



A pilot digital intervention targeting loneliness in young people with psychosis

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Abstract

Purpose Loneliness has been identified as a significant challenge for people with psychosis. Interventions targeting loneliness are lacking but adopting a positive psychology approach may reduce loneliness, promote well-being, and support meaningful social interactions. Together with youth mental health consumers, we developed a digital smartphone application (app) called +Connect, which delivers positive psychology content daily for 6 weeks.

Materials and methods Twelve participants diagnosed with a psychotic disorder were recruited from early psychosis services. Loneliness was assessed pre-intervention, post-intervention, and 3-month post-intervention. Acceptability, feasibility, and usability were measured post-intervention, including a semi-structured interview on the user's experience of +Connect.

Results We found evidence for the feasibility of +Connect. All but two participants completed the +Connect program, completing 95% (40.10 out of 42 days) of the program. Furthermore, 66.67% (8 out of the 12 participants) remained engaged with the program 3-months post-intervention. Our data indicates preliminary evidence that +Connect may reduce loneliness, with scores from pre-intervention ($M = 50.00$, $SD = 8.47$) to post-intervention ($M = 48.10$, $SD = 10.38$) and 3-months post-intervention ($M = 42.89$, $SD = 7.04$). We found that positive reinforcement of in-game rewards and evidence of positive mood changes added to the feasibility of the app. Regarding acceptability, while 10% (1/10 participants) reported not finding +Connect useful or enjoyable, 90% of participants agreed that +Connect helped them to increase their social confidence, enjoy life, look forward to being with other people, and feel more connected with others. Participant interviews supported these results, with participants highlighting the app's strengths in providing useful information, stimulating self-reflection, fostering positive affect, and encouraging transfer of skills into their social interactions.

Discussion While preliminary findings indicated that +Connect yielded high levels of acceptability and feasibility, it is important to consider that we recruited a small and selected sample of lonely young people. Further iterations of this proof of concept app, which can incorporate participant feedback such preferences for increased personalisation, in-app feedback, and gamification, may allow an opportunity to test an improved version in the future.

Keywords Loneliness · Psychosis · Positive psychology intervention · Digital intervention

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Introduction

Addressing loneliness has been identified as a high priority in helping people who have psychosis [1, 2] but we currently lack evidence-based solutions for this subjective sense of social isolation in this population [3]. Reducing loneliness in young people with psychosis is particularly important because there is increased stigma [4], societal discrimination [5], and a change in social roles (e.g., dropping out of education or work [6]) associated with the onset of psychosis. Most interventions have included enhancing social support and opportunities, improving social skills, or addressing

maladaptive social cognition [7] but thus far, positive psychology interventions (PPIs) have been overlooked as an alternative approach in combatting loneliness.

PPIs focus on *enhancing* the person's functioning [8] and can be used as complementary approaches within mental health interventions [9]. Rather than aiming to correct deficits, PPIs take a strength-based approach to psychotherapy, which may be more engaging and less pathologizing [10, 11]. PPIs have been shown to effectively enhance recovery by encouraging an individual to identify positive emotions [12, 13], express gratitude [14], practice kindness [15], set goals [16], and identify and use strengths [14].

PPIs can also be applied to improving personal and social relationships [17]. Several PPIs include exercises such as active–constructive responding; which aim to enhance the individual's relationship well-being in the context of responding to hearing positive news from others [18–20]. A PPI that promotes positive affect and facilitates the use of positive interpersonal skills could plausibly improve relationship quality [21]. Intervention studies using positive psychology approach have yet to specifically target loneliness [12, 13].

Digital tools are increasingly utilized within mental health treatment but it is important to consider that its success and integration to clinical services may relate to a multitude of factors from the user's psychiatric symptoms severity to lack of resources (e.g., finances and staff support) [22]. Digital tools have nonetheless been developed and tested for people with psychosis [23–25], either via web-based platforms [26], virtual reality/avatars [27, 28], and smartphone applications, or 'apps' [29]. These tools are used for a variety of purposes from monitoring symptoms [30], medication adherence [31], promotion of self-management strategies (e.g., improving coping), provision of psychoeducation [32], and social recovery, such as enhancing access to peers [33].

Pilot studies in smartphone app interventions so far have been found to be acceptable and feasible in people with psychosis, but the acceptability and feasibility criteria set prior to each trial may vary. For example, one study measured acceptability via satisfaction ratings on app features or retention rates, and feasibility, via login frequency, challenge completions, number of social interactions within the app [34]. Another defined acceptability as collecting participant feedback and feasibility was assessed as the program uptake, completion, and attrition. Smartphone technology is being used for a variety of ways in those with psychosis; from assessment and monitoring [35, 36], improving motivation and enhancing support (e.g., PRIME [34, 37]), addressing clinical symptoms and preventing relapse (e.g., Actissist [38]), delivering case management

cognitive-behavioural therapy (e.g., Heal Your Mind [39]), and facilitating medication adherence [40]. We extended upon this growing list by developing a smartphone app that can deliver PPI content to young people with psychosis to specifically target loneliness. Targeting loneliness rather than other broader social problems is currently lacking in the literature. This is because researchers have traditionally favoured measuring objective indicators of social connection such as increased social ties [3] over subjective indicators such as loneliness within psychosocial interventions. But more recent evidence has suggested that those with psychosis not only report loneliness as prevalent but also a top challenge for them to overcome [1, 2].

