree” to “Strongly Agree”. In addition to our novel online items and items from the Maladaptive Social Media Usage Scale (Werner-Seidler et al., 2020), we also administered the Interpersonal Sensitivity Measure (Boyce & Parker, 1989) to include items assessing offline social rejection sensitivity.

In study one we administered the full item pool to 545 participants and used exploratory factor analysis to reduce the items and evaluate the scale’s factor structure. In Study 2 the O²S³ was administered to two undergraduate student samples (*Sample 1*: $N = 904$; *Sample 2*: $N = 242$) and one community sample (*Sample 3*: $N = 787$) in order to confirm the factor structure of the O²S³ and assess internal consistency, concurrent and convergent validity as well as test-retest reliability. Specifically, the O²S³ was hypothesised to show good concurrent validity, evidenced by significant associations, with the Interpersonal Sensitivity Measure (Boyce & Parker, 1989) and the Rejection Sensitivity Scale (Downey & Feldman, 1996), as well as good convergent

validity, demonstrated by significant associations with the short-version of the Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995), in particular the depression subscale and the depression module of the Patient Health Questionnaire (Kroenke et al., 2001). Social rejection sensitivity measured with the O²S³ was further hypothesised to vary across levels of depression severity, when using clinical cut-offs. Moreover, given the association of offline rejection sensitivity with rumination, the O²S³ was predicted to show convergent validity with the short version of the Ruminative Response Questionnaire (Treynor et al., 2003), in particular the maladaptive brooding subscale. Finally, social rejection sensitivity was proposed to decrease with age from adolescence and throughout adulthood.

Methods – Study 1

Participants

545 participants (18-30 years, $M = 23.8$ years, $SD = 3.5$) were recruited through Prolific academic. 8 participants were excluded due to responding incorrectly to two or more attention items and another 18 participants were excluded due to missing data on attention items. 36% ($n = 189$) identified as female, 62% ($n = 330$) as male, 1% ($n = 6$) as other and 0.70% ($n = 4$) preferred not to say. Highest degree completed high-school (44%, $n = 234$), university, (39%, $n = 208$), postgraduate degree (8%, $n = 41$), vocational training (7%, $n = 38$), primary school (1%, $n = 6$) and preferred not to say (0.30%, $n = 2$). 34% ($n = 179$) of the sample reported having received a formal diagnosis for a mental health disorder (depression: $n = 80$; anxiety disorder: $n = 58$; obsessive-compulsive disorder: $n = 7$; bipolar disorder: $n = 6$; posttraumatic stress disorder: $n = 5$; schizophrenia: $n = 1$; other: $n = 23$).

Measures

For all measures included in studies 1 and 2, internal consistency was acceptable to excellent across all samples and is reported in Table S1. Internal consistency was measured with Revell's total omega (ω_T), which has shown to overcome limitations of Cronbach's alpha (McNeish, 2018). While there is no universal guide to evaluate Revell's total omega, scores of .50 and higher are considered to reflect acceptable internal consistency (Watkins, 2017). For existing measures Cronbach's alpha is reported for comparative purposes with previous research.

Item pool for rejection sensitivity measure

Novel items. To tap into the facets of social rejection sensitivity in offline and online contexts items were created during a series of workshops. The first workshop was run by the research team in $N = 8$ student volunteers (19-30 years, 7 female). This workshop involved a presentation by a member of the research team on the concept of social rejection sensitivity using age-appropriate language and a subsequent discussion and brain storming about potential items. The adolescent workshops were part of an event "Be a Researcher for a Day", where $N = 43$ high school students (11-18 years, 16 female) joined our research team to engage with each stage of research, from idea generation to dissemination. As part of the module on measurement they were informed that we were developing a measure of social rejection sensitivity. After introducing the concept, participants discussed the items in small (4-5 young people/group) age-matched groups with one research team member facilitating each group. Across the workshops 44 items were created. These were reduced to 17 by grouping items into overlapping themes. For example, the item "I often choose to participate or suggest ideas in a group setting" reflected proposed items including "I worry when giving a

presentation in class”, “I don’t express myself in group discussions” and “I feel comfortable speaking in a group.”

