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Guest Editorial

Vol 2 Issue 1 – Welcome to the issue

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Welcome to this second volume of *Northumbria Psychology Bulletin*, which showcases the outstanding research conducted by our Psychology students at all levels, both on campus, and remotely. Having returned to Northumbria University following a seventeen-year absence, I am struck by the transformation of the research infrastructure and culture during the intervening period. This bulletin is a perfect example of that upward trajectory in Psychology research excellence. The quality of papers in this volume is a testament to the staff and students in the School of Psychology, as is the range of subject matter and methodologies.

The papers in this issue include: a cross-sectional, quantitative investigation into the impact of gratitude writing (Wyre, 2025); an examination of the influence of atypical sensory processing on autistic and attention deficit hyperactivity disorder (ADHD) traits (Wilson-Dickson & Greer, 2025); a qualitative exploration of the efficacy of online mental health interventions (Husseini & Murphy-Morgan, 2025); and an assessment of the effectiveness of a brief checklist for mitigating attentional blindness in radiology (Lavender & Greer, 2025). Taken together these papers reflect both the methodological breadth and the applied aspects of our Psychology degrees. Each study also has clear benefits with respect to impact on, and engagement with, relevant communities. To echo the editorial from Volume 1 (Moss, 2024), it is particularly impressive that this bulletin exists because of continued student engagement beyond the degree. While there are institutional benefits from distinguishing our students with respect to research track record, clearly this bulletin stems from the intrinsic personal motivation to take self-initiated research ideas through to publication. I am sure that this volume will stimulate and engage readers and form part of a highly successful series.

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Research Article

Gratitude writing for positive and negative affect: moderation by life satisfaction

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Abstract

Gratitude writing interventions have been found to enhance wellbeing; however, these effects may not be equally effective for everyone. A moderator of interest is life satisfaction. The aim of this study was to explore the effects of a gratitude writing intervention on positive affect (PA) and negative affect (NA). The other aim of the present study was to explore the moderating role of life satisfaction on the effect of a gratitude writing intervention on PA and NA. A cross-sectional, quantitative design was employed. A convenience sample of 90 participants, aged over 18 from the general population, were recruited. Participants completed two self-report questionnaires: the Satisfaction with Life Scale to measure life satisfaction and the Positive and Negative Affect Schedule (PANAS) to measure PA and NA. Participants were randomised to a gratitude writing condition (n = 44), where they expressed gratitude to a person that had changed their life and wrote how that made them feel, or a control writing condition (n = 46), before repeating the PANAS. There was no significant effect found for the gratitude writing intervention on PA and NA, relative to the control condition. There was no significant effect found for the moderator of life satisfaction, possibly due to the length of the gratitude writing. This study demonstrates that further research is required into how life satisfaction moderates gratitude writing, and to assess under what conditions gratitude interventions are most effective. Studies should use a larger sample and a larger dosage.

Keywords: Gratitude, wellbeing, intervention, life satisfaction

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Introduction

Gratitude has been defined as a psychological construct that involves an individual acknowledging a benefit that they have received from an external source (Emmons & McCullough, 2003). Furthermore, gratitude can be conceptualised as a fleeting emotional state and as a trait (Wood *et al.,* 2008). Trait gratitude is the tendency that an individual experiences this state (Wood *et al.,* 2010). It has been positively correlated to life satisfaction, positive affect (PA), happiness, optimism, and hope, while being negatively correlated with negative affect (NA) and depression (McCullough *et al.,* 2002). State gratitude is defined as the momentary experience of thankfulness (Wood *et al.,* 2008). Like trait gratitude, it has been found to be positively correlated with life satisfaction and PA while being negatively correlated with depression and NA (Watkins *et al.,* 2003). Additionally, gratitude is classed as a social emotion that is commonly aroused after an individual has benefitted from another person's actions (McCullough *et al.,* 2001). Although it is possible for individuals to experience different types of gratitude, like for material goods and life events, it has several social implications such as developing interpersonal relationships (Algoe, 2012). Furthermore, it has been shown that expressing gratitude to another individual may be more impactful than just experiencing the gratitude and not expressing it (Kumar & Epley, 2018). In sum, it has been proposed that gratitude can affect wellbeing directly as a causal agent, or indirectly by lessening the negative emotions (Nelson, 2009).

Gratitude has been demonstrated to have effects on all aspects of wellbeing, including subjective wellbeing (Bono *et al.,* 2004). Subjective wellbeing has been proposed to have three distinct components: life satisfaction, PA and NA (Diener, 1984; Diener & Emmons, 1984; Froh *et al.,* 2009). This tripartite formulation is used to refer to how individuals experience and evaluate their lives, in either a positive or negative way (Diener *et al.,* 1999). Specifically, PA and NA can be used to assess the affective (feeling) side of subjective wellbeing and the mental health status of an individual (Diener *et al.,* 2015; Hu *et al.,* 2015). PA has been found to be positively related to life satisfaction (Gilman & Huebner, 2000), wellbeing (Lyubomirsky & Layous, 2013), and happiness (DeWall *et al.,* 2011). Whereas NA has been found to elevate the levels of depressive symptoms in non-clinical samples (Holmes & Pizzagalli, 2007) and increase anxiety (Watson *et al.,* 2011). The relationship between the two suggests that PA may mitigate the maladaptive effects of NA (Fredrickson *et al.,* 2000). Additionally, these specific domains of PA and NA have been found to be individually affected by interventions that evoke feelings of gratitude (Rash *et al.,* 2011; Pennebaker *et al.,* 1997; Cunha *et al.,* 2019). Gratitude interventions typically get an individual to express gratitude to accentuate the many benefits that gratitude has been demonstrated to have (Davis *et al.,* 2016). On the whole, gratitude interventions have been demonstrated to boost the affective components of subjective wellbeing (Shin *et al.,* 2020; Davis *et al.,* 2016; Dickens, 2017). Activities that can evoke gratitude includes writing a gratitude letter, a gratitude list, and more, which can have different effects on wellbeing.

A large selection of gratitude writing activities exist. Researchers typically direct an individual to express their gratitude to another individual who has significantly contributed to their wellbeing (Wood *et al.,* 2010). Gratitude lists, or gratitude journals, have been demonstrated to increase PA (Emmons & McCullough, 2003). A behavioural expression of gratitude is most commonly a gratitude letter, where participants are encouraged to express grateful feelings to others which leads to sustained wellbeing (Seligman *et al.,* 2005). Additionally, the letters do not need to be sent for an individual to experience the beneficial effects (Lyubomirsky *et al.,* 2011).

Several studies have explored the efficacy of these different gratitude interventions. It has been observed that different gratitude interventions have different effects on PA and NA. Specifically, they found that a gratitude letter increased PA to a greater extent compared to the other gratitude intervention conditions, including gratitude lists (Watkins *et al.,* 2003; Regan *et al.,* 2023). This could be due to the more open-ended nature of gratitude letters allowing participants to write more expressively, which has led to positive outcomes and a reduction in depressive symptoms (Booker & Dunsmore, 2017; Toepfer & Walker, 2009). However, gratitude letters have been found to instil a mixed emotional state, leading to feelings of guilt and indebtedness (Layous *et al.,* 2017; Hosaka & Shiraiwa, 2021). Overall, the evidence for the efficacy and reliability of writing gratitude letters is strong, with gratitude letter interventions being described as one of the most reliable gratitude-based positive psychology interventions (PPIs; Bolier *et al.,* 2013).

It has been demonstrated that PPIs are not equally effective for everyone. The positive-activity model found that a range of individual differences can moderate the effects of PPIs on wellbeing (Lyubomirsky & Layous, 2013). Moderators of PPIs can either be external or internal factors (Ng, 2015; Lyubomirsky *et al.,* 2011). For example, external factors like the dosage, or frequency, of PPIs influence the efficacy of PPIs, and if participants overdo an activity, then this can lead to hedonic adaptation (Lyubomirsky *et al.,* 2005). Additionally, taking part in multiple PPIs at the same time can lead to more benefits than utilising one activity (Parks *et al.,* 2012). PPIs that are administered in individual therapy sessions, under therapeutic guidance, are more effective than self-administered PPIs (Sin *et al.,* 2011). However, it is important to note that self-administered PPIs are still more effective at enhancing an individual's wellbeing compared to not using any PPIs at all (Sin & Lyubomirsky, 2009). There is also a selection of internal factors that may impact the efficacy of PPIs. Internal factors that have been demonstrated to influence the effect of gratitude interventions on aspects of wellbeing include personality, motivation, effort, and depression status (Senf & Liau, 2013; Lyubormirsky *et al.,* 2011; Sin & Lyubormirsky, 2009). Overall, it is clear that a large range of moderators exist for PPIs. Therefore, it is important to better understand how moderators can influence the acute effects of gratitude writing on wellbeing. This is needed to gain a clearer understanding of the optimal conditions under which these interventions can be applied and be the most effective.

A potential moderator of interest is life satisfaction; however, no studies have explored this as a moderator in relation to gratitude writing interventions. Previous research has suggested that there is a positive correlation between an individual's trait gratitude and life satisfaction (Kerry *et al.,* 2023; Hosaka & Shiraiwa, 2021). As previously discussed, the priming or experimental induction of gratitude leads to increased life satisfaction (Emmons & McCullough, 2003; Rash *et al.,* 2011). However, it is less certain whether gratitude interventions have a direct effect on life satisfaction (Kerry *et al.,* 2023). Further research has shown that a cyclical relationship between trait gratitude and life satisfaction exists, whereby increases in either one of these traits leads to increases in the other (Unanue *et al.,* 2019). Additionally, trait gratitude has been found to moderate the effects of a gratitude intervention on life satisfaction (Rash *et al.,* 2011). These findings have important implications for the role of life satisfaction in the wellbeing effects brought about by gratitude interventions. This question will be explored in the current study.

The aim of the present study was to explore the effects of a gratitude writing intervention on PA and NA. An additional aim was to explore the moderating role of life satisfaction on the effect of a gratitude writing intervention on PA and NA. It is hypothesised that: 1) the gratitude writing condition will be associated with a significantly greater increase in PA, between pre- and post-writing, relative to a neutral writing control condition; 2) the gratitude writing condition will be associated with a significantly greater decrease in NA, between pre- and post-writing, relative to a neutral writing control condition and 3) both effects will be moderated by life satisfaction, whereby the effects will persist only for higher levels of life satisfaction.

Method

Participants

An *a priori* power calculation was conducted using G*Power (version 3.1, Faul *et al.,* 2007) with 1 predictor of interest (IV*M) and 3 overall predictors (IV, M, IV*M). The minimum sample size needed to observe a medium effect size (f^2 = .15), was 89 participants at 95% power (α = .05). The final sample of 90 participants satisfied these requirements.

Participants could take part if they were aged 18 years or older, and were recruited from the general population via convenience sampling, between October 2024 and March 2025. The study was advertised using social media (Facebook and Instagram). This study received full ethical approval from the Northumbria University School of Health and Life Sciences Research Ethics Committee. All participants provided electronic informed consent.

Measures

Participants completed the Satisfaction with Life Scale (SWLS; Diener *et al.,* 1985) which is a five-item self-report measures which assesses life satisfaction. Example questions include "*in most ways my life is close to ideal*" and participants are asked to what extent they agree with each statement. Scores range from 5 to 35, where high scores indicate greater life satisfaction. The SWLS has good psychometric properties: the SWLS has good construct reliability (α = 0.85) and good convergent and discriminant validity (Diener *et al.,* 1985; Beuningen, 2012).

Participants also completed the Positive and Negative Affect Schedule (PANAS; Watson *et al.,* 1988) as a measure of PA and NA. The PANAS has two 10 item subscales (assessing PA and NA respectively). A higher score indicates greater PA or NA. The PANAS has been used in previous gratitude intervention studies (e.g., Cunha *et al.,* 2019; Fekete & Deichert, 2022) and has good psychometric properties: it has sufficient construct reliability (PA scale: α = .89; NA scale: α = .85) and good convergent and discriminant validity (Watson *et al.,* 1988; Crawford & Henry, 2004).

Writing Activities

The gratitude writing activity was adapted from Seligman (2011). Participants in the gratitude condition were instructed to think of the face of someone that changed their life for the better and to then write a letter to them about how they changed their life and how it made them feel. The control writing activity was adapted from O'Connell *et al.* (2017). Participants were instructed to think of an old friend that they have lost touch with, and to write a letter to them updating them on the events that since happened (*Supplementary Materials*).

Procedure

This study was pre-registered with the Open Science Framework (https://osf.io/vjczg). This study was completed online using Qualtrics XM (Qualtrics, Provo, UT).

Before completing the study, participants were not informed that the focus of this study was on gratitude writing, or the potential benefits of such techniques. Participants were simply informed that the aim of the study was to explore the effects of reflective writing. This was done to reduce demand characteristics, which are problematic in this area of research (Dickens, 2017).

Participants were asked to state their gender (male; female; other, please specify; prefer not to say) and age in years, before completing the SWLS and PANAS. Participants were then randomised (using the randomiser function on Qualtrics) to either the gratitude writing condition or the control condition. Participants were required to spend at least 10 minutes on their assigned writing activity and were not able to move onto the next activity until 10 minutes had elapsed. Participants then

completed the PANAS again. Two attention check questions were embedded before and after the condition, to ensure that participants were paying attention to the questions.

Data analysis

All data analyses were conducted using SPSS (Version 29; IBM Corp., Armonk, NY, USA). Any participants who met exclusion criteria, but ignored information telling them not to take part, were removed along with any extreme outliers (defined as deviations greater than 3.24 standard deviations from the mean). Extreme outliers were removed because a *z*-score of 3.24 equates to a probability of 0.5% or less of that value falling under the normal distribution. The removal of extreme outliers has been demonstrated to significantly increase accuracy and reduce errors of inference (Osborne & Overbay, 2004).

Also, if more than two values were missing from a subscale, or they had not completed the study, then they were removed. However, if only one value was missing from the subscale, then the mean of the other values in the subscale were calculated. This number was then rounded to the nearest whole number and imputed for the missing value. All categorical variables were dummy coded. Scores were then calculated for the SWLS and pre- and post-intervention PA and NA subscale scores. A change of scores was computed between the pre-and post-intervention PA and NA scores by subtracting pre-PA and NA from post-PA and NA. Assumption tests for moderation analysis were run. Analysis was run with and without any identified outliers. If the *p*-value significance was not affected; then the participants were left in the dataset for final analysis. All other assumptions were met.

Moderation analysis was conducted using SPSS PROCESS Model 1 (Version 4.1; Hayes, 2013). Means were centred for all variables that define products. Separate models were computed for the PA and NA change scores. Hypothesis 1 was tested by investigating the significance of the effect of condition on PA. Hypothesis 2 was tested by investigating the significance of the effect of condition on NA. Hypothesis 3 was tested by investigating the significance of the interaction effect in both models. An *a priori* decision was taken (before analysis) to only probe simple slopes if any findings were significant. Means and standard deviations were calculated for the participants age as a whole cohort and for the individual conditions. Results were considered to be statistically significant if *p*-values < .05.

Results

The total number of responses was 135. A total of 44 participants left the study when they reached the writing task, and 1 participant violated the exclusion criteria. Overall, 45 participants were removed from the sample because they demonstrated a lack of

adherence to the task instructions. Data analyses were conducted on a final sample of 90 participants with complete data (Figure 1).