Study aims and hypotheses

The first aim was to develop a pilot digital smartphone application to target loneliness that is feasible and acceptable to young people with early psychosis. We hypothesized that participants would complete at least 70% of the program (equivalent to 30 of the 42 days of content).

The second aim was to develop an app that is usable to young people as one necessary step to reducing the likelihood of poor engagement, a common problem with mental health smartphone apps [41]. We hypothesized that more than 70% of participants would report higher than *somewhat* in their satisfactory ratings across a series of criteria, including ease of understanding, enjoyment in life, and content helpfulness.

Third, we explored the usability of the app (e.g., functionality, navigation). Next, within an exploratory analysis, we also estimated the plausible effect size of +Connect on loneliness severity using a latent trajectory model. Last, we used a mixed methods approach using quantitative and qualitative data to deepen our understanding of how young people experience +Connect.

Methods

Participants

Twelve individuals aged 17 to 25 years ($M = 20.50$, $SD = 2.65$), were recruited from early psychosis services in Melbourne, Australia. Table 1 outlines the demographic information of the participants including clinical

Table 1 Demographics of participants

| Demographic variable | M (SD) or % |
|---|---------------|
| Gender | 25% female |
| Age | 20.50 (1.33) |
| Ethnicity | |
| Asian Australian or Asian | 25% |
| White (including Caucasian, European, Australian) | 66.7% |
| African Australian | 8.3% |
| Relationship status (% Single) | 91.7% |
| Living status | |
| Residing with housemates | 16.7% |
| Residing at home with immediate family | 75% |
| Residing with relatives | 8.3% |
| Residing with | |
| One other person | 25% |
| Two other people | 25% |
| Three other people | 16.7% |
| Four other people | 25% |
| Five other people | 8.3% |
| Completed education (in years) | |
| DSM V diagnosis ^a | 12.25 (1.72) |
| Schizophrenia | 50% |
| Schizoaffective | 16.7% |
| Schizophreniform | 16.7% |
| Psychotic disorder NOS | 16.7% |
| Secondary diagnosis | |
| DSM V social anxiety disorder | 25% |
| DSM V mood episode | 16.7% |
| Both social anxiety and mood episode | 25% |
| Neither social anxiety nor mood episode | 33.3% |
| NART FS IQ ^b | 109.67 (7.42) |

^aDSM V refers to the diagnostic and statistical manual of mental disorders 5

^bNART FS IQ refers to the National Adult Reading Test full scale intelligence quotient

diagnosis. The study inclusion criteria were: (1) aged 16–25; (2) current DSM V diagnosis of psychotic disorder (i.e., Schizophrenia, Schizophreniform, Schizoaffective Disorder, Delusional Disorder or Psychotic Disorder Not Otherwise Specified) as assessed by the SCID-5; (3) UCLA Loneliness Scale score > 38;¹ (4) identified a desire to connect with others; (5) currently engaged with a

mental health service, general practitioner or organization with consent for researchers to contact service in case of risk; (6) owned a compatible smartphone. The study exclusion criteria were presence of one of the following in the past month: (1) acute psychotic symptoms;² (2) moderate or severe risk issues, i.e., deliberate self-harm and suicidality;³ (3) psychiatric hospitalisation; (4) substance abuse or dependence; (5) known Axis II personality disorder; (6) inability to read or comprehend English (NART score < 70 or failure on reading comprehension test).

Development of +Connect digital smartphone application intervention

We first translated positive psychology concepts traditionally delivered via face-to-face group program⁴ into easy to understand, youth-friendly digital materials to assess the acceptability and feasibility of the PPI content. The aim of the content was to assist individuals to identify and harness their personal strengths, and to learn and practice positive interpersonal skills that could strengthen their current relationships. Themes included eliciting positive emotions, as well as showing kindness and reciprocity within relationships (see Online Resource 2 for more details). We added one additional theme, *Social Fears*, which addresses social anxiety. This was added to the program because of previous research which indicated a reciprocal relationship between loneliness and social anxiety over time [42].

In 2015–2017, we conducted a series of focus groups with young people aged 18–25. These groups comprised of young people with no mental ill health, young people with high prevalence disorders as well as those with serious mental illnesses. We opted to develop a smartphone app over other digital platforms because of its mobility and accessibility [43–45] and preferences obtained from focus groups. The smartphone app format meant that information was delivered more frequently but in a concise format as opposed to other conventional modes of psychotherapy (e.g., face-to-face) which may require more effort [34]. Before the development of the smartphone app, young people were invited to comment on: design (i.e., fonts, colours, layout), functionality (e.g., task completion and gamification), and language (e.g., written task and video content).