All items are rated on a four-point Likert-scale ranging from “Strongly Disagree” to “Strongly Agree”, Please see the supplementary material for a list of the 17 items (table S3).

Interpersonal Sensitivity Scale. The novel items were administered together the Interpersonal Sensitivity Scale (Boyce & Parker, 1989). The full 36-item Interpersonal Sensitivity Scale includes five subscales: interpersonal awareness, need for approval, separation anxiety, timidity, and fragile inner-self. The measure requires participants to indicate the extent to which each item applies to them on a four-point Likert Scale “Very unlike” to “Very like”. We included 24 of the 36 items in our Exploratory Factor Analysis (EFA). We included all items from the interpersonal awareness and the need for approval subscales, in addition to a number of items from the three other scales where they were relevant to social rejection sensitivity. All included items can be found in the supplementary material (table S3).

Maladaptive Social Media Usage Scale. The 8-item questionnaire was an adapted (Werner-Seidler et al., 2020) version of the original 7-item Maladaptive Facebook Usage Scale (Smith et al., 2013). The scale assesses social evaluation and social comparison in the context of social media usage. The modified version assesses these constructs in relation to a wider range of social media beyond Facebook. Four items most closely related to social rejection sensitivity were included. Please see the supplementary material for a list of all items (table S3).

Convergent validity

Depressive symptoms. The 7-item depression subscale of the short version of the Depression, Anxiety, and Stress (DASS-21; Lovibond & Lovibond, 1995) was administered to assess symptoms of depression. Administering the full DASS-21 allowed us to investigate the

differential association between each of the subscales to confirm our prediction that the association between our new measure and the depression subscale would be strongest.

Rumination. To explore the prediction that rejection sensitivity measured with the new scale would relate to maladaptive ruminative thinking, the short 10-item version of the Ruminative Response Questionnaire (Treynor et al., 2003) was administered. The scale requires participants to indicate the extent to which they engage in ruminative thinking when they feel sad or depressed. Items are rated on a four-point Likert-scale ranging from “almost never” to “almost always”.

Procedure

Following informed consent, questionnaires were administered online. The survey took on average 17 minutes to complete. After completing the survey participants were compensated with £5 if the survey was completed faithfully (i.e., one or fewer attention items incorrect).

Statistical analyses

An exploratory factor analysis using the parallel criterion was run on all the novel items, as well as items from the Interpersonal Sensitivity Measure (24 items) and the Maladaptive Social Media Usage Scale (4 items). These items were evaluated for their factorability using the Bartlett test of Sphericity as well as the Kaiser-Meyer Olkin test. A X^2 with a significance value of $\leq .05$ indicates the presence of significant correlations within the dataset on the Bartlett test of Sphericity. A Kaiser-Meyer Olkin test statistic of $\geq .80$ is considered to indicate a meritorious relationship. The initial factor analysis guided the selection of a subset of non-redundant and theoretically meaningful items, which were retained in the final scale. The factors to emerge

from the factor analysis were tested for internal consistency using Revell's total omega. Concurrent and convergent validity were assessed by exploring the associations with the existing measures of social rejection sensitivity as well as measures of depressive symptoms and rumination. To test the hypothesis that the association between the social rejection sensitivity was most strongly associated with the DASS-21 depression subscale and the brooding subscale on the Ruminative Response Questionnaire, associations were compared across the subscales using the Williams-Hotelling test. To compare social rejection sensitivity measured with the O²S³ across levels of depression, clinical cut-offs for the DASS-21 depression subscale were used, where a score below 10 indicates no depression, 10-13 mild depression, 14-20 moderate depression, and 21 and over suggest severe depression (Lovibond & Lovibond, 1995). Materials and analysis code for this study are available by emailing the corresponding author. We highlight here that where we discuss reliability, we refer specifically to participants' scores on each measure, not the scales in and of themselves. This study was not preregistered. Materials and analysis code for this study are available by emailing the corresponding author.