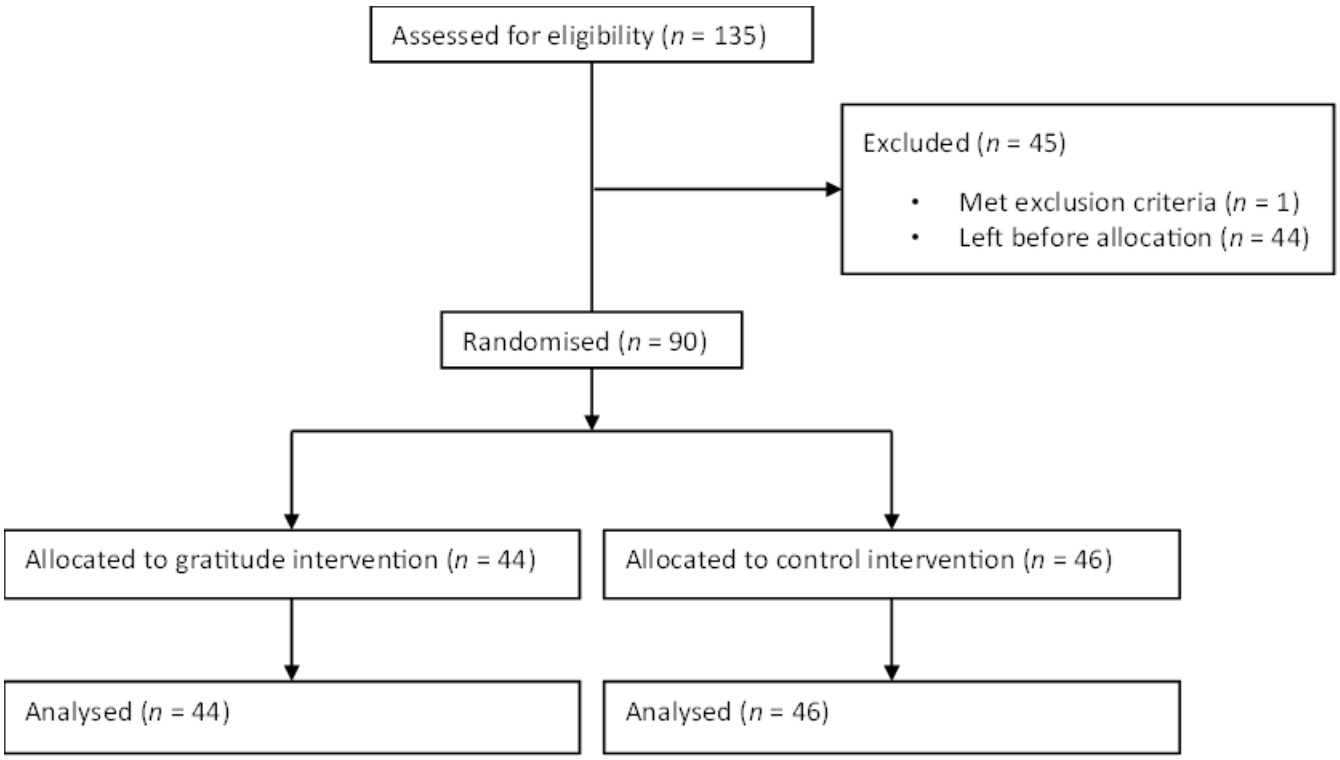

Figure 1: *Participant flow*

The overall cohort contained 90 participants (male = 26, female = 63, non-binary = 1), with a mean age of 26.40 years (SD = 11.66 years). There were 44 participants in the gratitude writing condition (male = 14, female = 30; M_{age} = 26.10 years; SD_{age} = 10.10 years). There were 46 participants in the control writing condition (male = 12, female = 33; M_{age} = 26.90 years; SD_{age} = 12.46 years). Descriptive results of sample characteristics can be found in Table 1.

Table 1: Gender characteristics of participants (*n* = 90)

	Gratitude (*n* = 44)	**Control (*n* = 46)**	**Full sample**
Female (n, %)	30 (68.2)	33 (71.7)	63 (70.0)
Male (n, %)	14 (31.8)	12 (26.1)	26 (28.9)
Non-binary (n, %)	0 (0)	1 (2.2)	1 (1.1)

Positive Affect

The first moderation analysis examined the influence of gratitude writing on positive affect and whether life satisfaction moderates the relationship between gratitude writing and positive affect (Figure 2). The model was able to account for 1.8% of the variance in PA score and was not significant (R^2 = .02, $F(3,86)$ = .51, p > .05; Table 3).

Of the individual predictors, neither life satisfaction (B = -.074, $t(86)$ = .60, p > .05) nor the condition (B = .79, $t(86)$ = 1.09, p > .05) were significant. Overall, there were no significant effects found in the analysis.

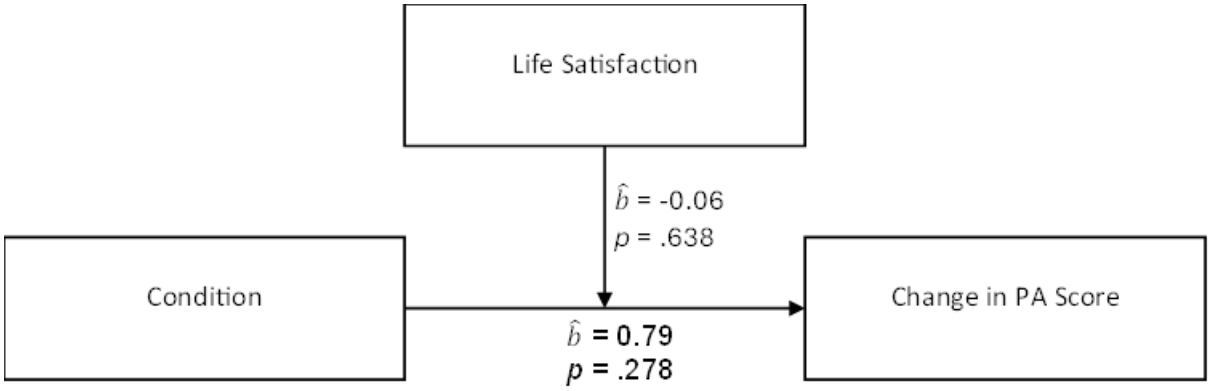

Figure 2: *Simple Moderation Model with Life Satisfaction Effect as a Moderator for Condition Effect on PA Change*

Table 2: Life Satisfaction Effect on Condition Effect on PA Change

	B	SE B	t	*p*
Constant	1.00 [-.44, -.01]	.72	1.39	.17
Condition	.79 [-.65, 2.23]	.72	1.09	.28
SWLS	-.07 [-.32, .17]	.12	-.60	.56
Condition × SWLS	-.60 [-.31, .19]	.13	-.47	.64

SWLS = Satisfaction with Life Scale

Negative Affect

The second moderation analysis examined the influence of gratitude writing on negative affect and whether life satisfaction moderates the relationship between gratitude writing and NA (Figure 3). The moderation model was able to account for

.97% of the variance in NA score and was not significant (R^2 = .10, $F(3,86)$ = .29, p > .05; Table 4). Of the individual predictors, neither life satisfaction (B = .06, $t(86)$ = .61, p >.05) nor the condition (B = -.46, $t(86)$ = -.75, p > .05) were significant. Overall, there were no significant effects found in the analysis.

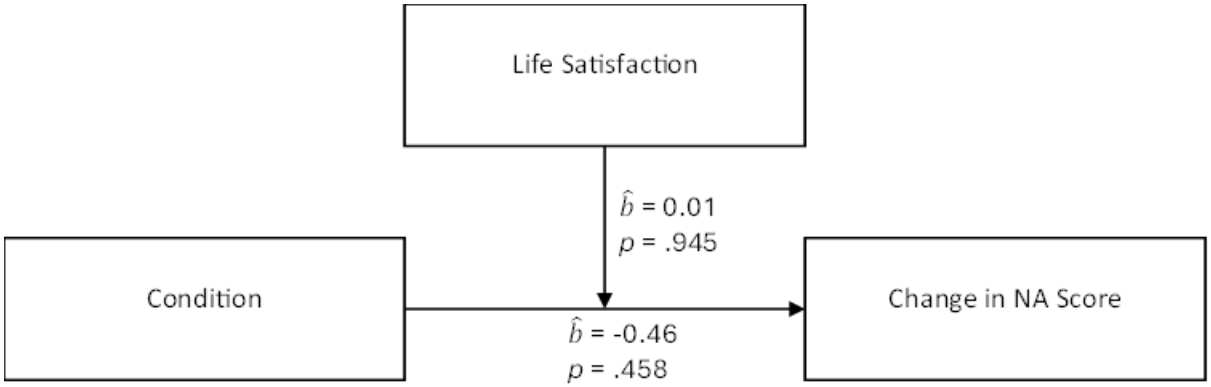

Figure 3*: Simple Moderation Model with Life Satisfaction Effect as a Moderator for Condition Effect on PA Change*

Table 3: Life Satisfaction Effect on Condition Effect on NA Change

	B	SE B	t	p
Constant	-1.30 [-2.52, -.09]	.61	-2.14	.04
Condition	-.46 [-1.67, .76]	.61	-.75	.46
SWLS	.06 [-.15, .27]	.11	.61	.55
Condition × SWLS	.01 [-.20, .22]	.11	.07	.95

SWLS = Satisfaction with Life Scale

Discussion

The aim of this study was to explore the effects of a gratitude writing intervention on PA and NA. The second aim, was to explore the moderating role of life satisfaction on the effect of a gratitude intervention on PA and NA.

Overall, there was not a significant increase in PA between pre- and post-writing. This result was not expected as it disagrees with the previous literature. It is proposed that expressing positivity enhances positive affect (Ruch, 1993; Harker & Keltner, 2001) and this is supported by extensive data (Seligman *et al.,* 2005; Lambert *et al.,* 2010;

Sheldon & Lyubomirsky, 2012). This has been demonstrated specifically with gratitude interventions (Emmons & McCullough, 2003; Stone *et al.,* 2022). Studies typically employ a larger dosage of gratitude interventions, in which they completed multiple gratitude letter writing activities, or spent more time writing the letters (Boehm *et al.,* 2011; Seligman *et al.,* 2005). The dose of an intervention is one of the most well-established treatment moderators in psychology (Howard *et al.,* 1986). This could be why the present study did not corroborate with the previous literature. Future research should take this into account by including more time for participants to write their letter for more pronounced effects. Additionally, a longitudinal study over a larger number of weeks may also increase the efficacy of the gratitude letter.

Secondly, the analysis did not find a significant reduction of NA between pre- and post-writing. This result was not wholly unexpected as previous research is more mixed when it comes to the effects of gratitude interventions on NA. No significant differences for gratitude interventions effect on NA versus a neutral control have been found (Dickens, 2017). This could be because previous literature has found that writing gratitude letters can instil a mixed emotional state (Layous *et al.,* 2017). Furthermore, participants have reported feeling a sense of indebtedness, shame, and guilt when writing a gratitude letter to someone important in their life, potentially increasing NA, as opposed to lowering it (Oishi *et al.,* 2019; Walsh *et al.,* 2022). However, it has also been found that a gratitude letter could decrease negative affect (Toepfer *et al.,* 2012; Tolcher *et al.,* 2024). It is unclear what directly causes these differences. This could be because some individuals do not enjoy gratitude letter interventions. For example, Smith *et al.* (2025) found that participants found it discomforting to write about their emotions and unfamiliarity with the writing task could make it difficult to complete. It could also be one of the many other moderators affecting the efficacy of gratitude interventions such as personality or dose (Senf & Liau, 2013; Lyubomirsky *et al.,* 2005). Further research is necessary to understand how to reduce NA in the general population when utilising gratitude interventions. For example, controlling for feelings of indebtedness could see a reduced NA (Hosaka & Shiraiwa, 2021).

Finally, no significant moderation effects were observed in either model. This means that the hypothesis that life satisfaction would moderate the effects of gratitude letter writing, whereby the effects would only persist for higher levels of life satisfaction, was rejected. The reason for this could be that the present study did not find a significant relationship between life satisfaction and PA or NA. This is not corroborated with previous literature that did find a significant relationship between the two variables (Busseri, 2018; Jovanović & Joshanloo, 2022). Studies exploring the relationship were typically done with much larger sample sizes compared to that of the current study (Busseri, 2018; Jovanović & Joshanloo, 2022). Therefore, it could be assumed that the relationship between life satisfaction and PA and NA is more nuanced. As this was the first study to examine the moderating effect of life satisfaction on this relationship, it may be of interest to explore this relationship with a larger sample size and smaller effect size to draw any definitive conclusions.

A number of limitations of the present study need to be noted. Firstly, even though the questionnaires utilised displayed good reliability and validity, problems could arise from their usage. Self-reported data may be affected by social desirability bias (Nederhof, 1985), especially as the activities used had a social aspect and could have led to negative feelings or embarrassment (Oishi *et al.,* 2019; Walsh *et al.,* 2022; Smith *et al.,* 2025). This might mean that participants did not complete the repeated PANAS truthfully, or did not interact with the intervention as expected, due to feeling embarrassed (Krumpal, 2013). Previous literature has found that when social norm beliefs are altered to be more favourable towards gratitude PPIs, they are more effective (Layous *et al.,* 2012). This was done by participants reading peer testimonials explaining the benefits of PPIs. Although this could be due to an increased belief in PPIs, it is equally likely that it shifted the participants social norms (Kaczmarek *et al.,* 2014). The current study had no such peer testimonials that could shift these norms and allow the participants to write more openly, which could have led to more truthful responses to the repeated PANAS, and allow the intervention to have more success. Future research should explore this effect further to reduce social desirability bias amongst individuals taking part in gratitude interventions.

Secondly, another limitation is the sample utilised in the present study was WEIRD (western, educated, industrialised, rich, and democratic; Henrich *et al.,* 2010), which significantly limits the generalisability of the current findings. This is due to solely recruiting participants using social media. This is an issue for the current study as only 12% of the world's population fit into the WEIRD category but can represent up to 80% of study participants (Azar, 2010). Studies specifically utilising PPIs have been found to follow this trend, with 78.2% of them focusing on a WEIRD sample; although it does seem to be improving, more work still needs to be done to improve applicability of PPIs (Hendriks *et al.,* 2019). Research has found that an individual's culture can affect the outcome of gratitude interventions. For example, it has been found that Eastern, collectivist cultures do not experience the same benefit from gratitude interventions as Western, individualist cultures due to their cultural perspective (Boehm *et al.,* 2011; Layous *et al.,* 2013; Shin *et al.,* 2020). Due to the online recruitment of the current study, anyone could have taken part, including those from different cultures, which could affect the results. In addition, the generalisability of the current study is severely limited. Therefore, future research is necessary to further examine the relationship between culture and its effects on gratitude intervention outcomes.

A further limitation of the present study was the small sample size. An *a priori* power calculation showed that 89 participants were required to detect a significant medium effect. This effect size was chosen due to the feasibility of being able to recruit enough participants within the timeframe of the present study. However, it was known that the more subtle effects of a gratitude writing intervention may not have been detected. A small effect size has been used in a wide range of previous literature utilising gratitude interventions (Davis *et al.,* 2016; Dickens, 2017). Therefore, future research should seek to recruit a larger sample to observe a significant small effect.

Despite these limitations, the present study does have some advantages. For instance, the study and recruitment were completed online. This allowed for the collection of the required sample size quickly and at no cost (Jones *et al.,* 2008). Additionally, completing a gratitude letter intervention electronically has been demonstrated to have the same effects as physically writing a letter, therefore it is acceptable to administer the intervention in this manner without suffering a loss of effect (Hosaka & Shiraiwa, 2021; Allen *et al.,* 2020). Overall, the use of online gratitude interventions should be considered for future studies due to its benefits.

The findings from the current study may have several implications for future research directions. Mainly, it demonstrates that further research is necessary into what dosage of gratitude interventions bring about a significant effect. Although studies with larger dosages, in which participants complete more interventions over a larger timespan, have demonstrated a significant effect on wellbeing and life satisfaction (Boehm *et al.,* 2011; Walsh *et al.,* 2022). There is also a selection of evidence that did not find a significant difference between expressed gratitude and control groups in life satisfaction (Froh *et al.,* 2009; Berger *et al.,* 2019). It has been proposed that this is due to the increased frequency of the gratitude interventions (Kirca *et al.,* 2023). This then leads to some participants perceiving the gratitude interventions as excessive and inhibiting the effects of gratitude interventions on life satisfaction (Renshaw & Hindman, 2017). This demonstrates that '*more is better*' is not the case and can lead to hedonic adaptation (Lyubomirsky *et al.,* 2005). Although in the present study, the intervention may have been too short, future research should determine at what point an intervention becomes excessive to participants. This shows that the underlying relationship between gratitude interventions and life satisfaction still requires further research into the direction of their relationship. Research should also investigate what dose provides the best efficacy, as there is evidence for a small dose, as well as a large dose, having no effect (Kirca *et al.,* 2013). Focusing on this relationship could provide a link between all aspects of the present study. For example, if the dose can provide a significant effect, then this could increase PA and provide the significant relationship to life satisfaction as is seen in the previous literature. This would then be able demonstrate whether life satisfaction can act as a moderator on gratitude interventions. If life satisfaction was shown to act as a moderator for gratitude interventions, then it could lead to the development of more effective and personal gratitude interventions to boost an individual's wellbeing.