To accurately relay socially oriented information and increase engagement in the app, we also opted to deliver content via video material where possible. We developed three types of videos: (1) shared experience videos (SEVs) using young people with lived experiences [46]; (2) expert

¹ There is no known threshold for problematic or severe loneliness but a score of 38 and above was used to indicate above the median score across different samples (Russell [58]).

² A rating of *moderate or more* on any positive psychotic symptoms as assessed by the Positive and Negative Syndrome Scale (Kay et al. [52]).

³ Assessed by the SCID 5 risk section.

⁴ Manuscript submitted for publication. Contact first author of manuscript and group program.

videos (EVs) featuring therapists [47]; or (3) actor videos (AVs) demonstrating how to elicit positive affect and initiate or maintain positive social interactions [48].

While mobile and accessible, core concepts had to be concise, and content was delivered over 42 days (6 weeks). When the application is opened, participants see a home screen, and are asked to log their mood using a mood evaluation tracker. They then proceed to the tasks which were delivered in one of four ways: (1) via text and images (e.g., an Instagram format); (2) SEVs featuring young people with lived experiences; (3) EVs featuring academics introducing core concepts; or (4) AVs featuring semi-professional actors modelling a range of social behaviours.

All videos were designed to be brief (i.e., 1.21–4.38 min). AV scripts were written by a scriptwriter and reviewed in a series of focus groups with young people with psychosis. This process enabled us to refine the language used and to ensure that the material was youth-friendly and relatable. The interview schedule for SEVs were developed by MHL, JA, and NT. Two independent coders rated the content of each SEV on whether it achieved the aims of the modules (e.g., Gratitude video: to relay that expressing gratitude can feel awkward at first and it is more than saying thank you).

After accessing daily videos, participants were given a task to answer questions (either multiple choice or True/False format) in relation to the material, taking under a minute to complete. +Connect is gamified⁵ (e.g., points, challenges, badges) to encourage participant engagement [41, 49, 50]. Online Resource 1 outlines the content of the +Connect app, developed by MHL, JFMG, TLR, and DLP. This table shows *when* the different modules and tasks were delivered via levels and days. It shows the aim of each module, for example, Level 5, Day 10–12, within Gratitude module, the aim was to introduce an interpersonal focused gratitude exercise, where the content should include the importance of going beyond to say thank you. Specifically, relaying that gratitude is difficult to do and can be confronting, however, doing the exercise can bring people closer. These concepts were delivered by three days of content titled, *Gratitude* (written content post), *The Gratitude Exercise* (an actor video) and *Showing Gratitude* (a shared experienced video). The table also indicates whether a challenge was introduced, and in all cases, challenges were only unlocked after the

entire module was delivered (e.g. Day 12 of the Gratitude module).

Materials

Participants attended three research assessments: Time 1 (T1), baseline; Time 2 (T2), post-treatment (after completing at least 33 days of +Connect); and Time 3 (T3), 3-month follow-up (conducted 3 months after the T2 assessment). Each assessment involved clinician-administered measures and self-report questionnaires.⁶ Participants also completed an interview at T2 in regards to their experience of using the app.

Acceptability, feasibility, and usability A series of questionnaires were created to assess acceptability, feasibility, and usability of +Connect. Participants were asked to rate their level of agreement with a series of statements regarding their experience of using the app, and how they felt after using the +Connect app. Scores were rated on a 5-point Likert-type scale ranging from 1 (Extremely Disagree) to 5 (Extremely Agree). A 20-item questionnaire designed for the study was used to assess how helpful each module was for the participants. Responses were made on a 4-point Likert-type scale ranging from 1 (Not Helpful) to 4 (Very Helpful).

Clinician-administered measures

The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders (SCID-5-RV; [51]). The SCID-5-RV was administered at only baseline to determine study eligibility and establish clinical diagnoses. Thirty percent of the assessments were randomly selected and independently rated by another coder (KC), with 100% consensus on diagnostic reliability.

The Positive and Negative Syndrome Scale (PANSS; [52]). The PANSS was used to assesses symptoms of schizophrenia. The PANSS is a 30-item clinician-rated symptom severity measure. The items are rated on a 7-point Likert scale ranging from 1 (Absent) to 7 (Extreme severity). The PANSS has demonstrated good internal inconsistency and reliability [53]. Internal consistencies ranged from $\alpha = 0.82$ to 0.93.

The Calgary Depression Scale for Schizophrenia (CDSS; [54]). The CDSS, a 9-item clinician-rated measure was used to measure depressive symptoms. It was specifically designed for the assessment of depressive symptoms in those with schizophrenia. It has been shown to have adequate reliability and validity [55]. Internal consistencies ranged from $\alpha = 0.77$ to 0.81.

⁵ Points were provided to participants when they correctly answered a question, but no penalty was given for incorrect responses. Challenges involved participants relating the information and skills learnt during the daily tasks to real-world situations. An example of a challenge was responding in an active and constructive manner to someone when they heard positive news. Badges were assigned for either progression through the app, completing the mood log over a particular period, or completion of a challenge.

⁶ Measures were administered at all timepoints except for the SCID-5-RV and NART which were administered only once at T1.