Results– Study 1

Item selection

The 45 items showed good factorability according to the Bartlett test of Sphericity (990 = 10165.41, $p < .001$) and the Kaiser-Meyer Olkin test (values ranged between .77 and .97 with an overall measure of sampling adequacy = .93).

Subsequently, an exploratory factor analysis on all 45 items yielded a five-factor structure (Table S2; See Figure S1 for the results of the parallel analysis used for the factor selection). Most items on the fifth factor showed significant cross-factor loadings. The fifth

factor (8 items) was therefore excluded. Items from the remaining four factors were excluded if they did not load on any of the factors (3 items), showed significant cross-factor loadings (2 item), or were redundant with other items at the content level (14 items). The remaining 18 items (for a copy of the scale see Table 1) were included in the O²S³ across four factors. The final 18 item scale (O²S³) showed good internal consistency, $\omega_T = .90$.

The first factor to emerge related to rejection sensitivity expressed as worry about others' approval (O²S³-A; e.g., *I worry about the effect I have on people*). The second factor assesses online social interaction (O²S³-O; e.g., *I delete my social media posts if I don't get the responses I wanted*). The third factor assesses individuals' perceived social investment potential (O²S³-SI; e.g., *If people knew what I am really like, they would think less of me*) and the fourth factor measures social risk taking (O²S³-SR; e.g., *Initiating contact online with others, such as sending friend requests, is not something I feel comfortable doing*).

Concurrent and convergent validity

The four-factor solution from the EFA suggests that on and offline social sensitivity are distinct sub-categories, and the offline (O²S³-A) and online (O²S³-O) sub-scales moderately correlated with one another (Table 2). For a full overview, the O²S³ and its subscales' correlations with the Interpersonal Sensitivity Measure, DASS-21 and Ruminative Response Questionnaire, see Table 2. These results remained consistent when controlling for age, see table S4.

The O²S³ showed good concurrent validity with the total Interpersonal Sensitivity Measure, $r(527) = .88, p < .001$, which remained acceptable after removing the shared items, $r(527) = .76, p < .001$.

Convergent validity of the full O²S³ with the DASS-21 total scale ($r(527) = .58, p < .001$; Figure 1A) and Ruminative Response Questionnaire ($r(527) = .51, p < .001$) was evidenced by moderate to strong associations. In line with our prediction the association between the Brooding subscale of the Ruminative Response Questionnaire was stronger than the O²S³'s association with the reflection subscale as evidenced by a significant Williams-Hotelling test, $t(524) = 7.09, p < .001$. However, the predicted differential association with the DASS-21 depression subscale was only partially supported, with the depression subscale showing a significantly stronger association with O²S³ compared to the anxiety subscale, $t(524) = 2.11, p = .03$, but not the stress subscale, $t < 1$. The stress subscale has been proposed as a measure of general distress, with shared variance with the depression subscale through an overarching general negative affectivity factor (Alfonsson et al., 2017; Osman et al., 2012). This common underlying factor may help account for lack of differentiation in the association with social rejection sensitivity. This argument is supported by the association of the validated Interpersonal Sensitivity Measure with the DASS-21 subscales (Table 2). Specifically, this established measure of social rejection sensitivity showed the strongest association with the stress subscale followed by its association with the depression and anxiety subscales.

Finally, rejection sensitivity measured with the O²S³ increased as a function of levels of depression severity (non-clinical level: $M = 22.9, SD = 8.3$; mild depression: $M = 26.4, SD = 6.5$; moderate depression: $M = 28.8, SD = 7.7$; severe depression: $M = 33.3, SD = 8.0, F(3, 525) = 51.92, p < .001, R^2 = .23$. These results held when controlling for age ($F(4, 524) = 39, p < .001, R^2 = .23$).