In conclusion, the current study examined the effect of a gratitude letter on PA and NA. It also explored the moderating effect of life satisfaction on the relationship between a gratitude letter intervention and PA and NA. The hypotheses were not met, as the gratitude letter intervention did not affect PA or NA. Additionally, life satisfaction did not moderate the relationship between the variables of interest. This study adds to the growing body of research into PPIs and their efficacy. As this was the first study to investigate the moderating effect of life satisfaction on gratitude letter writing, future

research would be beneficial in examining this concept further by utilising a larger sample to observe a significant smaller effect size and a higher dosage.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

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Research Article

Autistic and ADHD traits and their relationships with atypical sensory processing and anxiety

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Abstract

Autism and attention deficit hyperactivity disorder (ADHD) frequently co-occur and show a positive correlation when examined as traits in the general population. Both are associated with anxiety, and Atypical Sensory Processing (ASP) may play a role in this relationship. A cross-sectional design was used to examine ASP as a mediator between autistic / ADHD traits and anxiety and explore the role of ASP in their shared variance. A total of 224 adults from the general population completed self-report surveys of ADHD traits, autistic traits, ASP, and anxiety. All measures correlated positively, and ASP was a partial mediator between autistic traits and anxiety and between ADHD traits and anxiety. In a partial correlation, ASP accounted for the majority of the shared variance between ADHD and autistic traits. Mediation of anxiety via ASP appeared to stem from the shared variance between ADHD and autism but not their unique variance. These results highlight the importance of considering ASP as a source of anxiety for those with higher autistic and ADHD traits. ASP is suggested as a transdiagnostic factor that may help explain the high co-occurrence of ADHD and autism. Areas for further research are discussed.

Keywords: autism, attention deficit hyperactivity disorder, sensory processing, anxiety

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Introduction

Autistic Spectrum Conditions (henceforth 'autism') and attention deficit hyperactivity disorder (ADHD) are neurodevelopmental conditions that frequently co-occur (Kotte *et al.,* 2013; Rong *et al.,* 2021). Both can be conceived of as clusters of personality trait extremes, which are positively correlated and normally distributed throughout the population (Li *et al.,* 2019; Lundin *et al.,* 2018; Panagiotidi *et al.,* 2017). Understanding conditions in this way allows for investigation into their interactions with various constructs in non-diagnostic samples.

An approach to understanding the co-occurrence of ADHD and autism, either as diagnosed conditions or sub-clinical traits, is to examine their commonalities. A review by Antshel *et al.* (2016) presents evidence from brain imaging, genetic, neurocognitive, and behavioural studies, showing a mixture of both overlap and specificity. For example, a neuroimaging study using resting-state Functional Magnetic Resonance Imaging (fMRI), identified shared structural differences between autistic and ADHD children in the right striatum/pallidum when compared to neurotypical controls, with further differences unique to each condition in other areas of the brain (Di Martino *et al.,* 2013). A genetic overlap appeared evident in both social-communication challenges and behavioural responses of reaction time, whereas weak correlations were observed between other sub-domains of autistic and ADHD traits (Pinto *et al.,* 2016). Finally, using event-related potential methodology to examine social cognition, both autistic and ADHD participants demonstrated an attenuated response to face stimuli, however this was observed at a later stage of emotion processing in the ADHD group (Tye *et al.,* 2014). These examples suggest it is plausible that mechanisms accounting for the overlap between ADHD and autism may be distinct from those accounting for each condition alone. Such evidence has led to calls for more studies to examine features that are transdiagnostic across both conditions (Mikami *et al.,* 2019). Two such shared features that may be involved in this overlap are anxiety and atypical sensory processing (ASP).

ASP refers to the atypical perception and modulation of sensory input and may include both heightened (hypersensitivity) and reduced (hyposensitivity) sensitivity across a range of sensory modalities (Robertson & Simmons, 2012). For instance, hypersensitivity to touch might cause certain sensations, such as the feeling of a clothing label against the skin, to be experienced as painful. Conversely, hyposensitivity to touch could result in stimuli that most people find painful going unnoticed. ASP is widely reported in autism, with some studies suggesting prevalence between 82% and 97% in autistic children (see Dellapiazza *et al.,* 2018 for a review). It is recognised as a core feature in autism diagnoses (American Psychiatric Association, 2013) and is correlated with autistic traits in those with and without a diagnosis (Mayer, 2016; Robertson & Simmons, 2012). Studies have also found evidence connecting ASP with ADHD (Delgado-Lobete *et al.,* 2020; Ghanizadeh, 2011; Little *et al.,* 2017; Mimouni-Bloch *et al.,* 2018) and traits of ADHD have been found to

correlate positively with ASP in adults in the general population (Panagiotidi *et al.,* 2018).

A limited body of research has examined ASP in relation to autism and ADHD together (Cheung & Siu, 2009; Dellapiazza *et al.,* 2021; Sanz-Cervera *et al.,* 2017; Scheerer *et al.,* 2024). In particular, Little *et al.* (2017) found higher ASP in both autistic and ADHD child groups compared to typically developing controls. Similar findings were observed in adults (Ohta *et al.,* 2020) and is further supported with resting-state fMRI research (Itahashi *et al.* 2020) which found distinct sensory processing profiles of functional connectivity that held across autistic / ADHD groups, regardless of diagnosis. Furthermore, neural correlates observed between the autistic and ADHD groups were selective to sensory related areas of the brain, thus supporting a picture of ASP as transdiagnostic in ADHD and autism.

Autism, ADHD, and ASP are all related to anxiety. A recent meta-analysis indicates an estimated 27% of autistic adults also have an anxiety disorder (Hollocks *et al.,* 2018). Similarly, 25% of those with an ADHD diagnosis are estimated to have a co-occurring anxiety disorder (D'Agati *et al.,* 2019). Associations between ADHD and anxiety continue into older adulthood (Michielsen *et al.,* 2013) and may be reciprocal, such that higher levels of either may exacerbate symptoms of the other (Murray *et al.,* 2020). ASP plays a role in anxiety for autistic people. A qualitative study involving young autistic adults and health professionals, described a range of perceived sources for anxiety in autism with a key theme relating to sensory issues (Trembath *et al.,* 2012). Furthermore, ASP is associated with the positive relationship between ADHD and anxiety. Reynolds and Lane (2009) compared ADHD children with and without sensory over-responsivity with typically developing children. They found significantly higher physiological and psychological anxiety in the ADHD group with sensory over-responsivity compared with both the ADHD group without and typically developing control groups.

Two causal models have been proposed linking autism, ASP (specifically sensory over-responsivity; SOR) and anxiety (Green & Ben-Sasson, 2010): the Primary Anxiety model and the Primary SOR model. The Primary SOR model, which has empirical support (Carpenter *et al.,* 2019; Green *et al.,* 2011), posits aversive sensory experiences create negative associations with places, situations, or objects; thus, anxiety develops though the anticipation of threatening experiences associated with these. Amos *et al.* (2018) tested both models using Structural Equation Modelling, examining stress, anxiety, autistic traits, and ASP in healthy adults. They found the best fit for the Primary SOR model, with stress and SOR fully mediating the relationship between autistic traits and anxiety. However, model fit overall was poor for both models. To date, we are unaware of any equivalent studies examining ASP mediating anxiety in relation to ADHD severity or traits. Simultaneous examination of ADHD traits, autistic traits, ASP, and anxiety may help shed light on their relationships. More specifically, examining the role of ASP (both hypersensitivity and hyposensitivity) in the overlap

between ADHD and autistic traits, may illuminate how and why these traits / conditions are related. In addition, understanding sources of anxiety is of importance for supporting the wellbeing of both clinical and sub-clinical populations.

Using quantitative analysis of self-report measures in a general population sample, the aims of this study are: (a) to determine whether ASP partially mediates the relationship between autistic traits and anxiety; (b) to determine whether ASP partially mediates the relationship between ADHD traits and anxiety; and (c) to understand the role of ASP in the shared variance between traits of ADHD and autism, and how this relates to anxiety. In respect of aims (a) and (b), it is hypothesised that the levels of anxiety that correlate with ADHD traits and autistic traits will be partially mediated by ASP. In respect of research aim (c), it is expected that a proportion of the shared variance between ADHD and autistic traits will be accounted for by ASP. Further, it is expected that ASP will play a role in mediating between this shared variance and anxiety.

Method

Participants

The sample consisted of 277 participants. The required sample size for this study was based on *a priori* power calculations for the mediations. These were run using a web-based application (https://schoemanna.shinyapps.io/mc_power_med/; Schoemann *et al.,* 2017) which indicated that a minimum of 162 participants were required to achieve power of 80%. Participants were recruited online using social media and using the Northumbria University Department of Psychology research participation pool management software (Sona Systems; www.sona-systems.com). Participants recruited using Sona Systems received credits for completing the study. No other incentives were offered. To avoid selection bias, study adverts did not mention autism or ADHD. Participants were required to be 18 years or older and have self-reported normal hearing and vision. There were no additional exclusion criteria for this research study. The study was approved by the Faculty of Health and Life Sciences Ethics Committee at Northumbria University (ref: 49736). All participants provided informed consent.

One hundred and seventy-three participants (77%) identified as female, 50 (22%) as male and one (<1%) as Genderqueer. Ages ranged from 19 to 79 years (M_{age} = 44.51 years, SD_{age} = 13.37 years). One hundred and eighty-three participants had a highest education level of a degree or above (82%), 29 (13%) had reached A-level or equivalent, and 12 (5%) had a GCSE or equivalent. Seven participants (3%) reported a diagnosis of ADHD, 5 (2%) of autism and 62 (28%, including 3 of the participants with autism and 4 of the participants with ADHD) had other mental health diagnoses.

Measures

Participants completed the Broader Autism Phenotype Questionnaire (BAPQ; Hurley *et al.,* 2006), which is a 36-item measure of personality dimensions characteristic of autism. Example questions include "*I like being around other people*" and it is scored on a 6-point Likert scale (ranging from 1 ("*very rarely*") to 6 ("*very often*")). The BAPQ has been used to examine autistic-like traits in the general population and demonstrates good reliability for its three scales of *aloofness* (α = .89), *pragmatic language* (*α* = .76) and rigidity (*α* = .84; Ingersoll *et al.,* 2011). An excellent combined internal consistency of *α* = .94 was found in our sample.

Participants also completed the Adult ADHD Self-Report Scale (ASRS; Adler *et al.,* 2006) which measures ADHD-associated traits. The ASRS has 18 items and captures frequency of symptoms, for example ("*how often do you feel restless or fidgety*?"), using a 4-point Likert scale. The ASRS demonstrates good internal consistency for the *inattention* (*α* = .77) and *hyperactivity* (*α* = .74) sub-scales and good overall reliability (*α* = .83) for the combined items (Panagiotidi *et al.,* 2018). An excellent combined internal consistency (*α* = .91) was found in our sample.

Participants completed the Glasgow Sensory Questionnaire (GSQ; Robertson & Simmons, 2012), which measures hypersensitivity and hyposensitivity to stimuli across 7 sensory modalities (vision, audition, gustation, olfaction, touch, balance and proprioception). Participants are asked to respond to 42 items, such as "*do you find certain noises/pitches of sound annoying*?" with a 5-point scale of 1 ("*never*") to 5, ("*always*"). The GSQ has excellent internal consistency (*α* = .93; Panagiotidi *et al.,* 2017), with comparable consistency (*α* = .94) observed in our study.

Subjective anxiety was measured using the 7-item General Anxiety Disorder Scale (GAD-7; Spitzer *et al*., 2006). Respondents are asked to rate symptoms over the previous two weeks, such as ("*feeling anxious or on edge*") on a scale from 0 ("*not at all*") to 3 ("*nearly every day*"). The GAD-7 has good internal consistency (*α* = .85; Hinz *et al.,* 2017) in the general population and an excellent internal consistency (*α* = .92) was observed in our sample. Higher scores on all the above measures indicate higher levels of the underlying construct. Scores for each measure were calculated based on published methods.

Procedure

Participants completed an online study using Qualtrics XM (Qualtrics, Provo, UT). Participants completed demographic questions and the BAPQ, ASRS, GSQ and GAD-7, before they were provided with a debrief and further information and support.

Data analysis

Data were analysed using SPSS (Version 27.0, IBM Corp., Armonk, NY). Partial responses were removed, data was visually inspected for task engagement, checks were performed for normality, and scatterplots were generated to identify outliers. Scores were calculated for all subscales and totals for each measure. No outliers were found which affected the direction of relationships.

Descriptive statistics were generated and bivariate correlations conducted on the total scores for each measure of ADHD traits, autistic traits, ASP, and anxiety. Correlations of sub-factors for each measure were also investigated, to ensure the direction of relationships was consistent. Group differences were checked using *t*-tests or Mann-Whitney *U*-tests, as appropriate and correlations re-run controlling for confounds. To assess the extent to which the relationship between ADHD traits and autistic traits can be accounted for by ASP, partial correlations were run and compared, both with and without ASP as a control variable.

In the last stage of the analysis, suitability of the data for bootstrapping mediation was tested and mediations were run using SPSS PROCESS Model 4 (Hayes, 2013), with 10,000 bootstrapped samples and 99% confidence intervals (CIs), to allow for multiple comparisons. For the first two mediations, the variables of autism and ADHD traits were the main predictors, with ASP as the mediator and anxiety as an outcome. Then, since it is not possible to directly test mediation of the shared variance between two predictors, the unique variance of autistic traits was tested by controlling for ADHD traits within the mediation, and the unique variance of ADHD traits was tested by controlling for autistic traits. These results were compared to those for the basic mediations. Age was entered as a covariate in all analyses. Variance Inflation Factors for all the regressions were equal to 1, suggesting multicollinearity was not an issue.

Z-scores for Skew were outside of the range for a normal distribution for the GSQ total and its hyposensitivity and hypersensitivity subscales, and for the GAD-7 (Kim, 2013). On this basis, non-parametric analytical methods were used as appropriate.

Results

Fifty-three participants were excluded due to incomplete responses, leaving 224 complete responses for analysis. Using the self-report cutoff scores for males and females (as suggested by Sasson *et al.* (2013)), 67 participants (30%: 9 males, 1 genderqueer, and 57 females) were at, or above, the normative score for the Broader Autistic Phenotype (BAP). According to the ASRS, 77 participants (35%) had symptoms highly consistent with adult ADHD (Adler *et al.,* 2006) that might warrant further investigation if used clinically. Thirty-seven participants (17%) scored above both the BAP cutoff and ASRS screener. Descriptive statistics for the main research variables are provided in Table 1.

Table 1: Descriptive statistics (n = 224).

	Mean	SD	*Z* skew	*Z* kurtosis
ASRS Total	33.05	12.39	3.08	-0.37
BAPQ Total	107.42	26.17	3.32	1.38
GSQ Hypo	20.20	11.61	4.03[a]	1.52
GSQ Hyper	25.77	13.87	4.91[a]	0.57
GSQ Total	45.97	24.14	4.25[a]	0.92
GAD-7 Total	6.78	5.61	4.55[a]	-1.31

Abbreviations: ASRS: Adult ADHD Self-Report Scale; BAPQ: Broader Autism Phenotype Questionnaire; GSQ: Glasgow Sensory Questionnaire; GAD-7; 7-item General Anxiety Disorder Scale; SD: Standard Deviation
[a]: Standardised Skew values outside of the normal range according to sample size (Kim, 2013).

Bivariate Spearman correlations were calculated for the main research variables (in Table 2). As hypothesised, all variables measuring self-reported ADHD traits, autistic traits, ASP and anxiety, were positively correlated with one another, and significant (all *p*-values < .001).