Social Skills Performance Assessment (SSPA; [56]). We measured social skills as a potential covariate and to ensure that the intervention had no effect on social skills. The SSPA involves two 3-min role-plays with the research assistant on pre-determined social situations (e.g., participant plays the role of a tenant meeting a new neighbor). Role-plays were audio-recorded and two independent trained coders rated the social interactions on nine separate parameters.⁷ Intraclass correlation coefficients (ICCs) for T1–T3 ranged from acceptable to excellent (Scenario 1; ICCs = 0.85–0.90; Scenario 2: ICCs = 0.82–0.94). Internal consistencies ranged from α s = 0.90–0.91 for scenario 1, and 0.94–0.96 for scenario 2.

National Adult Reading Test (NART; [57]). We used the NART at baseline to ensure participants could comprehend the content of +Connect and were also able to obtain a pre-morbid IQ. The task involves reading a list of 50 words presented in increasing difficulty. Each word is irregular with regards to common pronunciation rules, ensuring participants have familiarity with the word rather than solely relying on phonemic decoding.

Self-report measures

The Revised UCLA Loneliness Scale (Revised UCLA-LS; [58]). The UCLA-LS, a 20-item self-report scale, was used as a measure of loneliness severity, employing a 1 (Never) to 4 (Always) Likert type scale. The measure consists of both positively and negatively worded items that assess loneliness (e.g., *How often do you feel that you are no longer close to anyone?*). The UCLA-LS has been shown to correlate negatively with life satisfaction and perceived social support, thus supporting its convergent validity with related constructs [58]. Internal consistencies ranged from α s = 0.91 to 0.94 across time points.

The Social Interaction Anxiety Scale (SIAS)—straightforward items (S-SIAS [59]). The original SIAS is a 20-item self-report questionnaire that measures anxiety-related reactions to different social interactions (e.g., *I get nervous if I have to speak with someone in authority*). The 17 *Straightforwardly-worded items (S-SIAS)* were found to be more valid indicators of social interaction anxiety than the reverse-scored items across different samples [60]. For this reason, we used the straightforward items and internal consistencies ranged between α s = 0.87 and 0.94.

The Scales of Psychological Well-Being (SPWB; [61]). The SPWB is a 54-item questionnaire that measures eudaimonic well-being across six dimensions: autonomy, positive

relations with others, environmental mastery, personal growth, purpose in life and self-acceptance. Items are scored on a 6-point Likert Scale from 1 (Strongly Disagree) to 6 (Strongly Agree). This widely used scale has demonstrated good internal consistency and construct validity [61]. We used an overall SPWB score. Internal consistency for the SPWB ranged from α s = 0.81 to 0.87.

Semi-structured qualitative interview Participants were invited to complete a semi-structured interview regarding their experiences using +Connect at T2.⁸ The interview was transcribed verbatim prior to analysis.

Design and procedures

We employed an uncontrolled single-group design with three time points to assess the feasibility, acceptability, and usability of a digital intervention targeting loneliness. Participants were recruited via case managers working at local early psychosis teams. Potential participants were initially screened via telephone to assess study eligibility. Participants were screened to ensure that they were not acutely unwell, engaging in problematic substance use, or at moderate to high risk. Participants also completed the UCLA Loneliness 3-item Scale (see [62] for more details); those who scored 5 or more and did not meet exclusion criterion were invited to a baseline assessment, during which they completed the remaining measures.

At the baseline assessment, participants provided written informed consent and proceeded to complete the UCLA-LS, NART, SCID-5, and PANSS. Participants were excluded at this point if they met any of the exclusion criteria. Participants who were deemed eligible proceeded to complete the remaining baseline assessments including the CDSS, SSPA, and self-report questionnaires. Participants' responses were audio-recorded for quality assurance purposes for the SCID-5, PANSS, SSPA, NART, and the semi-structured interview. Participants were not identified by name during these recordings to ensure the data was de-identified.

Once participants had been accepted into the program, research assistants provided an introduction and orientation to the app, specifically, helping them fill in basic demographic questions within the app. Research assistants explained the purpose, design, and functionality of the app, and provided a demonstration of navigating through the different components. As participants progressed through the app, research assistants monitored their progress via a web portal. Participants were contacted once a week as a brief check in either via text message or a phone call. This was to ensure that they could address any technical issues they

⁷ The coders did not code the SSPA grooming question as only audio coding was available. The research assistant conducting the assessment however coded this item.

⁸ The interview schedule is available upon request from the first author.