Methods – Study 2

In the second study the O²S³'s factor structure was validated across three independent samples. Available measures and procedures varied across the three samples; variations are described below.

Participants

To be included participants needed to report being fluent in English, have no history of neurodevelopmental and neurological disorders, and no history of traumatic brain injury. In *Sample 3* participants needed to additionally live in the US, UK, or Australia. Participants under 18 years needed to provide written parental or guardian consent.

Sample 1 included 904 undergraduate university students (17-52 years, $M = 19.7$ years, $SD = 11.4$; 63% identified as female, 37% as male) who completed a large test battery including the O²S³ and DASS-21 as part of their course work. Of these 67 were excluded due to missing data.

Sample 2 included 242 undergraduate psychology students (17-28 years, $M = 23.8$ years, $SD = 3.5$) who were recruited through the psychology research participation course. Of these 12 individuals were excluded due to responding incorrectly to two or more attention items, another 18 individuals were excluded due to missing data on the attention items. 66% ($n = 139$) of participants identified as female and 34% ($n = 73$) as male (see supplementary material for further demographic information). Of the 212 participants who completed time 1, 95% ($n = 201$) completed time 2. At time 2, five participants were excluded due to 2 or more incorrect attention items. 90% ($n = 191$) had completed high-school, 8% already had another university degree and 1% ($n = 3$) had other training. 16% ($n = 33$) reported having received a formal diagnosis for a

mental health problem (depression: $n = 12$; anxiety disorder: $n = 11$; bipolar disorder: $n = 2$; posttraumatic stress disorder: $n = 2$; obsessive-compulsive disorder: $n = 1$; other $n = 5$).

Sample 3 was recruited through social media advertising to complete a survey on the mental health, social and cognitive effects of COVID-19. 2619 individuals accessed the survey, 1058 (age range: 12-89, $M = 39.44$ years, $SD = 17.39$) had completed the survey up to or beyond the O²S³ at the time of data extraction. Of these individuals 10 were excluded due to incorrect attention items and 261 were excluded due to missing data, leaving a final sample of 787 individuals. 87% ($n = 684$) of the sample identified as female, 12% ($n = 94$) as male, 0.8% ($n = 7$) as other and 2 chose “Prefer not to say”. Across the full sample, 84% of participants identified as Caucasian, 4% Asian and 12% other.

Measures

See Study 1 for a description of the DASS-21 (measure of depressive symptoms *Sample 1 and 2*), Ruminative Response Scale (included in *Sample 2*) and Interpersonal Sensitivity Scale (included in *Sample 2*).

Online and Offline Social Sensitivity Scale. The O²S³ included 18-items each rated on a four-point Likert-scale ranging from “Strongly Disagree” to “Strongly Agree”. For all psychometric properties see Results. Included in all samples.

Concurrent validity

Rejection Sensitivity Questionnaire. The short version of the Rejection Sensitivity Questionnaire was added as an additional measure to investigate convergent validity to *Sample 2*. The scale includes 8 scenarios that are rated on two dimensions: anxiety and likelihood of acceptance. That is, for each scenario participants first indicate how concerned/anxious they

would feel in a given scenario. Second, participants indicate how confident they feel the scenario would result in acceptance.

Convergent validity

Depressive symptoms. Depressive symptoms in *Sample 3* were assessed with the depression module of the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001). In the current study, the item assessing suicidal ideation was excluded as the clinical risk could not be managed within the context of an international online survey. The remaining 8 items describe symptoms of depression and participants were asked to indicate how often a symptom was present over the past two-week period. Ratings range from 0 = Not at all to 3 = Nearly every day.

Anxiety symptoms. In *Sample 3* symptoms of anxiety were assessed with the 7-item Generalized Anxiety Disorder (GAD-7; Spitzer et al., 2006) scale. The scale assesses symptoms of generalised anxiety as defined by the Diagnostic and Statistical Manual for Mental Disorders, fourth edition (American Psychiatric Association, 2000). Participants were asked to indicate how often a symptom was present over the past two-week period. Ratings range from 0 = Not at all to 3 = Nearly every day.