Table 2: Correlations (Spearman rho) for main research variables (n = 224)

	BAPQ Total	GSQ Hypo	GSQ Hyper	GSQ Total	GAD-7 Total	Age (years)
ASRS Total	.52***	.62***	.66***	.68***	.62***	-.27***
BAPQ Total	-	.57***	.58***	.60***	.51***	-.27***
GSQ Hypo		-	.79***	.94***	.49***	-.22***
GSQ Hyper			-	.95***	.56***	-.20***
GSQ Total				-	.56***	-.22***
GAD-7 Total					-	-.26***

Abbreviations: ASRS: Adult ADHD Self-Report Scale; BAPQ: Broader Autism Phenotype Questionnaire; GSQ: Glasgow Sensory Questionnaire; GAD-7; 7-Item General Anxiety Disorder Scale
Note: *** $p < .001$

Correlations were all in the moderate range, with the strongest between the ASRS and the GSQ total scores ($r(222) = .68$, $p < .001$). This was marginally stronger than the relationship between the BAPQ and GSQ total, ($r(222) = .60$, $p < .001$). The ASRS also showed the strongest correlations with the GAD-7, ($r(222) = .62$, $p < .001$), compared to a slightly weaker moderate correlation between the BAPQ and GAD-7, ($r(222) = .51$, $p < .001$). Both the hyposensitivity and hypersensitivity subscales of the GSQ were strongly positively correlated with each other and moderately positively correlated with the other measures, suggesting they are both measuring the same underlying construct. Thus, only the total measure was considered from this point forward.

Correlations between the sub-factors of all measures, including all sensory modalities of the GSQ, were also positively correlated: ranging from weak (BAPQ aloof vs GSQ Olfactory subscales; $r(222) = .28$, $p < .001$) to moderate (BAPQ pragmatic language subscale vs. ASRS total; $r(222) = .67$, $p < .001$). It is of note that the latter correlation is stronger than the correlations between BAPQ pragmatic language and the other two BAPQ subscales (BAPQ aloofness ($r(222) = .57$, $p < .001$); BAPQ rigidity ($r(222) = .55$, $p < .001$)). A correlation matrix, including sub-factors, is provided (Supplementary Material 1).

Gender has been associated with ASRS scores (Adler *et al.,* 2018), ASP (Ujiie & Wakabayashi, 2015), and anxiety (Leach *et al.,* 2008), thus, independent sample *t*-tests were used to compare ASRS scores by gender. Mann-Whitney *U* tests used with the GSQ and GAD-7. A Bonferroni correction ($p < .017$) was applied to account for multiple comparisons, but none reached significance (all *p*-values ≥ .025); consequently, all data, irrespective of gender, were analysed together. Age has been shown to correlate with the GSQ (Panagiotidi *et al.,* 2017) and was included in our correlation matrix (Table 2). Age showed a weak negative correlation with all outcome variables, such that, as age increased, the average score on the ASRS, BAPQ, GSQ, and GAD all decreased. Consequently, the main correlations were re-run, controlling for age. All remained significant ($p < .001$) and were in the moderate range. Correlations of the main research variables were rerun, excluding all those with ADHD, autism or mental health diagnoses. All correlations remained significant *(*$p < .001$) and were in the moderate range; thus, all participants were included in the partial-correlations and mediation analysis.

To examine the proportion of shared variance between autistic traits and ADHD traits that is accounted for by ASP, two partial correlations were run and compared. The first examined the correlation between autistic traits and ADHD traits, controlling for age. A moderate positive correlation was observed, indicating that an increase in ADHD traits was associated with an increase in autistic traits ($r(222) = .48$, $p < .001$). Next, a partial correlation was run between autistic traits and ADHD traits controlling for both age and ASP. In the presence of ASP, the strength of the correlation was reduced to weak, although it remained significant ($r(222) = .16$, $p = .016$). In line with expectations, this

suggests ASP can account for the majority of the relationship between autistic traits and ADHD traits.

Mediations

To test our first hypothesis, we examined whether ASP partially mediated the relationship between autistic traits and anxiety (*Figure 1*). In line with expectations, autistic traits predicted ASP (*a* = 0.58, *p* < .001), which in turn predicted anxiety (b = 0.08, p < .001). The indirect effect (*ab* = .05) was significant (99% CI [.02, .08]). The direct effect (*c*' = 0.07) was also significant, (99% CI [0.03, 0.11]), indicating a partial mediation through ASP of approximately 41%.

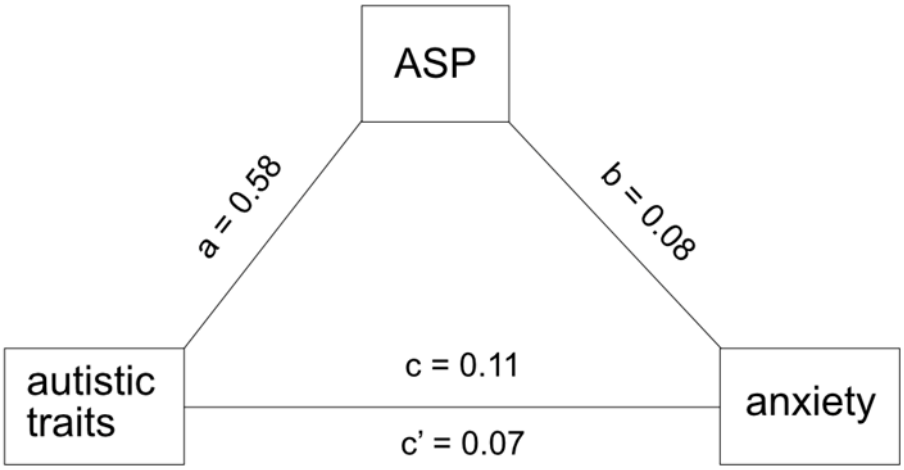

Figure 1: Atypical sensory processing (ASP) as a mediator between autistic traits and anxiety (*b* = unstandardised beta coefficients showing partial mediation; all coefficients are significant at *p* < .001).

To test the second hypothesis, we examined whether ASP partially mediated the relationship between ADHD traits and anxiety (*Figure 2*). As expected, ADHD traits predicted ASP (*a* = 1.33, *p* < .001), which in turn predicted anxiety (*b* = 0.06, *p* < .001). The indirect effect (*ab* = .08) was significant (99% CI [0.02, 0.15]). The direct effect (c' = 0.19) was also significant (99% CI [0.11, 0.28]). This indicates a partial mediation through ASP of approximately 29%.

To test our final hypothesis, the first mediation was re-run, with ADHD traits entered as a control variable (*Figure 3*). Autistic traits continued to predict ASP (*a* = .35, *p* < .001), but the path from ASP to anxiety was no longer significant (*b* = .03, *p* = .077). In this analysis, the indirect effect was no longer significant (99% CI [-0.01, 0.03]). The direct effect was significant (*c'* = .06; 99% CI [0.02, 0.09]). This shows that the unique

variance in the autistic traits, when controlling for ADHD traits, is not mediated by ASP but maintains a direct relationship with anxiety.

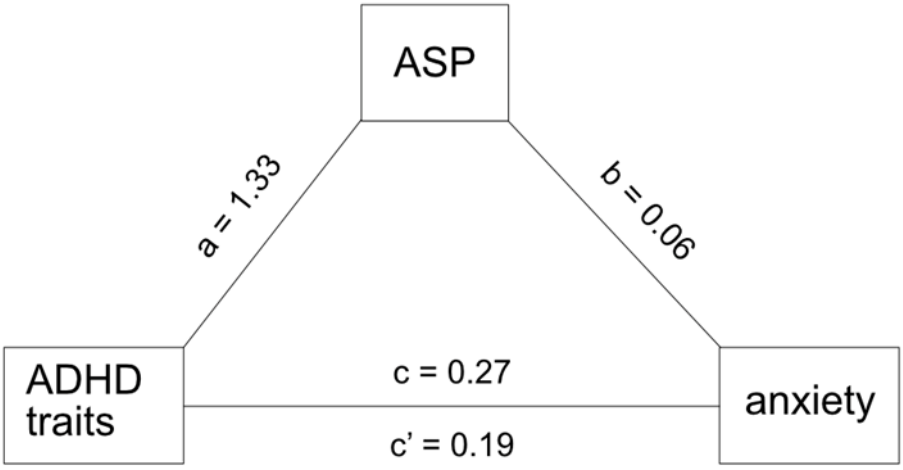

Figure 2: Atypical sensory processing (ASP) as a mediator between ADHD traits and anxiety (*b* = unstandardised beta coefficients showing partial mediation; all coefficients are significant at $p < .001$).

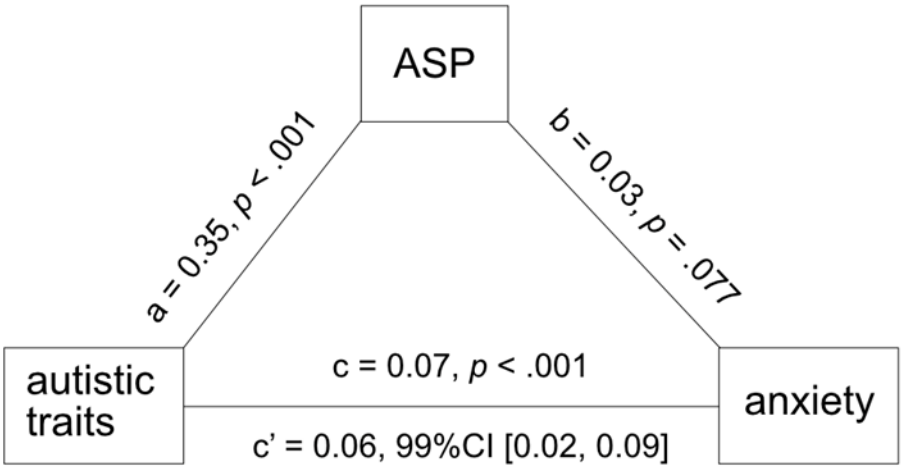

Figure 3: *Atypical sensory processing (ASP) as a mediator between ADHD traits and anxiety* (*b* = unstandardised beta coefficients).

Subsequently, the second mediation was also re-run, controlling this time for autistic traits (*Figure 4*). ADHD traits continued to predict ASP (*a* = .95, $p < .001$). However, ASP no longer predicted anxiety (*b* = .03, $p = .077$). Once again, adding the control variable meant that the indirect effect (*ab* = .03) was not significant (99% CI [-0.02, 0.09]). The only significant relationship between the variance unique to autistic traits

and anxiety was in the direct effect (*c'* = .17; 99% CI [0.09, 0.25]). Thus, the unique variance in ADHD traits, when controlling for autistic traits, is not significantly mediated by ASP but has a direct relationship with anxiety. In line with our hypothesis for research aim (c), these final two mediations suggest that the mediating effect of ASP on anxiety applies to the shared variance between autistic traits and ADHD traits, rather than their unique variance.

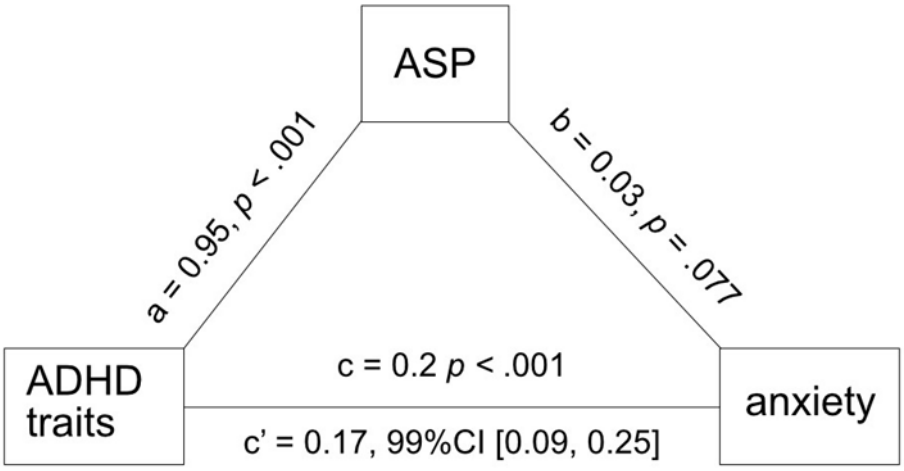

Figure 4: *Atypical sensory processing as a mediator between ADHD traits and anxiety, controlling for autistic traits* (*b* = unstandardised beta coefficients)

Discussion

This study had three main aims: (a) to test ASP as a mediator between autistic traits and anxiety, (b) to test ASP as a mediator between ADHD traits and anxiety and, finally, (c) to examine the role of ASP in the relationship between ADHD and autistic traits, including investigating ASP as a mediator between the overlap of ADHD / autistic traits and anxiety. All hypotheses testing these aims were upheld and the results revealed further insights into the relationships between the research variables.

In line with the first hypothesis, higher autistic traits were associated with higher anxiety, and ASP was a partial mediator of this relationship. This is consistent with literature suggesting that a proportion of the anxiety that co-occurs with autism may result from ASP (South & Rodgers, 2017; Trembath *et al.,* 2012). In the present study, mediation through ASP accounted for more than a third of the relationship between autistic traits and anxiety, indicating a substantial role for ASP in this relationship. These findings are consistent with Amos *et al.* (2018) who demonstrated sensory over-responsivity (hypersensitivity) as a mediator between autistic traits and anxiety. The current study extends these findings, to show that this relationship holds when combining measurements of hyposensitivity as well as hypersensitivity.

Our second hypothesis was also confirmed, with ASP also acting as a partial mediator between ADHD traits and anxiety. This novel finding highlights the importance of considering ASP in the context of the anxiety experienced by those higher in ADHD traits. It is consistent with research in children, suggesting those with ADHD plus sensory over-responsivity are more prone to anxiety than those with solely ADHD or typically developing controls (Reynolds & Lane, 2009). As with autistic traits, the mediation of anxiety is partial, highlighting that ASP is not the only variable connecting ADHD traits with anxiety.

It is interesting to note that, whilst the numbers diagnosed with ADHD or autism in our study were closer to population averages, the numbers at or above normative trait scores were higher. This is consistent with other studies that have found considerable ADHD symptom burdens in undiagnosed adults (e.g. Pawaskar *et al.,* 2019). Given both their association with anxiety and with other adverse health outcomes (Bishop *et al.,* 2019; McMorris *et al.,* 2018), our findings emphasise the extent to which neurodevelopmental differences may be affecting the wellbeing of substantial, but undiagnosed, proportions of the population. In addition to underscoring the need to explore interventions, this provokes a wider question around how we support and accommodate this diversity in workplaces, educational establishments and society in general.

A prerequisite of the analyses in this study was that all the main research variables would be positively correlated. This was found to be the case, replicating and extending findings from Robertson and Simmons (2012), and Panagiotidi *et al.* (2017; 2018). Positive modest correlations were apparent in subscales of both hyposensitivity and hypersensitivity in the GSQ. This supports other literature suggesting similar patterns of both hyposensitivity and hypersensitivity associated with ADHD and autistic traits (Little *et al.,* 2017; Ohta *et al.,* 2020). The strongest of the main correlations was between ASP and ADHD traits. This is consistent with findings from Ohta *et al.,* (2020) where similar or higher ASP was observed in their ADHD sample compared with their autistic sample. Given that ASP is now recognised as a core feature of autism (American Psychiatric Association, 2013), our findings lend weight to investigating ASP as a core feature of ADHD as well.

The final aim of this paper was the exploration of ASP in the relationship between autistic and ADHD traits. It was hypothesised that ASP would play a role in this relationship and in mediating between their shared variance and anxiety. A partial correlation was used to examine the extent to which ASP was involved in the association between ADHD and autistic traits. When compared to a correlation without controlling for ASP, it was apparent that the larger part of the relationship between ADHD and autistic traits could be accounted for by ASP. Furthermore, by controlling first for ADHD traits and then for autistic traits in the mediations, it was possible to analyse the variance unique to both autistic and ADHD traits. When doing this, only the direct effects of autistic and ADHD traits on anxiety remained significant. Thus, it

can be inferred that the anxiety being mediated by ASP, is associated, not with the unique variance, but with the variance that is shared between ADHD and autistic traits. Two important observations are consistent with these findings. Firstly, there are specific and distinct associations with anxiety that are unique to both ADHD and autism. Whilst these associations may be multiple and complex, they are associated separately with each neurodevelopmental condition. This upholds the conception of distinct elements unique to both conditions (Antshel *et al.,* 2016) and is evidence against hypotheses suggesting both ADHD and autism sit on a single, unidimensional continuum. Secondly, within the overlap between ADHD and autistic traits, there is a relationship with anxiety that is mediated by ASP. Together with the result of the partial correlation, this evidence suggests ASP as a transdiagnostic factor in ADHD and autism, that may substantially account for the relationship between them.