Table 2 Loneliness, mental health symptoms, social skills, and well-being across time

| | <i>M</i> (SD) | | |
|---------|----------------|----------------|----------------|
| | T1 | T2 | T3 |
| UCLA-LS | 52.58 (9.94) | 48.10 (10.37) | 42.89 (7.04) |
| S-SIAS | 39.50 (12.46) | 29.60 (8.91) | 30.75 (4.86) |
| CDSS | 6.00 (4.71) | 4.40 (4.22) | 2.78 (2.86) |
| PANSS | 40.00 (8.66) | 34.60 (5.42) | 35.11 (8.04) |
| SSPA | 62.08 (14.99) | 67.55 (13.73) | 71.56 (12.27) |
| SPWB | 183.82 (33.73) | 189.44 (28.62) | 212.63 (21.61) |

Note: Total $N=12$, except for T2 where $n=10$ and T3 where $n=8$ due to participants lost to follow-up. T1 refers to baseline, T2 refers to post-treatment, T3 refers to 3 month follow-up. Values are based on observed values

UCLA-LS University of California Loneliness Scale, *S-SIAS* straight-forward items from Social Anxiety Interaction Scale, *CDSS* Calgary Depression Scale for Schizophrenia, *PANSS* positive and negative symptom syndrome, *SSPA* Social Skills Performance Assessment Scale, *SPWB* Scales of Psychological Well-Being Scale

may have experienced, and to ensure that potential emerging risk issues were identified and addressed. Participants were reimbursed for the completion of each assessment (\$15 per hour) and for mobile data based on the number of days they had logged in (\$3.33 per day).

Data analytic procedure

The means and standard deviations were calculated for each measure (see Table 2). The feasibility of the intervention was assessed by uptake, attrition, app completion, and retention at T2. *Uptake* was defined as the number of potentially eligible individuals who attended the T1 assessment. *Attrition* was defined as non-use of the app for > 3 consecutive days and inability of researchers to contact the participant. *App completion* was defined as accessing and completing content at least 70% of the content (30 out of the 42 days). Consistent with most pilot interventions and recommendations [63], we also considered *Safety*, which was operationalized as the incidence of serious adverse events (such as inpatient psychiatric admissions) during the course of the study [64]. Intervention acceptability and app usability were assessed using satisfaction rating questionnaire and participant interviews at T2. Participant interviews were analysed using content and thematic analysis.

To estimate the overall effect of treatment with the greatest precision given the small sample size, we used a latent trajectory model in Mplus [65]. This technique had the advantages of (a) assessing the effect of treatment across the entire study (e.g., not just pre to post) and (b) allowing a summary across variables (i.e., instead of a series of underpowered *t*-tests or effect size estimates for each variable).

We first present results using the UCLA-LS, which is considered the gold-standard self-report measure for loneliness. To increase precision of the estimate, we examined which other variables were most associated with loneliness at pre-intervention as measured by the UCLA-LS; these were the SPWB and CDSS, which correlated so highly with the UCLA-LS ($r_s > 0.79$) that examining the measures individually could be misleading (i.e., because they appeared to primarily reflect overlapping variance). These measures were put on the same metric (that of standard deviations) and treated as being influenced by a single intercept and a single linear slope. These analyses are, of course, underpowered; nevertheless, if they were to indicate that the intervention produced a harmful effect or close to no effect, such a result would weigh against the acceptability of the intervention.

Results

Feasibility ratings

Twenty-five potential participants identified by their case managers were telephone screened over 18 months of recruitment across three sites. Of this, seven were found to be ineligible for the study; three were uncontactable, two were assessed to be experiencing acute psychotic symptoms, and the last two individuals reported they were no longer interested in participating. Therefore, 18 young people met the initial telephone screening criteria and attended baseline assessments, of whom 12 met the study eligibility. Four out of 18 of participants were excluded due to a having a diagnosis of substance-induced psychosis and one participant was uncooperative and we were unable to make a confirmatory diagnosis. The final participant did not meet criteria for a psychotic disorder, rather their primary diagnosis was a mood disorder with psychotic features.

Hence, only 12 participants were accepted into the study based on the study's inclusion and exclusion criteria. Two out of 12 participants (16.67%) dropped out during the intervention, one moved away and one did not cite a reason. Participants (i.e., $n=10$)⁹ on average completed 95.47% of the +Connect ($M=40.10$ days, $SD=3.04$), exceeding the a priori criteria of app completion (33 out of 42 days). Eight out of the ten participants also remained engaged in the program 3 months following the end of treatment assessment.

Feasibility qualitative engagement data Of the ten participants, two reported early difficulties integrating the use of the app into their routine, with one describing the app as “*sort of a chore*” as they “*felt like [they weren't] really working towards anything.*” *Nevertheless, these two*

⁹ Percentage figures reported refer to the % out of 10 completers.