Procedures

Sample 1 completed the O²S³ and DASS-21 as part of a large testing battery. They received no compensation as this was completed as part of their course work. *Sample 2* completed all measures online at time 1. One-week after time 1, participants completed the O²S³ and DASS-21 again. Participants were compensated with 0.75 course credit for completing time 1 and 0.25 course credit for time 2, if they completed the measures with no more than 1 attention item answered incorrectly. *Sample 3* completed the O²S³ as part of a large survey on the effects

of COVID-19. Every 100th participants completing the survey won an Amazon gift card worth AUS\$100.

The study was approved by the University of New South Wales Human Research Ethics Advisory Panel C: Behavioural Sciences (approval number: HREAP-C 3265), for *Sample 3* separate ethics approval was received from the University of New South Wales Human Research Ethics Committee (HC-200287).

Statistical analyses

Confirmatory factor analyses were run to confirm the factor structure of the O²S³ in all samples. The fit of the four-factor structure was tested against a range of fit indices, as the different indices can be influenced by sample size, model parameters, and data-normality (Bentler, 2006). Specifically, the Satorra-Bentler scaled chi-square goodness-of-fit test, where a chi square to *df* ratio of no greater than 3 was used to indicate an acceptable model fit (Byrne, 2001), as well as the Comparative Fit Index (CFI), Tucker Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA) and standardized root square mean residual (SRMR). According to strict/conservative criteria, values of > 0.95 on the CFI and TLI and ≤ .05 on the RMSEA and SRMR scores indicate a satisfactory model (Schermelleh-Engel et al., 2003). According to liberal fit criteria, values of >.90 on the CFI and TLI and ≤.08 on the RMSEA and SRMR scores indicate a satisfactory model (Schermelleh-Engel et al., 2003). In *Sample 2* the O²S³ test-retest reliability was assessed with correlations between time 1 and time 2. All other analyses were as Study 1.

Results– Study 2

Confirming the Online and Offline Social Sensitivity Scale's Factor structure

Confirmatory factor analyses revealed good fit indices according to conservative fit criteria for the O²S³ across all three samples (Table 3), except for the Standardised Root Mean Square Residuals in *Sample 2*, which showed a good fit when applying lenient criterion.

Psychometric properties of the Online and Offline Social Sensitivity Scale

Concurrent validity. Concurrent validity was assessed in *Sample 2*. The O²S³ showed good concurrent validity with the Interpersonal Sensitivity Measure, $r(210) = .71, p < .001$. The concurrent validity with the Rejection Sensitivity Questionnaire was low, $r(210) = .45, p < .001$. However, this is likely due to the latter's format as a scenario-based measure that specifically assesses anxious anticipation of rejection (Normansell & Wisco, 2017). In contrast, the O²S³ and Interpersonal Sensitivity Measure both assess rejection sensitivity beyond anxious anticipation to include constructs such as need for approval and perceived social investment potential.

Convergent validity. Across all three samples the O²S³ showed good convergent validity with measures of depressive symptoms (Figure 1B-C). Categorising respondents as meeting criteria for non-clinical, mild, moderate to severe depression according to the DASS-21 and PHQ-9's cut-offs, revealed that levels of depression account for 19-30% of the variance in social rejection sensitivity as measured by the O²S³ (Table 4).

As predicted the O²S³'s associations with depressive symptoms were significantly stronger than its association with symptoms of anxiety (Table 4), when measuring anxiety with the DASS-21, *Sample 1*: $t = 4.25, p < .001$; *Sample 2*: $t = 2.01, p = .04$. However, there was no significant difference, $t < 1$ between the O²S³'s association with symptoms of depression and