Genetic and other evidence suggest that the mechanisms accounting for autism and ADHD alone may be distinct from those accounting for their overlap (Antshel *et al.,* 2016). The centrality of ASP in this overlap, as evidenced in the present study, may be reflective of distinct underlying neural mechanisms. This is consistent with Itahashi *et al.*'s (2020) fMRI study which demonstrated that these areas of overlap are specific to sensory areas of the brain. Furthermore, Ohta *et al.* (2020) found white matter alterations in the corpus callosum that were similar in ADHD and autism and also related to ASP. This neurobiological evidence is consistent with evidence from this study, suggesting that the relationship between ADHD and autism may be connected to ASP.

A notable finding from the correlations of sub-scales in this study, was that the correlation between the BAPQ Pragmatic Language sub-scale and the ASRS, exceeded the intercorrelations between the three BAPQ subscales. Findings such as this emphasise the dimensionality of autistic and ADHD traits and pose a challenge to traditional diagnostic categories. A similar argument was made by Krakowski *et al.,* (2020), who found that scores of inattention and hyperactivity / impulsivity could not differentiate between children diagnosed as autistic and those with ADHD. They used this finding to argue for a framework that considers neurodevelopmental domains across diagnostic boundaries. The findings in our study support such an approach.

The evidence reported in this study should be considered in the light of some limitations. Firstly, all measures were based on self-report and as such will be vulnerable to certain biases (Stone *et al.,* 1999). However, the instruments used are validated and showed excellent reliability. Moving forward, studies combining self-report, observational and physiological measures would be useful to confirm the observed relationships. Care was taken to avoid selection bias, by not mentioning ADHD or autism in the recruitment material. However, people who completed and shared the survey may have referenced diagnostic labels. As is common in this type of research, the sample recruited in this study was weighted towards people identifying

as female. Future studies with a more representative selection of participants would increase confidence in the generalisability of these findings.

The mediation analyses run in this study are based on assumptions of a causal connection from higher autistic and ADHD traits to anxiety, both directly and via ASP. Although our findings are consistent with such a picture, they are purely correlational. More studies using longitudinal designs, particularly with adults, are needed to test the direction of these relationships. A number of further research possibilities flow from this study. As already mentioned, interventions targeted at the management of ASP are warranted in the general population for those with higher anxiety / ADHD or autistic traits. Current interventions for ASP in autism should also be explored in relation to ADHD.

In conclusion, this study adds important detail to our understanding of the relationships between ADHD traits, autistic traits, ASP and anxiety. Mediation analyses showed that the positive association between anxiety levels and both autistic and ADHD traits was partially mediated by ASP. Our second hypothesis was also supported, showing a comparable mediation of anxiety by ASP in relation to ADHD traits and highlighting ASP as a potential source of anxiety for adults with higher ADHD traits. It supports the case for considering ASP as a core component of ADHD and suggests interventions focused on ASP (such as Mindfulness Based Cognitive Therapy and Sensory Integration Therapy; Yuan *et al.,* 2022) merit exploration in adults with higher traits irrespective of diagnosis. Finally, our study showed that ASP could account for most of the association between ADHD and autistic traits. Furthermore, when ASP is acting as a mediator of anxiety, this mediation occurs in the variance that is shared between ADHD and autistic traits and is not significant in their unique variance. This suggests that the ASP that co-occurs with neurodevelopmental traits may be important to understanding the relationship between ADHD and autism. Further studies are warranted to explore how ASP may be involved in traits and mechanisms shared between these conditions.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

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Research Article

Exploring the experience and efficacy of online interventions for mental health: a qualitative study.

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Abstract

Remote care for a range of mental health needs is now increasingly offered using online support. Understanding the benefits and challenges of receiving remote mental healthcare, from the perspectives of individuals accessing support, is important for considering the development of future interventions. In this study, semi-structured interviews were conducted with 10 participants who were receiving two or more online mental health support interventions. Thematic analysis was used to identify patterns and gain meaningful interpretations of these experiences. These data revealed advantages and challenges regarding receiving online support for disorders such as anxiety and depression. Three key themes ('*accessibility of treatment*'; '*therapeutic process'*; '*options and choices'*) were identified, which related to the accessibility of online support, the therapeutic process with regards to the role of the therapist and expectations of the intervention recipient, and the individual options and choices. These results suggest that the increased availability of psychological interventions (through telephone and videoconferencing platforms), and establishing remote therapeutic relationships, contributes to the effective delivery of these services. In this study, participants considered online support to be largely advantageous, however, many participants had the view that online support should remain supplementary or act as a gateway to face-to-face support. Future mental health services could be improved by increasing options and the length of support where possible, as a 'hybrid' approach might allow for more flexibility and better meet individual needs.

Keywords: Mental Health, eHealth, digital healthcare

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Introduction

Mental ill health is increasing globally, with 2019 statistics suggesting that one in eight people currently live with a mental disorder (World Health Organisation, 2022). The COVID-19 pandemic subsequently saw a rapid rise in disorders such as anxiety and depression (World Health Organisation, 2022), but it also contributed to the change in how individuals accessed support services, forcing them to seek help remotely, as opposed to face-to-face support (Philippe *et al.*, 2022). Whilst attempts to digitalise mental health care in the UK had been initiated pre-pandemic (Ham, 2017), efforts escalated quickly, with the value of accessing digital mental health services highlighted within a post-pandemic society (Lattie *et al.*, 2022). The application of digital technologies enhanced mental health treatment by providing novel online services and improving established in-person formats (Bond *et al.*, 2023; Teachman *et al.*, 2022). Online interventions for psychological support proved to be particularly effective during this time (Ye *et al.*., 2022) as research concluded that interventions that were accessed online were effective (Zhou *et al.*, 2021). This included interventions for anxiety and depressive disorders (Luo *et al.*, 2020; Pescatello *et al.*, 2020; Andrews *et al.*, 2018) and reducing or removing potential barriers including cost, location, privacy and locality (Andrade et al., 2014).

Following the COVID-19 pandemic, psychological interventions continue to be crucial in helping problems such as anxiety and depression (van Agteren *et al.*, 2021). Digital interventions are becoming more accessible through self-help programmes, online group therapies, and video conferencing calls with a trained professional (Barak & Grohol, 2011). These types of interventions, which are also known as '*e-mental health'* interventions due to their availability and delivery through internet related technologies (Christensen *et al.* 2002), have become a useful and effective way to manage mental health conditions such as anxiety and depression (Johansson & Andersson, 2012). Modified versions of psychotherapy treatments including behavioural activation and mindfulness interventions became accessible digital options (Fairburn & Patel, 2017). Meta-analyses evidence the effectiveness of online treatment, such as for internet-based cognitive behavioural therapy (CBT; Andrews *et al.*, 2010; Andrews *et al.*, 2018). There is considerable evidence that internet-based self-help programmes are effective in both alleviating, and preventing, symptoms of mental ill-health (Edge *et al.*, 2023; Wang *et al.*, 2023).

With growing evidence of efficacious online options, alongside technological advancement, together with an increase in a variety of digital resources, online care may have the potential to overtake in-person support for specific patient groups (Crisp & Griffiths, 2014). Internet and mobile applications have provided access to coping strategies for stress, anxiety and depression and improved quality of life, particularly for young people (Zhou *et al.*, 2021). Current literature emphasises a particular interest in the experience of psychological service use for young people and university

students but is lacking for other age-related categories (Barnett *et al.*, 2021; Dederichs *et al.*, 2021; Holding *et al.*, 2022; Osborn *et al.*, 2024).

Current evidence suggests that platforms used and the processes by which people can gain support online are varied. For example, peer support groups and social networking sites like Facebook have shown to be beneficial (Prescott *et al.*, 2020) as have more structured types of intervention like guided self-help led by a primary care mental health worker (Falbe-Hansen *et al.*, 2009). Even for aspects of digitally delivered CBT which incorporate self-help, the process can vary. These programmes can provide various levels of guidance from a qualified clinician, or other professional, or can be self-led. Due to the range of treatment options and processes it is difficult to conclude which type of support is optimal (Farrand & Woodford, 2013). However, there are benefits that come with remote care, such as accessibility. For those unable to travel, struggling with physical impairments, or other difficulties with attending in-person meetings, remote care provides opportunities to access support (Liberati *et al.*, 2021). Delivering treatment online has also enabled more efficient communication, offering flexibility in the form of recorded support sessions which can be accessed and replayed at any time (Murphy-Morgan *et al.*, 2024).

However, with the exponential rise in the amount and variety of online mental health interventions, it is important to consider that several factors can influence experience and efficacy. Individuals may have safety and privacy concerns regarding online interventions and need online services that are engaging and accessible (Berry *et al.*, 2016; Garrido *et al.*, 2019) Accessible support pathways and addressing digital literacy barriers once individuals can access online support are crucial to ensuring appropriateness and efficacy of support (Memon *et al.*, 2016; Murphy-Morgan *et al.*, 2024). There is still some way to go in exploring online mental health interventions from the perspectives of individuals accessing support, how individuals themselves perceive the efficacy of online mental health interventions, and to what extent their expectations of online support are met through their direct experiences.

When considering online interventions, it is important to unpack the concept of recovery to further understand how this might be recognised and conveyed by the individual. Recovery alludes to personal independence and productivity within a meaningful life (Le Boutillier *et al.*, 2011). Attitudes of people who have experienced mental ill-health highlight the importance of time through recovery stages, as well as referring to this as being an ‘ongoing quest in life’ (Ventosa-Ruiz *et al.*, 2024) rather than a precise, achievable end result. This implies that recovery may be defined as a constant striving for, and reaching of, milestones to enable management of mental health issues. For improved patient self-care and recovery outcomes, there is a need for support providers and recipients to work towards a common goal with a shared understanding of what constitutes progress (Ventosa-Ruiz *et al.*, 2024). The concept of recovery is complex and multi-dimensional (Vera San Juan *et al.*, 2021) whilst the experience of it remains unique to the individual. For this reason, it is important that

each person has the opportunity to describe, in their own words, their recovery journey enable healthcare services to better tailor their support. It is therefore important to consider what recovery looks like in the context of online interventions, and to what extent the online experience is comparable to in-person support when it comes to aiding the recovery process. A scoping review of 15 papers suggested that online experiences have the potential for both the patient and service provider to work together on recovery-orientated goals, but that the quality of the therapeutic relationship is critical in online practice (Williams *et al.*, 2019). However, there is only limited literature considering how recovery is conceptualised specifically in the context of online support, and, given the rise in the number of mental health online interventions as already discussed, this warrants further investigation.

A systematic review showed that digital mental health intervention engagement and efficacy were strongly linked to past experiences. This suggests that people with positive past experiences are more likely to trust and benefit from online support, whereas those with negative experiences may find it harder to engage, as their expectations are shaped by those past experiences (Borghouts *et al.*, 2021). Whilst mental health web-based interventions provide benefits due to their accessibility and affordability, their users have reported a desire for human interaction, or to have the ability to contact a trained professional when they are needed (Ho *et al.*, 2024). This implies that purely digital applications (‘apps’) and resources may be a less effective solution for improving mental health. Alternatively, online peer-to-peer support groups have been shown to increase therapeutic benefits such as connection (Coulson *et al.*, 2017) whilst offering a safe environment which allows for the sharing of experiences, and for attendees to learn new mental health management skills, which might help to alleviate depressive symptoms (Smit *et al.*, 2021). It is suggested that online educational materials could be used in conjunction with therapeutic measures to increase the self-efficacy of people reporting mental ill-health (Koly *et al.*, 2022). This implies that online mental health support strategy is multi-faceted, and with both psychological and technological developments, there are different ways to deliver effective services.

Since no single strategy could effectively meet the needs of every person, one of the main considerations involves access to personalised support to gain treatment that feels truly meaningful for the individual. Encouragement of individual autonomy and the offer of choice throughout the process could be the key to achieving effective mental health support (Pretorius *et al.*, 2022). Empowerment of the help-seeker in this way is likely to have a profoundly positive impact on the success of the treatment received, regardless of the nature of it. In the quest to increase the efficacy of individual support services, there is potential for the development of new strategies using online platforms and digital tools, which would help to remove barriers and improve access to mental health support (Koly *et al.*, 2022).

Developing a better understanding of lived experiences of online mental health interventions from the perspectives of individuals with direct experience of receiving online mental health support has the potential to optimise future delivery of support by considering targeted and holistic solutions. Qualitative research provides a set of approaches to develop a deeper understanding of personal experiences in a real-world setting (Braun & Clarke, 2014; Cleland, 2017). Qualitative research is used to effectively access the thoughts and feelings (Sutton & Austin, 2015) of individuals in relation to their experiences. Carrying out interviews can provide invaluable insights into the emotions and behaviours of individuals (Braun & Clarke, 2014) and is useful for identifying recurrent themes (Braun & Clarke, 2006). Recent qualitative studies in this area have explored the attitudes of individuals in relation to their previous experiences of online mental health support, potential engagement barriers, and in their use of specific platforms (e.g. peer-to-peer support forums; Prescott *et al.*, 2020; Rayland & Andrews, 2023). Phenomenological approaches can allow for meaningful, rich data to be collected, however, data in the form of individual lived experience in relation to online mental health support services are currently limited. Lived experience is a crucial consideration that goes beyond academic knowledge and benefits future mental health advocacy and policy (Sunkel & Sartor, 2022). However, it could be particularly beneficial when exploring aspects of treatment such as accessibility (Bunyi *et al.*, 2021) and might be used to ensure that those who need help can get it (Kauer *et al.*, 2014). This can potentially contribute to understanding the experience and efficacy of interventions on a larger scale. The aim of this study was to explore the use of modern mental health support services by drawing on personal accounts.

Method

Participants

A total of 10 participants completed online interviews. Participants were aged 18 years or over, lived in the UK, and were currently receiving an online mental health intervention (that was defined as having experienced at least two sessions of this intervention). For safeguarding purposes, individuals were not eligible to take part if they had received in-hospital treatment for any mental health disorder within the last 6 months or if they were receiving help for substance misuse or dependency. Participants were recruited using social media (Facebook and Instagram).

This study was granted ethical approval by Northumbria University Research Ethics Committee (ref: 6169) and all participants provided electronic informed consent. Given the sensitive nature of the study, helplines and sources of support were made available to participants.

Procedure

For screening purposes, participants completed a pre-registration survey using Pavlovia (https://pavlovia.org/, Open Science Tools, Nottingham, UK). If eligible, participants provided consent using the survey platform and provided an email address so they could be contacted for interview. A final consent form was completed by each participant prior to interview. Video interviews were conducted using *Microsoft Teams*. Given the potentially sensitive interview topic, participants were given the option to stop the interview at any point if they did not want to continue and were also aware that they could withdraw from the study at any time. Participants were given the option of having their camera on or off.

Each semi-structured interview used an interview schedule consisting of 13 questions. The questions were organised into three sections: 1) the experience of the support received (example question: "*can you talk me through the most memorable parts of receiving that support*?"); 2) personal perspectives on the efficacy of online support (example question: "*has the quality of your life improved since the intervention and if so, do you think that was a consequence of the intervention*?") and 3) accessing help prior to the intervention (example question: "*did you feel as though there were barriers to seeking help and if so, what were they*?"). Interview questions were open-ended, and participants were given time at the end of the interview to share any additional thoughts.

Interviews were transcribed using *Microsoft Teams'* transcription feature, and *Apple Voice Memos* was used to ensure transcription accuracy.

Data analysis

Ten final interviews resulted in data saturation. Interviews were analysed using a six-stage reflexive thematic analysis (Braun & Clarke 2006; 2019). This began with data immersion, reading and re-reading the scripts, and making initial notes about the common concepts (Stage 1), before formulating and systematising initial codes (Stage 2). Once codes were identified, they were categorised into possible themes, ensuring that all meaningful data was included (Stage 3). These codes and themes were assessed to ensure that they fit and were acceptable, before a thematic map was created (Stage 4). This was then analysed and clarified, and specific themes were defined (Stage 5). The final step was crucial for producing an evidence-based interpretative account of the data, analysed in a way that related to the research question and fulfilled the objectives of this research (Stage 6).