Table 3 Participant interview feedback

| Theme | Representative quote |
|--------------------------------------|---|
| Feasibility—app engagement | |
| Relatability of content | “I like the shared experience videos to see that ... normal people like I ... they applied it and got something out of it. So like I can too. ... And, and the videos seemed like really realistic...and honest” “I felt all of the sections were relevant. Because I felt like the people in the videos felt at some point” |
| Gamification | “I really like the badges idea. Because... that really helped me to keep going with the thing instead of seeing like, ‘Oh, I don’t know like 30 videos!’ because then it doesn’t seem that appealing” |
| Evidence of positive changes | “At the beginning I kept forgetting because it wasn’t part of my routine... but when I did do it, I started seeing kind of like results” |
| Notifications | “It’d be a couple of days where I’d be like ‘oh **** I haven’t done it yet’. And because the reminder was up on my phone I was like “oh yeah, do that now”.” |
| Acceptability—app outcomes | |
| Increased positive affect | “The best thing about the app... it just makes you feel more positive” |
| Improved social interactions | “I reckon I’ve become better at talking to people I don’t actually know” |
| Increased social confidence | “I think I feel a lot more confident in myself... I think prior to it I was a bit, not shy, but a bit hesitant in social situations” |
| Intent to apply in future | “I find that there are some things I could apply to real life... And this is what I am planning, or would like to do later on when I have a chance to meet with other patients, or I could use this app to help me to build those new relationships.” |
| Encouraged learning | “I felt like it was quite an educational app that teaches you many things” “I like how at the end of the videos there is always a summary that talks about what was discussed in the video and puts it into text, makes it easier to remember the key points” |
| Acceptability—app outcomes continued | |
| Encouraged self-reflection | “I think it was good that it logged different moods... just to know how I was feeling ... different times of the week. And yeah, so I could look back and see what I did and see how I felt in different scenarios” “It’s good to actually just ruminate on what is your strengths, like what you’re actually good at. I found that writing down some of your strengths and stuff each day before you go to bed was good” |
| Usability | |
| App design and navigation | “I like the simple set up and layout of the app” “The layout and that make it really easy for anyone to use even if you’re not a tech-head” |
| Video quality | “I found the videos very good. I thought they were well made...I thought the acting was actually pretty good” |
| Task and challenge difficulty level | “It wasn’t complicated at all and you can apply it pretty much on the day, like the skills that you learn and stuff” “I found the [question] difficulty not too hard, but it’s not too easy at the same time, like you’d have to have watched the video to get a better gauge of the answers.” “Some [challenges] were hard. Yeah, some were tricky. I’d be like ‘I’m not doing that’....They were just ones... way out of my comfort zone” |

participants, as well as five further participants reported that the app eventually became “*just another item to do on [their] schedule*”. Eight out of 10 participants reported that they were interested in logging into +Connect daily (i.e., agreeing or extremely agreeing). Six out of 10 participants found the app did not create a significant time burden and reported a duration of 1 and 3 min per day in the program, while the remaining 4 out of 10 reported using the app at least 5 or more minutes per day. See Table 3 for more details regarding engagement.

Acceptability quantitative outcome satisfaction and agreement ratings

Moreover, 80% of participants (8 out of 10) agreed that the +Connect app was useful (see Table 4). Ninety percent of participants (9 out of 10) agreed (or strongly agreed) that they enjoyed using the app, that they gained a lot from using +Connect, and that they found the content understandable and relatable. The ratings of the enjoyment of challenges, however, appeared to be split, where five out of 10 participants endorsed a neutral rating and the other

Table 4 Post-intervention feasibility, acceptability, and usability ratings of +Connect

| Question | Extremely disagree | | Disagree | | Neutral | | Agree | | Extremely agree | |
|--|--------------------|---|----------|----|---------|----|-------|----|-----------------|----|
| | n | % | n | % | n | % | n | % | n | % |
| Feasibility | | | | | | | | | | |
| Interested in signing in | – | – | 1 | 10 | 1 | 10 | 6 | 60 | 2 | 20 |
| Acceptability | | | | | | | | | | |
| Enjoyed using +Connect | – | – | 1 | 10 | – | – | 7 | 70 | 2 | 20 |
| +Connect was useful | – | – | 1 | 10 | 1 | 10 | 5 | 50 | 3 | 30 |
| Enjoyed content | – | – | – | – | 3 | 30 | 6 | 60 | 1 | 10 |
| Understand the ideas | – | – | – | – | 1 | 10 | 5 | 50 | 4 | 40 |
| Gained a lot | – | – | 1 | 10 | – | – | 7 | 70 | 2 | 20 |
| Could relate to content | – | – | – | – | 1 | 10 | 7 | 70 | 2 | 20 |
| Relate to characters | – | – | – | – | 3 | 30 | 5 | 50 | 2 | 20 |
| Videos helped with content | – | – | – | – | 3 | 30 | 2 | 20 | 5 | 50 |
| Videos were entertaining | – | – | 2 | 20 | 2 | 20 | 3 | 30 | 3 | 30 |
| Questions helped with content | – | – | – | – | 2 | 20 | 6 | 60 | 2 | 20 |
| Questions were the right level of difficulty | – | – | 1 | 10 | 1 | 10 | 6 | 60 | 2 | 20 |
| Enjoyed challenges | – | – | – | – | 5 | 50 | 3 | 30 | 2 | 20 |
| Badges encouraged participation | – | – | 1 | 10 | 1 | 10 | 6 | 60 | 2 | 20 |
| Usability | | | | | | | | | | |
| Easy to navigate | – | – | – | – | – | – | 5 | 50 | 5 | 50 |
| Format made sense | – | – | – | – | – | – | 7 | 70 | 3 | 30 |
| Language is easy to understand | – | – | 1 | 10 | 1 | 10 | 6 | 60 | 2 | 20 |
| Liked colour scheme | – | – | – | – | 3 | 30 | 5 | 50 | 2 | 20 |
| Liked fonts | – | – | – | – | 1 | 10 | 9 | 90 | – | – |
| Liked photos | – | – | – | – | 2 | 20 | 6 | 60 | 2 | 20 |
| Content is interesting | – | – | 1 | 10 | 1 | 10 | 6 | 60 | 2 | 20 |
| Liked videos | – | – | – | – | 1 | 10 | 6 | 60 | 3 | 30 |