symptoms of anxiety in *Sample 3* (Table 4). The lack of dissociation between depressive and anxiety symptoms in *Sample 3* is likely accounted for by the assessment of anxiety with a measure of generalised anxiety disorder symptoms. Unlike anxious arousal symptoms measured by the DASS-21 (Alfonsson et al., 2017; Lovibond & Lovibond, 1995; Osman et al., 2012), generalised anxiety disorder symptoms are highly comorbid with depression (Goldstein-Piekarski et al., 2016; Kessler, 2000). Moreover, as in Study 1 there was no significant difference between the association between symptoms of depression and the O²S³ compared to the scale's association with the stress subscale of the DASS (Table 4), *Sample 1*: $t < 1$; *Sample 2*: $t = 1.53$, $p = .13$. As outlined above this is likely due to their depression and stress subscales both assessing a shared underlying factor of negative affectivity.

Further, supporting the scale's convergent validity was a moderate association with the ruminative response questionnaire, $r(210) = .40$, $p < .001$. As predicted, the O²S³ showed a significantly (*Sample 2*: $t = 4.51$, $p < .001$) stronger association with the brooding subscale of the Ruminative Response Questionnaire, $r(210) = .48$, $p < .001$ compared to its association with the reflection subscale, $r(210) = .19$, $p = .006$.

Test-retest reliability. Test-retest reliability for the O²S³ scores across a one-week interval in *Sample 2* was good for the total scale, $r(196) = .87$, $p < .001$ as well as the Approval, $r(196) = .85$, $p < .001$, Online, $r(196) = .85$, $p < .001$, and Social Investment, $r(196) = .84$, $p < .001$ subscales. However, it was reduced to acceptable to low for the Social Risk subscale, $r(196) = .69$, $p < .001$. The association with depressive symptoms at time 2 remained moderate to large, $r(196) = .58$, $p < .001$.

Social rejection sensitivity from adolescence to adulthood

In line with our hypothesis, *Sample 3* showed a decrease in social rejection sensitivity from adolescence to adulthood ($r(778)=-.40$ (95% CI: $-.45, -.33$), $p<.001$).

General Discussion

The current studies developed a measure of social rejection sensitivity that assesses this central social risk factor for depression in both online and offline contexts. Across both studies, the four-factor structure of the Online and Offline Social Sensitivity Scale (O²S³) was established, demonstrating that online and offline rejection sensitivity are dissociable, but related, constructs. The novel O²S³ showed good internal consistency and test-retest reliability. Concurrent validity with the offline Interpersonal Social Sensitivity Measure was good, though weaker with the scenario-based Social Rejection Sensitivity Questionnaire. The O²S³ was reliably associated with higher levels of depressive symptoms and more self-reported brooding, indicating good convergent validity. Indeed, when classifying individuals into categories ranging from non-clinical to severe depression according to clinical cut-offs on established depression measures, social rejection sensitivity increased significantly across each level. These associations are in line with the social risk hypothesis of depression (Allen & Badcock, 2003) and research showing an association between social rejection sensitivity and depressive symptoms in offline contexts (Andrews et al., 2020; Hsu et al., 2015; Platt et al., 2013; Silk et al., 2014). Demonstrating that these associations hold for online social rejection sensitivity is critical in the context of increasing online social interactions, especially in young people (George & Odgers, 2015).

In line with developmental research on social rejection sensitivity (Sebastian et al., 2011), social rejection sensitivity decreased from early adolescence to late adulthood (12-89 years). The impact of boundless opportunity for social interaction offline and online and consequently sustained anxious anticipation of rejection then may be particularly detrimental in young people high on social rejection sensitivity. However, it is important to note that this observed association with age may be confounded by factors such as familiarity with, and time spent on, social media, and the number of friends an individual has who actively use social media. Whilst this finding should be interpreted in the context of this limitation, it necessitates future research into age differences in social rejection sensitivity and subsequent risk for depression.