As inferred by the authors, advancing through the process was not linear. From initial data observation, codes alluding to the broader themes were noticeable because of their recurrence through interview transcripts. An inductive approach drew upon the data to recognise and formulate codes and identify overarching themes. In this way, the exploration was data-driven, drawing meaning from what was there and not forcing

data to fit into a pre-existing coding framework (Braun & Clarke, 2006). During the coding process, themes were extracted from the data with consideration to lived experience of mental health support. Care was taken to not diverge from the subjects and theories that were set out (Braun & Clarke, 2006). Ultimately, understanding the participant's personal thoughts, feelings and their experience of accessing support online was seen as a strong indicator of whether the online space was a reliable and effective platform for the treatment of mental health problems.

Braun and Clarke's concept of reflexivity shows that researcher life experiences, knowledge and personal interests can influence qualitative data interpretation (Braun & Clarke, 2006; Braun & Clarke, 2019). In this way, the researcher's role may have impacted the interpretation of these results. Researcher subjectivity is an essential and valued element within the analysis (Austin & Sutton, 2014) and the themes that have arisen are, in part, a result of the researcher's personal perspective, prior knowledge and previous experience. As well as a pertinent interest in mental health struggles, the lead author (SH) has a background of working within mental health which may mean that the existence of personal biases and experiences have influenced data collection and analysis. Considering reflexivity, and accounting for the interpretative nature of research guided by world beliefs (Denzin & Lincoln, 2005), the lead author was keen to identify conscious and subconscious assumptions, personal experience and potential biases brought to the analysis. This might include how SH, or those individuals close to her, have been affected by poor mental health and how SH might have made sense of those thoughts and consequential challenges. SH was also keen to explore whether and if so how, the research and findings might challenge these biases. After many re-visits, the codes were categorised and linked to the overarching themes: accessibility to treatment, expectations and efficacy of the therapeutic process and relationship, how options and choices were presented, and finally comparative experiences from participants who received both in-person and online support. Initially, there was evidence of overlap and links between themes but with research aims in mind, the accuracy of the interpretation was preserved by specifying the most dominant themes backed up by prominent and meaningful examples within the data.

Results

All 10 participants were female. Three participants completed the survey but did not arrange an interview. Interviews lasted for an average duration of 43 minutes.

Mental health interventions experienced by participants included talking therapy, CBT, Cognitive Analytic Therapy (CAT), hypnotherapy, and somatic work. The digital platforms used included *WhatsApp,* videoconferencing platforms (*Microsoft Teams, Zoom* and *VSee*), and telephone. Five participants had previously experienced in person support.

Many of the participants described the intervention as a matter of urgency. Two were referred for urgent care due to the highly critical nature of their situation and others chose to access support as an ongoing process to improve the quality of their life. Table 1 summarises the participant sample with regards to the different types of intervention, platforms used and reasons for the intervention.

Table 1: Participant type of intervention, platform used and reasons for intervention.

Participant	**Type of intervention**	**Platform Used or Format**	**Reason for Intervention**
P1	Hypnotherapy; somatic Therapy; talking Therapy	*WhatsApp; Zoom*	Generalised anxiety; panic attacks; fear of flying
P2	CBT	*Teams*	Postnatal depression
P3	CBT; talking therapy	*Teams;* in person	Generalised anxiety; obsessive-compulsive disorder
P4	Talking therapy	*Zoom;* in person	Trauma processing; low mood
P5	CBT; parenting therapy	Telephone	Anger issues; low mood
P6	Talking therapy	*Zoom*	Domestic violence-induced stress and depression
P7	CAT	*Teams;* in person	Self-harm; eating disorder
P8	Talking therapy	*VSee*	Grief & bereavement counselling
P9	CBT; talking therapy	*Teams;* in person; telephone	Grief & bereavement counselling
P10	Anger therapy; talking therapy	*Zoom;* in person	Trauma; anger issues

Abbreviations: CAT: Cognitive analytic therapy; CBT: Cognitive behavioural therapy

Interviewee insights included the practical application and access of the intervention, the benefits and limitations of online support received, and the overall impact of the intervention on their quality of life. The final three themes generated were *Accessibility of Treatment, Therapeutic Process and Options and Choices*. The final thematic map is shown in Figure 1.

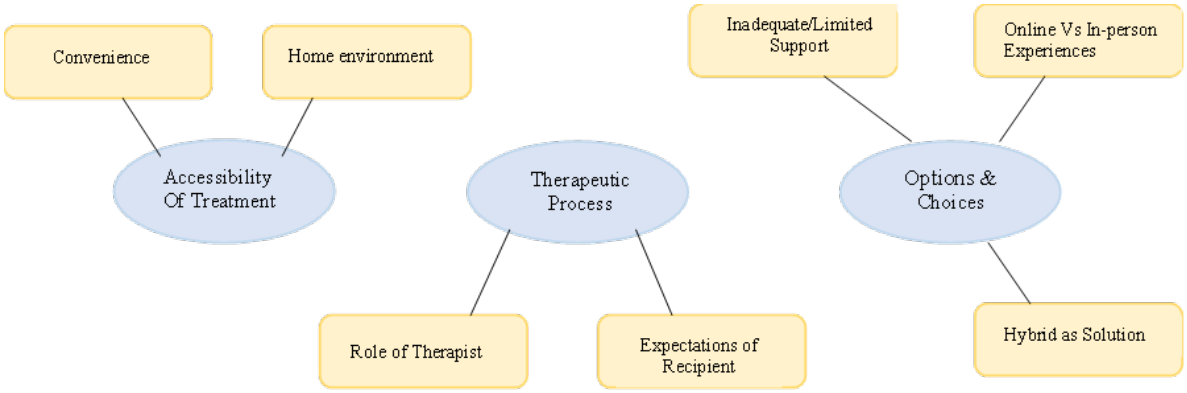

Figure 1: *Thematic map*

Theme 1: Accessibility of treatment

The theme of accessibility was prominent throughout the interviews, with online interventions seen as beneficial for the ease and flexibility they offered. Participants spoke positively about the convenience of gaining support remotely and how that enhanced their involvement in the process, lending to its efficacy. They reflected on their personal experience of accessing the intervention from home, revealing how the home environment could bring both advantages, such as the minimal requirements for additional time and effort and disadvantages, such as being in a location that is potentially disruptive or not set up specifically for the session aims. Accessibility differed according to personal circumstances, urgency, and the reasons for either needing or wanting support. Those who were referred as part of crisis intervention experienced accessibility differently to those who sought supplementary mental health professional support.

Subtheme 1: Convenience

The convenience of accessing online support is outlined as one of the main benefits. The participants advocated for remote care, saying that the time-saving aspect was very important to them:

> I go for convenience…I think the major thing that's sways me in that direction is the convenience. Saving time (Participant 8).

It was largely agreed that fitting appointments in alongside work and other life commitments could be challenging if they were required to go and attend the appointment in person and that "*it would have taken so much longer than an hour*" (Participant 6) which made it unappealing.

One participant, despite having enjoyed the benefits of face-to-face support, requested to move from in-person support to online after her therapist moved a bit

further away. She talked about the logistics being "*just easier*" (Participant 10) that way and made that decision based purely on convenience.

Accessing the support remotely is considered particularly helpful when responsibilities such as childcare are considered, stating that it was one less thing to worry about and one participant who was receiving help with postnatal depression also spoke about her gratitude for remote services because her situation made time accessibility for outside appointments problematic:

> It was all done online so I didn't have to go anywhere obviously, you know with having a small, small baby, it's not easy to just make yourself available for a couple of hours to go out and have an appointment (Participant 2).

She went on to say that the pandemic had caused in-person services to move online but had she been given the choice, she would have still chosen to access CBT online rather than face-to-face.

Having the flexibility associated with planning digital meetings was also reported as being an important consideration when seeking mental health support. It was reported that people are much more likely to continue accessing support when it can be adapted to suit a busy lifestyle.

One participant spoke of the flexibility being "*a factor*" (Participant 10) when her work demands created an inconsistent schedule, and how her online therapist could make that offering that previous in-person therapists just couldn't. This was viewed as a huge advantage for her.

It was also agreed that having flexibility of location is advantageous because it doesn't require much physical effort, plus saves money and time when comparing it to have to drive to an appointment. The fact that the session could be attended from anywhere was very appealing:

> I mean the flexibility is there 'cause you don't have to like get in the car and drive here, drive there (Participant 9).

The general ease associated with online intervention was mentioned multiple times suggesting that it also spared mental energy as "*the thought's taken out of it for you*" (Participant 10). Interestingly, individuals who initially had reservations about digital access changed their views on it after the experience, particularly because of the ease of the whole process, saying "*I probably would just pick online again just for the ease of it*" (Participant 6).

Subtheme 2: Home environment

In this study, the experiences of accessing support from home were varied. Some participants reported the appeal of the home environment because it offered comfort and familiarity whilst getting mental health support. Participant 1, who received a hypnotherapy-based intervention for the treatment of a phobia, associated the high level of efficacy with being able to access it from her home:

> It's probably more effective because I was comfortable in my environment and, you know, on my own bed, on my own, to lie down and listen to something I was fully relaxed as opposed to maybe on a couch in an office somewhere (Participant 1).

She spoke fondly of the familiarity of her home, and the smells and sounds that came with it which allowed her to fully engage with the mindfulness and meditation practices when the right time was found. For this reason, she found being at home during treatment could be effective for her mental health struggles.

However, she also discussed the challenges that came with arranging a suitable time with regards to having privacy. Due to having a husband with a variable work schedule, she said it wasn't easy to pinpoint an appropriate time, concluding that it was "*annoying to try and find somewhere…that's actually private*" (Participant 1).

One participant spoke at length about the difficulty of accessing treatment from home and implied that it negatively impacted the efficacy of the process. Restricted engagement and poor focus meant that it was not easy to fully immerse or engage with the therapy:

> My husband, my husband [husband's name] was at home. Then it made it more difficult to like, talk freely when I could talk. And so I found it quite difficult to do stuff online to begin with (Participant 7).

During several interviews with participants, the researcher (SH) observed a lack of privacy, particularly when family members were present in their homes. This often led to disrupted conversation, with Participants 5 and 9 apologising for the interruptions.

The idea of obtaining sufficient privacy was explored as a possible benefit, and that it might be better to have sessions within the environment of the therapist or support-giver, rather than at home. In-person treatment offers a possible solution to the privacy issue:

> This wouldn't be the case with like an in-person session in that I wouldn't struggle to find somewhere to be, to have privacy, and to have that time to really get engaged with the session (Participant 1).

As previously suggested, disruptions within the home environment negatively impacted concentration, and caused further issues as a result. Washing machines, pet dogs and people knocking on the front door were all listed as possible disturbances, and these caused the participants more stress and frustration. These

kinds of "*stressful*" disruptions (Participant 1) have the opposite effect of what mental health intervention aims to achieve and dramatically impact the efficacy of the service.

Participant 4 talked about the difficulty with engaging from home in the early stages of therapeutic intervention, explaining that it was a challenge to open up. She was reluctant to delve into a traumatic past whilst in her 'safe place':

> I think that initially I found it really difficult to do it at home. Cause I was like I don't really want to enter this part of my brain while I'm at home because I don't want the association (Participant 4).

Whilst exploring possible solutions to the privacy problem, Participant 1 removed herself from the home environment and attempted to access an appointment whilst sitting in her car, but this created more problems:

> [I] had a session in my car once and ended up somehow draining the battery of the car. So that was inconvenient 'cause I had to come and get someone to jumpstart (Participant 1).

These examples demonstrate the difficulties people face when receiving support online and is a reminder that the online process can be very challenging.

Theme 2: Therapeutic process

Subtheme 1: Role of therapist

The therapeutic relationship was a common theme across the interviews, and the participants shared their thoughts and experiences around how that developed within an online format. There were many positive experiences reported which suggests that accessing support remotely did not negatively impact the ability to build a conducive therapeutic relationship:

> That's an important part of the counselling is the relationship, but you can, yeah, I think you can still achieve that (Participant 8).

She indicated that she would access mental health support online again if she needed it, saying that the therapeutic relationship was not missing any important facets required for success. Video conference calling platforms did not negatively impact communication, or the ability to build rapport, meaning the effectiveness of the process was not hampered:

> I don't think video is a barrier for that…I think if it was, that would be a big problem (Participant 8).

A preference for the online format for effective communication was expressed by multiple participants. One reported how the physical and geographical barrier

between her, and the person giving support, meant that she was able to give much more to the process:

> Sometimes I, I won't always say what I feel on face to face, so is much better where I'm typing or where there's just some sort of break between me and the person (Participant 5).

The online format increased her ability to be authentic, open and honest, which in turn, improved her experience and the efficacy of the intervention. This was further explored through another participant's experience, and there was a question around whether physical separation between the support giver and receiver could make for a more efficient process in terms of reducing awkwardness to build a positive relationship. Another participant agreed that connecting across screens made no difference to her being able to establish a meaningful helping relationship:

> I could see her. So it was no different from having her in front of me (Participant 8).

Participant 2 also spoke positively about the online therapeutic delivery, saying it was preferential to in-person treatment. Whilst she would have considered a face-to-face option, she questioned her ability to be "*as open*" due to it feeling "*a bit awkward*". She described the support as "*encouraging*" and reflected on how her therapist gave her the space to "*talk freely*". Participant 5 also spoke about the calming benefit of telephone counselling and how that increased the effectivity. She reflected on how much she enjoyed listening to her therapist's voice and how beneficial she felt that was for the treatment process:

> She had one of those voices that, I don't know if they're trained to have a voice like that, but it was just she instantly calmed me every time I heard her voice (Participant 5).

Participant 5 used words such as "*soothing*" and "*relaxed*" to describe the therapist and how experiencing her calming demeanour through a digital platform helped their relationship to flourish and build good foundations for what became very effective work. Whilst Participant 5 spoke positively of the anonymity that online intervention offered, another (Participant 7) spoke of the difficulty of having conversations online and how it felt less effective specifically because of the physical separation:

> The lady that I was working with used quite a lot of body language, and when you're on like a webcam, however, I set it up, sometimes you can't see that (Participant 7).

Other participants agreed with this sentiment, suggesting that there was a lack of connection which led to it feeling impersonal.

A participant who has experience of both online and in-person support said that she believes in-person therapy can be very effective because of her natural preference

for being amongst others, and how that lends to building connection and effective relationships:

> I'm a people person. I like to feel the room (Participant 10).

This facilitated discussion around whether an online format can replicate the atmosphere that is created when people share the same space, to effectively build rapport and aid the therapeutic process.

The participants spoke about the traits, qualities and skills that are required for an effective and sought-after therapist or caregiver. One of these skills is the ability to listen non-judgmentally and to help the recipient feel heard and supported. They recalled the importance of being accepted for who they are, without judgement:

> No matter what I said to her, I didn't feel like she was judging me or anything like that. And I just felt she got it (Participant 5).

The online format did not seem to hamper the therapeutic effect. In fact, participants spoke about the positive impact of the therapist's "*presence*" such as the creation of a valuable 'safe space' which encouraged them to open up. This illustrates that strong connections can be made and that physical distance is not necessarily a limitation or barrier for building good foundations for an effective service.

Participant 9 suggested that treatment efficacy depended on the therapist skill and ability rather than the format:

> I think the issues I had were more down to the therapist itself than the actual system of having it online (Participant 9).

This implies that if a therapeutic process involves a skilled therapist who can build a positive relationship with the recipient and can deliver a suitable therapy, then it is likely to be successful. Whether it is delivered in person or digitally, it can be an effective treatment process.

Subtheme 2: Expectations of recipient

The recipient's expectations of both the therapist and the process were outlined within the interviews and included an acknowledgment of being pro-active, completing work outside of the sessions, practicing traits such as vulnerability and courage and being open to accessing additional support to bolster the support offered within therapeutic meetings. This also reveals how the recipient experienced the process as a whole and predicts the efficacy of it. Several participants spoke about the unknowns with online mental health support:

> I mean, I've never had counselling before, so, or any experience of it, so I wouldn't really know what to expect (Participant 6).

One participant sought help because she felt she needed it but revealed that she did not know what she was looking for and did not know what to expect. In some cases, the reality of the intervention did not match the participant's prior expectations, but it did positively exceed these expectations:

> It's not what you expect...It's based on you, your experience, and then they just talk you through it and give you things that are relevant for you (Participant 5).