Table 5 Post-intervention outcome satisfaction ratings of the +Connect digital intervention

| Question | Very satisfied | | Somewhat | | Not at all satisfied | |
|---|----------------|----|----------|----|----------------------|----|
| | n | % | n | % | n | % |
| Ease of understanding | 5 | 50 | 5 | 50 | 0 | 0 |
| Look forward being with people | 5 | 50 | 4 | 40 | 1 | 10 |
| +Connect helped me enjoy life | 5 | 50 | 4 | 40 | 1 | 10 |
| +Connect helped me feel connected with others | 4 | 40 | 5 | 50 | 1 | 10 |
| +Connect helped increase social confidence | 5 | 50 | 4 | 40 | 1 | 10 |
| Helped create new relationships | 4 | 40 | 3 | 30 | 3 | 30 |
| Helped accept mental health symptoms | 3 | 30 | 7 | 70 | 0 | 0 |

five out of 10 participants agreed that the challenges were enjoyable. See Table 4 for more details.

Seventy percent of participants (7/10) reported that they were *somewhat or very satisfied* across each outcome criterion assessed. For example, all participants (100%) reported being somewhat satisfied or very satisfied that +Connect was easy to understand and helped them accept their mental health symptoms. Ninety percent of

participants (9 out of 10) also reported that +Connect helped them to increase their social confidence, enjoy life, look forward to being with people, and feel more connected with others. However, three out of 10 participants also reported that +Connect did not help create new relationships, which was consistent with the focus on improving the quality of current relationships rather than creating

new ones. More details of the outcome satisfaction ratings are shown in Table 5.

Acceptability qualitative outcome data The qualitative findings indicated three key outcomes from engagement with +Connect: improved positive affect ($n = 5$) improved social interactions ($n = 4$), and increased social confidence ($n = 2$). Three out of 10 participants also reported an intent to apply +Connect skills in future social interactions. Participants attributed their positive outcomes of app usage to two main processes induced by the app: *learning* and *self-reflection*. These findings were supported by the survey results.

Acceptability qualitative content data Participants reported an overall high level of satisfaction with the app modules; 50–90% of participants found the modules of +Connect to be either helpful or very helpful. In interviews, participants reported Strengths, Gratitude, Sharing Positive News, Three Good Things, and Social Fears as their favourite modules. In terms of content difficulty, participants reported the greatest difficulty was completing the challenges, with five out of 10 participants reporting that they did not do many of the challenges. Participants reported no concerns with the difficulty level of the questions (see Table 4).

There were no differences in participant preferences regarding the type of video (i.e., expert, actor, or shared experience; see Online Resource 2 for more details and examples of representative quotes). Participants generally associated EVs with information provision, AVs with behaviour modelling and fun, and SEVs with motivational examples of how people had successfully applied the skills. Online Resource 2 also describes how the SEVs and AVs were the most well-received videos with all participants stating they were either somewhat or very much satisfied with their usefulness. Most users (90%) also found the SEVs and AVs enjoyable, but while they found the expert videos useful (90%), a smaller number (70%) found it enjoyable.

Usability

All ten participants agreed, or strongly agreed, that the app was easy to navigate and the format made sense (see Online Resource 3 for additional qualitative feedback). Eight out of 10 participants agreed that the language was easy to understand, the content was interesting, and that they liked the photos. Similarly, nine out of 10 participants liked the videos and fonts used in the app. This was supported by the interview feedback (see Table 3). App design feedback primarily focussed on increasing app personalisation, gamification, and feedback functions. A list of participant improvement suggestions is also provided in Online Resource 3.

Safety

There were no adverse events (i.e., psychiatric admissions) recorded during the trial.

Exploratory analyses

Table 2 shows the means and standard deviations across each timepoint. These scores can be used to compute effect sizes that generally suggest acceptability of the intervention; however, we focus on latent trajectory tests to limit subjective interpretation of these patterns. We used a latent trajectory model [66] to estimate the effect size of change in (a) the UCLA-LS and (b) the outcome measures (i.e., SPWB and CDSS) most associated with loneliness during the intervention. As described above, the slope is in terms of standard deviations based on the pre-intervention scores. The mean of both slopes indicated participants were more likely to benefit from the intervention (UCLA-LS: $M = -0.34$, $SD = 0.24$; three measures: $M = -0.29$, $SD = 0.14$). Thus, for both analyses, participants could be expected to have scores that are about 0.3 standard deviations lower at post, and about 0.6 standard deviations lower at follow-up than at pre (i.e., because the slope used was linear). This finding adds to the indications above that the intervention was seen as acceptable.