Importantly, however, online environments also provide a potentially fruitful ground for intervention. For example, depressive symptoms may be targeted by translating evidence-based treatment and prevention interventions to online interventions (for reviews see: Caelear & Christensen, 2010; Deady et al., 2017; Richardson et al., 2010). Experimental work suggests there may also be scope to target social risk factors of depression. For example, social connectedness has been shown to be derived from online interactions (Deters & Mehl, 2013; Grieve et al., 2013). Despite the mixed success of social network interventions on depressive symptoms, if social rejection sensitivity is particularly high in adolescence, fostering online social connectedness especially in adolescents at risk for depressive symptoms may have preventative advantages (Rice et al., 2014). The O²S³ is uniquely placed to contribute to the identification of at-risk individuals by distinguishing those high in social rejection sensitivity across online and offline contexts

The current set of studies needs to be considered in the context of the limitations of the study samples. The scale was developed using an online sample and validated in two

undergraduate and a further online sample. The undergraduate samples by definition lacked diversity in educational background. Given the limitations of our sample, caution should be taken when making generalisations beyond this population and future works should seek to administer the O²S³ in a more nationally representative sample. For the online samples there was no control of their testing environment. However, this was mitigated by applying stringent attention criteria excluding individuals who did not complete the study faithfully. Additionally, samples one and two did not capture data on ethnicity, and in sample three the majority of participants identified as Caucasian. However, the benefits of online research samples have been proposed to outweigh their limitations by increasing the reach of psychological research and diversity of the sample populations (Gosling & Mason, 2015). Additionally, given the correlational nature of the study, we are unable to establish any directionality of cause between scores on the O²S³ and depressive symptoms; such associations are likely to be reciprocal. Finally, we did not assess the discriminant validity of the scores on our O²S³ measure, necessitating future work to establish relationships between the O²S³ and constructs not expected to relate to the O²S³. Given this, we are unable to establish whether our O²S³ measure is capable of discriminating risk across different psychological disorders. In turn, we are unable to make inferences beyond the relationship between social rejection sensitivity and depression, which should be the focus of future work. However, given that most psychological disorders have a social component to them, and are often characterised by comorbidities with depression and anxiety, we hypothesise a significant relationship with most psychological problems. We would predict these relationships to increase with symptom severity, in the same way that we show that scores on the O²S³ increased as a function of depressive symptomatology.

Conclusion

In conclusion, the O²S³ offers a reliable measure of social rejection sensitivity in online and offline contexts. The study provides preliminary evidence across four separate samples including a total of 2381 individuals ranging in age from 12-89, that rejection sensitivity across online and offline social environments shows a strong association with depressive symptoms as well as maladaptive ruminative brooding. The scale has the potential to advance future research aimed at understanding the role of social rejection sensitivity in mental health in a digital area.

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Table 1. The Online and Offline Social Sensitivity Scale

Item	Statement	Factor
1	I worry about the effect I have on other people	1
2	I delete my social media posts if I don't get the responses I wanted	2
3	I feel that people generally like me	4
4	I feel anxious before posting anything on social media	4
5	I always expect criticism	3
6	I care about what people feel about me	1
7	Initiating contact online with others, such as sending friend requests, is not something I feel comfortable doing	4
8	When I update my social media status and no one comments on it, I tend to be disappointed	2
9	I check my responses to my social media posts very often	2
10	If others knew the real me, they would not like me	3
11	My value as a person depends enormously on what others think of me	1
12	When I update my social media status, I expect others to comment on it	2
13	I worry about being criticized for things I have said or done	1
14	I feel others do not understand me	3
15	I prefer to post on social media sites where I can stay anonymous (i.e., without revealing my name or identity)	4
16	If other people knew what I am really like, they would think less of me	3
17	I worry about what others think of me	1
18	I feel insecure if I don't receive positive responses to my social media posts	2

Note: Individuals indicate for each statement on the O²S³ how much they feel it describes them on a four-point Likert-scale ranging from “Strongly Disagree” to “Strongly Agree”. Factor 1 (O²S³-A) = Worry about Approval; Factor 2 (O²S³-O) = Online Social Interaction; Factor 3 (O²S³-S) = Social Investment; Factor 4 (O²S³-SR) = Social Risk Taking. Items can be scored for each subscale, or for the full scale. Higher scores indicate greater social sensitivity.