One expectation that came up multiple times is based on the idea that the receiver must apply effort for the treatment process to be effective, especially to recover:

> I think it's as, as effective as you make it. I put in a lot of effort to listen. to do the activities, to really read the stuff she sent afterwards as well, because I wanted. I generally wanted the help and I wanted to, to get [the most] out of it. (Participant 5).

Participant 5 explained that she knew what to expect with regards to becoming "*self-efficient*", even though the online format was a novel one, which implies that she either had previous knowledge or understanding of the therapeutic process or that she was adequately briefed before it began. However, Participant 3 was surprised about the process delivery and outcome, suggesting that she felt a huge recipient responsibility to overcome her mental health struggles, even with regular support. She claimed that if the recipient isn't equipped with the right personal qualities or is willing to work, then the process would fail:

> They, they gave me the tools, but it wasn't, it's not very motivational. I think that comes from the person rather than the, the therapy as a whole (Participant 3).

This became even more evident when she compared it to her experience of face-to-face support that she went on to have afterwards. At this point, she explains how an in-person format 'forces the uncomfortable' which is what is needed for recovery:

> On here I can press the call button and I can just end it…In a room, you, you, you have to deal with the uncomfortable. Therapy is uncomfortable (Participant 3).

There were realisations through the process with regards to efficacy being strongly linked to certain personal traits and characteristics. One participant noticed that being open, courageous and achieving a high level of self-awareness was key to experiencing a more effective process:

> It wasn't immediate [the change], but that's more my restrictions than the therapy, so took me a little while to open up completely to her (Participant 2).

Another participant also spoke of the courage needed for best results, which is not an easy thing to do particularly when you aren't with somebody face to face:

> The effectiveness of it is how much you're willing to, to go there with those things, the courage (Participant 8).

She also suggested that self-awareness was described as "*the whole process*" which shows how intrinsic that quality is, and how she felt that certain activities to cultivate self-awareness were challenging, but important. This participant made it clear that the priority for her was not the format of the intervention, but that the therapist had lived experience of the struggle that she also faced. In this instance, the efficacy of the intervention was rooted in having somebody who could truly empathise and share the same worldview:

> You could have other counselling, but I really don't think meeting somebody that hadn't been through child loss would be as effective, personally (Participant 8).

Accessing support remotely was also well-suited to Participant 7, who struggled to verbalise her thoughts and feelings during an episode of selective mutism. She spoke about how they wrote letters to each other which she said, "*seems a bit weird*" but was actually "*really appealing*" and effective in her situation.

Theme 3: Options and choices

Subtheme 1: Inadequate/limited support

The theme of having options available was recurrent amongst the experiences of the participants. The words "*only option*" and "*only choice*" were reported multiple times which suggests that there were limitations to accessing support, even in an online capacity.

There were also concerns around receiving inadequate support with regards to the number of sessions allocated. One participant reflected her frustration at only having six appointments, as per National Health Service (NHS) procedure, and how that had negative implications for the efficacy of the process:

> You're just getting comfortable, aren't you? And then you're like, yeah, bye. (Participant 6).

This was also one of the reasons that another participant (Participant 4) chose to seek private help, because she did not want to lose the consistency of working with a specific person, stating that rather than having to have to go through meeting a new therapist all over again, she would "*just pay*".

One participant described receiving mental health support online as a being on a "*conveyor belt*":

> That's basically what it is, is a conveyor belt like, yeah, you're done. We'll discharge you. Yep. You're done. You can go. (Participant 3).

This implies that the process is impersonal and uncaring, and not the kind of experience one would hope to receive when working towards recovery. Similarly, another participant described her experience of accessing support remotely as:

> ...a bombardment of phone calls from, from three different places…and at the same time not a lot of support actually available (Participant 8).

Through this, it seems that the participant felt that the support that was offered was hopeless, lacked efficacy and left them in a heightened state of anxiety. She explained that she knew she needed help but the services available failed to meet this need and she ended up feeling lost until she was later signposted to a therapist. She also reflected on a previous experience of receiving mental health support online, stating that she found it to be unprofessional which made her feel disconnected from the therapist. A lack of respect and possibly confidence in the therapist left her feeling a bit doubtful about the process:

> I'm sure she was like in, in her bedroom with that bed post behind her, which I found just a little bit unprofessional (Participant 8).

In situations where there were offerings of collaborative sources of support both to run alongside and to follow the online intervention, the feedback lacked positivity.

One participant reported group support as not being relevant for her personal situation and believing that her struggles with self-harm were atypical and so she would not feel that the group would be supportive, claiming:

> that just wasn't for me… (Participant 7).

Another participant also spoke about the disadvantages of being in a room with a group of people, talking through similar problems. She suggests this method could hinder recovery, particularly because she found that sharing in this way was not helpful:

> If you kind of access the full room for me personally, hearing other people's problems, it feels like you're burdening their problems as well. Or maybe they could be planting seeds of things that then contribute again. I was just a bit like it's not, I need to concentrate on fixing myself (Participant 3).

Subtheme 2: Hybrid as solution

For those that had only accessed remote support, there was some clear interest in the possibility of receiving support within an in-person format. Although one participant spoke positively of the online format particularly with regards to establishing and maintaining a helpful relationship, she also spoke about a curiosity and wondered whether a face-to-face meeting would further improve the service:

> I kind of yearn for just having one session just to get a feel of, like if just to get a feel of who they are (Participant 8).

Similarly, a participant who was satisfied with receiving counselling via telephone spoke about her desire for a video call, to be able to see a face to further develop the therapeutic relationship and increase the efficacy of the intervention:

> It would have been nice to maybe see a face or have the option to have like a hybrid once or maybe twice a week (Participant 5).

This theme of having a hybrid option which combines online with face-to-face support was also explored by other participants, with one saying how effective it might be to be able to give people regular choice as to how they would like to receive treatment:

> Ask, do you want to come into the clinic or to do it online? Yeah, just offer the people the choice (Participant 9).

Another participant identified that a choice regarding the therapy format that could change session to session would have been appealing to her and implies a positive adjustment to the structure as it is:

> Sometimes I might have wanted to go in and do a face-to-face with her…they don't offer that option... (Participant 5).

However, one participant spoke about the struggles she faced with the changing format, which happened because of the COVID-19 pandemic:

> Switching between online and face-to-face is quite a difficult thing to do. Well, it was for me (Participant 7).

She explained that her mental health issues drive her need for control and the inconsistent format of her therapy sessions contributed to increased stress and anxiety.

Subtheme 3: Online vs. in-person experiences

Five participants received both online and in-person treatment, allowing for comparisons. Three participants experienced both types for the same problem, moving between face-to-face and online support during COVID-19. This provides a valuable analysis of the advantages and disadvantages of each treatment approach, particularly considering efficacy.

One participant, who works as a mental health nurse, spoke positively about both types, claiming that each had benefits, and both should be maintained as options to best suit the individual:

> I think it's good that we're doing it online [but] I don't think we should lose the face-to-face (Participant 9).

Whilst online mental health support was praised for being a convenient, accessible and cost-effective way to deliver urgent and necessary psychological care, participants perceived that this would not work as the only option for some people:

> As much as I found like doing it on *Teams* helpful. I think when I had counselling face-to-face, I found that much easier and much more comforting (Participant 9).

The same participant spoke about the different responses she noticed from others who experienced different approaches:

> Some of my patients have done online therapy before and they prefer the therapy that we do at work. Some others prefer the *Teams* because they can just switch the camera off…they've got a bit of privacy (Participant 9).

However, another participant said that, in her experience, what is best for the receiver in terms of overcoming their struggles, might not be what they think:

> So personally I preferred in-person than online, but she said to me that she thought that I gave her more online (Participant 4).

This implied that the therapist believed that the participant was more open and able to give more to the process when engaging remotely, suggesting that she believed the process might be more effective for her in this way.

There were a few examples of participants whose face-to-face treatment moved online due to the COVID pandemic and how they hoped they could return to that original first choice. One participant described the benefits of accessing support in-person and explained that she simply didn't enjoy the online experience. She found the face-to-face meetings much more effective and hugely beneficial to her recovery process:

> I needed more face to face because that's how I get better (Participant 3).

It seems certain types of people much prefer being able to be in the same environment as their helper so would choose it if the option was both available and accessible.

Participant 10 spoke about a preference for in-person but explained that online counselling still worked well for her. After previous experience of working with a therapist face-to-face, she described the new experience of using Zoom to host the sessions as a "sacrifice" but an acceptable one if it meant she could still have that support.

The accessibility was identified as a hugely positive feature for many who had previously preferred the idea of face-to-face:

> Everything was actually more convenient that way (Participant 1).
>
> [face-to-face support] is better 'cause it fits better, like with life. You can do it from anywhere (Participant 1).

Moreover, the efficacy of the treatment increased as a direct result of the online format. Having that distance enabled a few of the participants to open-up more and engage fully in the process:

> I don't think I'd have been as honest [if it was face-to-face] because I could see the other person and they could see me, I think I would be worried that I'd feel a bit more judged (Participant 5).

Participant 6 spoke about the fact that prior to the meetings, they would have preferred the face-to-face option but ended up finding they were satisfied with the online option. She said:

> I think face to face probably would have been my first choice because it just feels like it would be better, but actually it was fine (Participant 6).

This suggests that the online format exceeded expectations and that initial concerns were likely to be a result of its unfamiliarity. Having the chance to explore the remote option enabled her to find a way that fit with life and was surprisingly effective for her mental wellbeing.

Discussion

This study examined real-life experiences of receiving mental health support online to further understand the effectiveness of this treatment approach. Analysis of participant interviews revealed how online interventions may be advantageous for some individuals. Our study found that treatment accessibility, the role of the therapeutic relationship, and the choices and options for online support were crucial in considering the efficacy of online mental health support interventions.

In terms of accessibility, online interventions offer flexibility. Many of the interviewees in this study agreed that arranging and participating in online meetings was convenient, especially with regards to having flexibility and ease of accessibility. This corroborates with previous findings (Christensen *et al.,* 2009) including research assessing patient outcomes (Johns *et al.,* 2021). Logistical ease, such as not needing to travel, can also lead to higher adherence levels overall although different types of online intervention show varying levels of attrition rates (Linardon & Fuller, 2020). It has been shown that having an aide involved in the process to offer some level of guidance does improve attrition rates (Jabir *et al.,* 2024). Our study participants spoke positively about working with a specific guide, but did not find additional, less structured support, such as peer support groups, helpful or worthwhile. The benefits for accessing treatment with guidance included the ability to personalise the process and allocate person-specific remedies (Andersson & Titov, 2014). This was reflected within this study as participants spoke of the significance of learning about strategies that were tailored to them rather than being generalised. Furthermore, having a therapist with lived experience was highly valued as the guidance became more

personal. Not only does this personalisation increase the likelihood of help-seeking behaviours, but it also makes the process more efficacious.

The home is the setting in which most people choose to access supportive intervention online as it is viewed as advantageous (Pruitt *et al.,* 2014). Arguably, there are certain groups of people who would benefit more from remaining at home throughout treatment, such as those with long commutes, physical disabilities or significant responsibilities, including new mothers with postpartum challenges (Hensel *et al.,* 2024) as identified in this study. However, this study found that there are added complications of accessing support from home which involve disruptions and the detrimental impact this has on concentration and focus. During the interviews, the researcher (SH) experienced the participants dealing with disruptions first-hand such as the children of one participant who were promptly encouraged to leave the room as she explained she was busy with something important. Another participant also paused and apologised for her son loudly returning home. There was also discussion of the fear of possible disruptions, including from knocks at the door, or washing machines. This again emphasises the idea that whilst accessing mental health support from home can be viewed positively due to a sense of control it offers (Ashwick, 2019), the home environment may also involve disruptions which are beyond the control of the individuals receiving support which could impact the efficacy of their experience. Similar findings suggest that environmental distractions not only impact the engagement of the receiver but could also present privacy issues (Payne *et al.,* 2020).

The role of the therapist or caregiver is crucial, particularly when delivering efficacious mental health support online. This includes the instigation and cultivation of the relationship, which in this study was largely therapeutic in nature. Particularly with CBT, certain therapist behaviours could lead to better client engagement and adherence (Paxling *et al.,* 2013) and there is an indication that therapeutic alliance is important for web-based therapy outcomes (Sucala *et al.,* 2012). To positively impact the therapeutic alliance, personal attributes such as understanding, compassion and empathy are required by the therapist (Ackerman & Hilsenroth, 2003). Despite communication challenges online (Barak *et al.,* 2009), most of the experiences in this study revealed a positive helping relationship, suggesting that the online format allowed for a strong therapeutic alliance.

The character traits and qualities demonstrated by the therapist are key and can aid rapport-building for an effective treatment process (Pashak & Heron, 2022). Specific traits, such as empathy and genuineness, contribute to the receiver feeling heard and supported which was expressed as a valuable part of the intervention and its outcomes (Nienhuis *et al.,* 2016). In this study, some participants spoke about the positive impact that interest from the therapist had on their engagement and trajectory. It has been shown that when individuals feel a deeper connection to the process there is an increased chance of treatment success through patient change (Ackerman & Hilsenroth, 2003). Alternatively, many of the opinions in this study expressed a belief

that the effectiveness of the therapeutic process depended on the receiver's effort level. This is echoed in literature which emphasises the importance of both the therapist and patient contribution to increase the efficacious nature of the treatment (Wampold & Flückiger, 2023).

This collaboration can be improved by the online format of the receiver seeing themselves on screen alongside the therapist, creating a sense of 'togetherness' and strengthening the therapeutic alliance (Agar, 2019). A higher level of contact with the therapist is a key factor for digital interventions to increase patient support and adherence to the treatment process (Melville *et al.,* 2010). Online support that is led or guided by a therapist or mental health professional could achieve higher uptake and attrition rates (Fleming et al., 2018). Additionally, the ability to personalise the treatment approach and draw on relevant tools specific to the individual is desirable with regards to increasing the efficacy of the intervention (Carlbring *et al.,* 2011). Most participants in this study stated that they would access mental health support online again if they needed to due to the positive nature of the therapeutic relationship. This is supported by studies concluding that relationships can be positively and successfully cultivated online (Parks & Roberts, 1998). Whilst some participants were surprised by this, most agreed that the online format does not seem to hinder the development of a strong therapeutic alliance or negatively impact the efficacy of the treatment process (Berger, 2017; Pihlaga *et al.,* 2018).

However, there is some opposition to digital therapy due to potential ambiguity around therapist body language (Skinner & Latchford, 2006). This perspective sits in alignment with the experience of one participant in this study who spoke of the difficulties of accurately reading body language, even with a webcam, and another who received telephone support but spoke of a desire to have at least one session where she could see the therapist in-person, to reveal whether it would positively contribute to the process and outcome. Studies suggest that a lack of non-verbal cues could hinder the efficacy of the therapy due to therapists misreading or failing to understand how the client is feeling (Lin & Anderson, 2024).

The expectations of the recipient within online mental health treatment are interesting, varied and unique to the individual. They include thoughts around the treatment process itself as well as recovery (Biringer *et al.,* 2017). As again emphasised in this study, some people have more experience of the process because they have accessed help previously, have worked in mental health, or know people who have been through the process. This could have an impact on their expectations of the experience and outcome in a variety of different ways due to having less knowledge and understanding. It might be assumed that these individuals would require more clarity and a higher level of support throughout the process to avoid absenteeism. Whilst dropout rates are difficult to predict, studies show that the 'unknowns' of receiving therapeutic intervention online could impact attendance of the sessions (Melville *et al.,* 2010). Although this did not seem to impact attendance rates for

participants of this study, uncertainty of what might be involved was demonstrated by a couple of participants, which is in agreement with previous studies (Hoek *et al.,* 2012; Crisp & Griffiths, 2014). Regardless, there is strong evidence in this study of positive experience, whereby the process and results surpassed expectations. Similar findings were highlighted in a study on therapists' perspectives of client experiences (Kotera *et al.,* 2021).

The idea of options and choices with regards to digital mental health support was valued by recipients. However, in cases where interventions were accessed through the NHS, treatment options were extremely limited. For some participants this did not have a negative impact, and they had positive experiences. However, others reported feelings of disappointment, due to limited support, or being offered the incorrect type of support. Those who paid privately for treatment gave positive feedback regarding their treatment process and its efficacy, likely because they had options and therefore more autonomy around choices and decisions during the intervention.