Discussion

Loneliness in people with psychosis is a significant challenge [1, 2] that is currently neglected within existing psychosocial interventions [3]. While researchers are interested in improving social outcomes and deliver a vast array of psychosocial interventions for those with psychosis, loneliness is not seen as the traditional treatment target. We proposed using a positive psychology approach to promote the development of meaningful relationships and reduce loneliness. As digital tools are increasingly being used for individuals with psychosis [23], we co-designed a smartphone app, called +Connect, that could deliver youth-friendly materials.

Our findings indicate that loneliness may be addressed via digital means using PPI content. Overall, +Connect was found to be feasible and acceptable intervention to address loneliness in young people with psychosis. However, while there is promising evidence that +Connect may mitigate loneliness, further research should consider testing an improved version within a larger trial.

Participants identified Strengths, Gratitude, Sharing Positive News, and Three Good Things as favourite modules. Watching a peer's experience of doing tasks or sharing their experience within the SEVs was especially important in creating participant engagement with the app, and in

encouraging the transfer of skills learnt within the app to real-life context. This is consistent with previous research that suggest that online peer-related material can improve a sense of connection to others with lived experiences [46, 67, 68]. Furthermore, positive feedback on usability may have been elicited because of consumer involvement in the development phase using groups of young people, where feedback was given on design, gamification, font, photos, content, and videos. Involving consumers within these processes within coproduction design frameworks could plausibly increase the engagement of health services [41, 69, 70]. While participants reported the EVs as useful, particularly for the provision of information, they did not find the EVs as enjoyable as the other videos. One way forward is to consider using more engaging, fun, and interactive ways to relay academic information, as proposed by one participant (e.g., animations, narrative storytelling, or choose-your-own adventure scenarios).

At least 50% of our participants also met a clinical diagnosis of social anxiety disorder, and this is consistent with studies that have found that individuals with psychosis also report comorbid social anxiety disorder [71, 72]. Furthermore, higher social anxiety symptom severity is associated with higher loneliness, with a known reciprocal relationship between loneliness and social anxiety being evident over a 6-month period [42]. Taken these findings, we proposed that it was crucial to augment interventions targeting loneliness by addressing possible co-occurring social anxiety symptoms. In our case, the content of +Connect was designed to normalize social anxiety.

Study quality and methodological limitations

First, we recruited a small sample size in the first pilot evaluation, in part due to the strict study inclusion and exclusion criteria. For example, we only focused on participants who met a loneliness severity score of above 38 on the UCLA-LS, and excluded substance-induced psychosis, which was a common presenting problem at the mental health early psychosis services. We adhered to the study eligibility as our main focus was to get an understanding of the acceptability and feasibility of a proof of concept digital intervention. Hence, although appropriate to our primary aims of developing the intervention for a specific population, our sample size did not allow good statistical power for quantitative tests. Second, at its current phase of development, +Connect is simply a tool to deliver content. While the gamification components attempted to create a sense of achievement through progression (e.g., badges awarded), some participants nonetheless reported a lack of engagement in the early phases of the app. The user may benefit from clearer or multiple indicators of progressions (e.g., adding more functions that signal of a growth of knowledge like

representing by building blocks within the home screen in addition to total points won).

Additionally, the app did not entail functionality to facilitate interactions between young people and their peers, or between moderators and young people. Further development can include chatrooms designed for either one or two functions: (1) peer-to-peer interaction, which allows young people to interact with each other including sharing their experiences of doing challenges and having safe opportunities to provide and give social support to each other; (2) moderator-to-user interaction, which allows trained moderators (i.e., clinician or peer moderators) to assist young people to translate skills learnt within the app to real life. The availability of moderator to user chat functions may be especially important because participants reported difficulty with completing challenges. A chatroom dedicated to assisting the translation of app skills to real life will not just provide an opportunity to provide support and to facilitate close monitoring but also allows clinician moderators to provide tailored assistance to the young person. Should such a function exist, it will require both technical and clinical human support to monitor participant safety and any indicators of deteriorating mental state [73].

Future improvements of the app will address participants' need for personalization, and this may include the capacity to upload participant profile photos and record reflective comments. Participants also verbalized a need to gamify with different rewards schedules. This maybe include either varying types of rewards (e.g., unlocking the ability to track their journey) or delivering random rewards, which may contribute to increased engagement.

Conclusion

We evaluated a pilot smartphone app, called +Connect, in terms of acceptability, feasibility, and usability. We triangulated quantitative and qualitative data to give us a deeper understanding on the feasibility, acceptability, and usability of +Connect. It is likely that +Connect is not just feasible, acceptable, and useable to young people with psychosis, and it holds the promise of mitigating loneliness even at a development phase. A positive psychology approach underpinning the content, as well as the use of engaging shared experience and actor videos, may have led to increased engagement of the program. Further developments are required to make expert videos more interesting and improve the opportunities for participants to interact with peers and, or trained moderators.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interests.

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