Table 2. Study 1 Convergent and concurrent validity of the Online and Offline Social Sensitivity Scale

	1	2	3	4	5	6	7	8	9	10	11	12	13
	O ² S ³ - A	O ² S ³ - O	O ² S ³ - SI	O ² S ³ - SR	O ² S ³	ISM	DASS -T	DASS -D	DASS -A	DASS -S	RRQ- T	RRQ- B	RRQ- R
1	1.00	.49	.41	.39	.80	.86	.44	.37	.47	.44	.39	.47	.18
2		1.00	.30	.32	.74	.53	.36	.29	.32	.36	.37	.42	.21
3			1.00	.33	.72	.65	.55	.56	.42	.46	.43	.47	.26
4				1.00	.65	.48	.32	.32	.24	.29	.28	.33	.15
5					1.00	.88	.58	.52	.47	.53	.51	.58	.27
6						1.00	.55	.49	.45	.52	.48	.55	.26
7							1.00	.89	.88	.90	.55	.60	.32
8								1.00	.65	.68	.47	.53	.25
9									1.00	.75	.46	.50	.29
10										1.00	.54	.58	.33
11											1.00	.86	.84
12												1.00	.44
13													1.00

Note: O²S³-A = Approval subscale of the Online and Offline Social Sensitivity Scale; O²S³-O = Online social interaction subscale of the Online and Offline Social Sensitivity Scale; O²S³-SI = Social Investment subscale of the Online and Offline Social Sensitivity Scale; O²S³-SR = Social Risk subscale of the Online and Offline Social Sensitivity Scale; O²S³ = total score of the Online and Offline Social Sensitivity Scale; ISM = Interpersonal Sensitivity Measure (Boyce & Parker, 1989); DASS-T = total score on the short version of the Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995); DASS-D = Depression subscale of the DASS-21; DASS-A = Anxiety subscale of the DASS-21; DASS-S = Stress subscale of the DASS-21; RRQ-T = total score on the short version of the Ruminative Response Questionnaire (Trenor et al., 2003); RRQ-B = Brooding Subscale of the Ruminative Response Questionnaire. All associations were significant at $p < .001$.

Figure 1 Association between the O²S³ and depressive symptoms across samples

Note: The figure shows the association between the novel O²S³ and depressive symptoms measured on the Depression subscale of the short Depression, Anxiety, and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) for panels A-C, and in panel D measured with the Depression module of the Patient Health Questionnaire (PHQ-9; excluding the item tapping into suicidal ideation; Kroenke et al., 2001).

Table 3. Fit indices for the four-factor structure

	Sample1	Sample 2	Sample 3
Factor structure			
df/X^2 Ratio	2.89	1.13	2.46
CFI	.98	.99	.99
TLI	.97	.99	.99
RMSEA	.05	.02	.04
SRMR	.05	.07	.05

Note: df/X^2 Ratio = Degrees of freedom to Chi square ratio; CFI = Comparative Fit Index;

Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; Standardised Root Mean Square Residual.

Table 4. Association of the Online and Offline Social Sensitivity Scale with anxiety and stress

	Sample1	Sample 2	Sample 3
Levels of depression F , R^2			
	71.07, .20	87.63, .30	102.9, .28
Descriptives: M , SD (n)			
Non-clinical levels	22.15, 8.3 (446)	20.9, 7.7 (94)	13.1, 8.2 (85)
Mild depression	26.51, 7.7 (95)	26.5, 6.2 (35)	19.1, 9.4 (252)
Moderate depression	29.09, 7.6 (152)	30.3, 6.8 (45)	24.8, 10.2 (185)
Severe depression	32.39, 8.0 (142)	32.6, 8.4 (38)	30.8, 9.8 (265)
Associations with anxiety and stress (r)			
DASS-A	.41	.53	--
GAD7	--	--	.53
DASS-S	.47	.54	--