The offering of group therapy is an option that failed to attract participants in this study due to their perception of its limited effectiveness. Research shows that a group format may be more effective than individual intervention for some people (Weinberg, 2021), suggesting that it might be personality-dependent, or that the efficacy depends on specific symptoms and previous experiences. Although the comparison between individual and group therapy was not studied here, participants implied that individual support was preferential and research supports the sentiment that when operating digitally, individual therapy has better outcomes than group therapy (Barak et al., 2008). One study found that prospective patients worried about the harm that a group setting might cause if the aide lacks appropriate qualifications and credentials (Wesolowski *et al.,* 2023). Some study participants described a group format as unappealing, unhelpful and possibly harmful if it involves sharing personal traumatic experiences in a setting which is not designed to deal with the impact this might have on others. Additional research is needed to understand how e-groups work to elicit patient progress and to ensure that group therapists or facilitators embody the necessary skills and qualities needed for success online (Payne *et al.,* 2020).

The interviews included numerous requests for a type of hybrid intervention which includes both online and face-to-face options. Delivering mental healthcare as a hybrid has been shown to be effective for certain populations (Cohen *et al.,* 2023), promoting higher levels of engagement. Whilst further studies might need to assess whether this finding is transferable to other population groups, it is evident that receivers recognise the unique benefits of both modes of delivery. There are different ways in which online treatment might fit into a hybrid design to boost the efficacy of the service. Online intervention may be effective as a 'gateway' but not as an exclusive replacement of the face-to-face option (Barak & Grohol, 2011). This suggests that initial points of contact could be achieved through telephone or videoconferencing with a follow-up of in-person appointments, or that in-person sessions form an additional and

supplementary service throughout the treatment process. Other studies have found that a hybrid plan which involves both in-person and online support could be particularly effective in situations where the relationship between caregiver and receiver has been established (Shore *et al.,* 2018), highlighting the importance of nurturing the therapeutic relationship face-to-face before moving to an online format. This reinforces that there is no one specific way to deliver treatment but for increased efficacy, the nature of the process would rely heavily on the preferences of the patient, and the individual circumstances surrounding them.

It is interesting to note that individuals who have experiences of both in-person and online mental health support offer a unique perspective. However, results are mixed when assessing the efficacy of either online or in-person treatment options as both formats have associated benefits and disadvantages, as have been explored here. One study showed that the only advantage of remote intervention was its accessibility, and the convenience associated with that, but otherwise, digital support failed to meet participant expectations (Musiat *et al.,* 2014). These findings imply that an online format is less efficacious for managing or recovering from mental health struggles. Within this study and elsewhere, online psychological services can be considered less favourable when compared to in-person options. Whilst its accessibility has been seen as a key benefit for treatment continuity during the COVID-19 pandemic, there are concerns around the efficacy and credibility of this format in relation to possible risks and whether it is suitable for all mental health issues and therapeutic subtypes (Wesolowski *et al.,* 2023). This study alongside current literature supports the idea that in-person treatment is viewed as something special, particularly by those who could make direct comparisons between treatment formats. It seems there might be perceived increased efficacy in support-giver and receiver being together within the same environment because of the impact on the therapeutic relationship and sense of self (Mercadal & Cabré, 2022).

Other research presents online intervention as an increasingly popular choice for some individuals (King *et al.,* 2006) cementing its importance in current and future treatment options. In line with this study, it seems that the individual preferences, specific mental health issue, therapy type and therapist are all factors which affect the efficacy of both online and in-person treatment. To counteract some of the disadvantages mentioned, it has been suggested that online delivery promotes a clearer and more open expression of emotion from the individual receiving the support due to the online disinhibition effect (Suler, 2004). This finding has been corroborated by this study as some participants considered the online format to be potentially less awkward and more comfortable, which allows for a more effective process due to participant transparency and authenticity. Online mental health interventions, although newer and developing, have strong backing by research studies and individual experiences.

The limitations within this study include the sample size, demographics and wider application of findings. The very nature of qualitative research involves finding meaning through each individual experience which adds to the challenge of looking at experiences through a comparative lens. This study involved a range of participant experiences and as a result, attitudes towards the effectiveness of their support. The type of intervention, mental health condition and platform used are just some of the differentiating factors involved, as well as the unique position of each participant. For example, some participants had received professional help previously and some had received multiple types of therapy, which can impact their attitudes, perspectives and experience, and whilst this has been noted, realistically, these factors cannot all be accounted for. High heterogeneities amongst participants and across studies mean it is difficult to generalise findings or apply them to a wider or specific population. Finally, the use of thematic analysis presents some limitations, particularly around subjective interpretation, rigor and reliability (Roberts et al., 2019). It may also be that because participation was self-selecting in nature, this study attracted a specific type of person or viewpoint and that would skew the sample type and conclusions. Although arguably, the aim of this study was to explore and understand experiences on an individual basis and from this, broader commonalities can be established.

This study did not find sufficient evidence across the data set to demonstrate positive previous online support experiences leading to a greater likelihood of participants accessing or continuing future online interventions. This may have been due to participants needing to access two or more online sessions to be eligible to take part in this study. Further research is recommended with individuals who have received a longer-term online mental health intervention to be able assess the levels of trust and confidence in receiving online support. Further research is also recommended to study a larger sample of participants with a more diverse range of demographics, attributes and experiences to obtain a more detailed overview, or to increase the specificity of the sample to draw conclusions about a more specific subset of people, such as older adults, or those who identify as male.

Accessing and receiving effective psychological support is vital to improve mental and holistic wellbeing. Therefore, research in this area is important to help raise awareness of the type of support offered for mental health online and to identify both the challenges and rewards of receiving such support. In a developing world, there needs to be an assurance that these services are meeting expectations and offering efficacious outcomes.

This study reveals that whilst individual experiences vary, online support interventions can be successful for improving mental health. The appeal of online support is associated with its accessibility largely due to low cost, time and effort requirements. Interviewees agreed that a skilled therapist with the necessary qualities can build and maintain trusting relationships in a remote setting. Additionally, if the individual receiving support has access to a quiet space where they can talk freely, online

formats can be highly effective. A hybrid approach was reported as a preferential and effective treatment option for participants who had received both remote and in-person support. Based on these findings, future research recommendations include more specific criteria relating to participant group, (e.g. gender or age) or further research designed to examine the efficacy of online interventions for specific mental health diagnoses.

Data availability statement

The interview transcripts on which the study is based are not publicly available to protect the anonymity of the participants.

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Research Article

Inattentional blindness in radiology: a concise checklist approach

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Abstract

Inattentional blindness has been identified as a partial cause for missed diagnoses among radiologists. Missed findings present a significant challenge as they can have clinical implications for patients. This study investigated the effectiveness of a four-item concise medical checklist in reducing inattentional blindness among radiologists when interpreting chest computed tomography (CT) scans. Thirty-two radiologists participated in the study: an experimental group (with the checklist, *n* = 18) and a control group (no checklist, *n* = 14). Participants were instructed to read seven chest CT stacks (one practice case and six experimental cases), and to mark all lung nodules ≥3 mm. In the final CT stack, a breast cancer mass and lymphadenopathy served as the inattentional blindness stimuli. Lung nodule detection was marginally higher in the control group (62%) than in the experimental group (55%), but this difference was not statistically significant. Almost 80% of radiologists in both groups failed to report the breast cancer mass, whilst lymphadenopathy identification was at chance level in both the control (50%) and experimental (58%) groups. Group comparisons for both analyses were also non-significant. These findings suggest that a concise medical checklist may not be an effective solution to mitigate inattentional blindness among radiologists when interpreting chest CT scans. Further research and alternative approaches are warranted to address diagnostic errors in medical imaging resulting from inattentional blindness.

Keywords: Inattentional Blindness, radiologists, diagnostic Errors, chest computed tomography (CT), medical checklist.

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Introduction

When attending to even the simplest tasks, observers commonly fail to notice a stimulus — either an object or an event — that, in hindsight, appears obvious. This is known as inattentional blindness and was famously demonstrated in an experiment where participants, who were required to count the number of ball passes between players, missed seeing a person in a gorilla costume present within the scenario (Simons & Chabris, 1999). Since then, inattentional blindness has been observed in various studies, such as static and moving objects displayed on a computer screen, walking and talking on a cell phone, and simulated assault (Bressan & Pizzighello, 2008; Chabris *et al*., 2011; Hyman *et al*., 2010; Most *et al*., 2001). This failure to perceive seemingly noticeable stimuli is thought to reflect limitations in one's attentional capacity and the selective processing of information (Mack, 2003; Simons, 2000).

Within healthcare settings, inattentional blindness can have real-world implications for clinical diagnosis, with high rates of diagnostic errors being partially attributed to this phenomenon (Garg et al., 2022; Jager *et al*., 2014). For example, Kim and Mansfield (2014) found that out of 1,269 abnormalities present in 656 radiology examinations, 42% were missed. Notably, 7% of these errors were attributed to inattentional blindness.

While human error cannot be discounted in such incidents, even experts are susceptible to inattentional blindness (Ekelund *et al*., 2022). Some studies have suggested that expertise might reduce its occurrence by freeing up attentional resources (Drew *et al*., 2013; Pammer *et al*., 2018; Simons & Schlösser, 2017), while others have claimed experts may be more susceptible due to their deep focus on specific tasks (Ho *et al*., 2017). However, a meta-analysis revealed that experts only had marginally improved performance compared with novices, and crucially, that differing stimuli (e.g., experimental manipulation such as a non-clinical image cf. clinically relevant such as a lung nodule) had minimal modulating effects, even when it was related to the expert's domain (Ekelund *et al*., 2022). In one of the included studies, Drew *et al*., (2013) found that 83% of expert radiologists failed to identify an image of a gorilla located in computed tomography (CT) images of the lungs, despite the gorilla being 48 times larger than the average lung nodule. Expectedly, expert radiologists outperformed naïve participants with no medical training in regard to the mean lung nodule detection rate (55% vs. 12%), but only slightly outperformed them when it came to inattentional blindness (83% vs. 100%).

Building on previous work (Drew *et al*., 2013), Williams *et al*., (2021) used clinically relevant stimuli in the form of an incidental finding, which is the discovery of unexpected or unrelated abnormalities (Lumbreras *et al*., 2010). In their first study, when searching for lung nodules, 66% of radiologists did not report an incidental breast cancer mass. However, in their second study, with a different sample of radiologists, only one out of 30 radiologists did not report it when they were asked to check all the abnormalities present from a list of six options (Williams *et al*., 2021). These studies emphasize the

robustness of the inattentional blindness phenomenon across stimuli and underscore the need to mitigate its impact in clinical practice, given the harm that could arise from missed incidental findings for both patients and clinicians (Berlin, 2007; Morris *et al*., 2009).

To reduce the high incidence of diagnostic errors in radiology generally, several strategies are used with varying success. For example, double-reading, where two or more radiologists examine the same images, is grounded in the belief that multiple clinicians reviewing the same images improves accuracy. Yet the rates of discrepancy between clinicians' diagnoses are relatively low and therefore need to be balanced against demanding workloads (Geijer & Geijer, 2018). Additionally, a considerable number of second-opinion radiology reports go unread, suggesting the potential for more efficient resource allocation (Heinz *et al*., 2020). Thus, there is a need for a low-resource-dependent solution that can be easily integrated into radiologists' workflows.

One such tool might be a medical checklist. Medical checklists have been proposed by several researchers over the years to try and address the challenge of inattentional blindness in medical imaging (Gefter & Hatabu, 2023; Williams *et al*., 2021). They are common within healthcare settings and encouraged in diagnostic radiology generally (Iyer *et al*., 2013), typically consisting of a series of steps or questions to help guide medical professionals during tasks such as surgical procedures, medication administration, and patient admissions and discharges (Winters *et al*., 2009). Studies have demonstrated their effectiveness in reducing prescription, and surgical errors (Alagha *et al*., 2011; Haugen *et al*., 2015; Haynes *et al*., 2009; Thomassen *et al*., 2014). To date however, limited research has assessed the efficacy of a checklist in medical imaging, and no study has comprehensively tested the use of a checklist in relation to the incidence rate of inattentional blindness among radiologists when interpreting chest CT scans. Whilst the study discussed above (Williams *et al*., 2021) suggests a checklist might have some efficacy, its scope is restricted by the analysis of only two scans and no control group.

One study, however, does provide some support for its use. The study found that among 40 medical students who were tasked with reading 18 chest X-rays, those who used a systematic medical checklist detected more abnormalities compared with those who did not (Kok *et al.,* 2017). In contrast, research using a checklist-style structured report for maxillofacial CT scans did not find any increase in the reporting accuracy rates for undetected pathology issues (Powell *et al*., 2014). The main drawback identified in this previous study (Kok *et al*., 2017) was that the systematic checklist was too time-consuming as it consisted of anatomical areas, potential pitfalls, and commonly missed diagnoses. This poses significant implementation challenges in a clinical setting where accuracy and efficiency are key.

Perhaps more suited to real-life clinical settings would be a concise medical checklist, consisting of short, simple questions that can encompass a range of possible findings and abnormalities, without the need to specify all of them. The underlying rationale is

that a checklist might disrupt the observer's cognitive process, effectively slowing them down and potentially enhancing their overall visual perception and decision-making accuracy (Croskerry *et al*., 2012a, 2012b; Ely *et al*., 2011).

The aim of the current study was to determine if a concise medical checklist could reduce inattentional blindness among radiologists, thereby resulting in greater detection of clinical abnormalities. It was hypothesised that 1): a concise checklist would facilitate a more vigilant search strategy, leading to improved detection of lung nodules, and 2): using the checklist would increase the detection rate of incidental findings.

Method

A between-group quasi-experimental design was used comparing two independent groups (experimental (checklist) or control (no checklist)) on the detection of lung cancer nodules (hypothesis 1) and breast cancer symptoms (hypothesis 2).

Participants

An *a priori* power analysis, conducted using G*Power 3.1 (Faul *et al.,* 2007), using an independent samples *t*-test (α = .05 and effect size of d = 0.5 at 80% power determined that a sample size of 128 participants (64 participants per group) was required. A group allocation matrix was created based on the desired sample size (n = 124) using an online randomisation tool (https://www.graphpad.com/quickcalcs/randomize1/; GraphPad, Boston, MA). A total of 64 participant numbers were randomly assigned to either Group A or Group B. Participants assigned to Group A were allocated to the experimental group (with the checklist), while those assigned to Group B were allocated to the control group (without the checklist).

Participants had to be aged 18+ years old, and an attending radiologist or a resident in a radiology training program. Participants could not participate if they had self-reported abnormal or non-corrected vision. The study was approved by the Faculty of Health and Life Sciences Ethics Committee at Northumbria University (ref: 4953). All participants provided electronic informed consent.

Recruitment began by contacting radiology line managers at three cancer centres in Guangzhou, China, who advertised the study on *WeChat*, and by word of mouth. The line manager communicated when and where the researcher (C.L) was on-site conducting the study. A total of 32 participants were recruited. Upon signing up for the study, each participant was sequentially assigned a participant number and allocated to either the experimental or control group accordingly.

Materials and Measures

Pre-task survey

Participants completed a self-report pre-task survey that gathered demographic information, including professional experience (the number of years that they had been working in the field of radiology), position, specialty, the number of CT scans interpreted by each radiologist per week, and vision-related impairments.

Computed tomography (CT) stacks

The same anonymised seven chest CT stacks used by Williams *et al.,* (2021) were used in this study, six of which are freely available from the Lung Image Database Consortium (LIDC) for research purposes (Armato *et al.,* 2011).

Three of the CT stacks (CT1, CT4, CT6 and CT7) contained lung nodules, and three did not (CT2, CT3 and CT5). CT stack 1 (the practice case), had eight lung nodules; CT stack 4 had 23; CT stack 6 had 10; and CT stack 7 (the inattentional blindness stack) had eight lung nodules. Williams *et al.,* (2021) reported the inattentional blindness stack as having nine lung nodules. However, one specified location did not appear to show a visible nodule, resulting in a total of eight lung nodules in this study. The seventh CT stack also included a large (9.1 cm) breast cancer mass, visible on 17 of 66 image slices, along with lymphadenopathy. These incidental findings served as the inattentional blindness stimuli and were chosen for their clear visibility within typical lung window settings (*Figure 1*). All stacks had a resolution of 512x512 pixels.

Lung nodule detection accuracy was measured by comparing participants' annotations with the LIDC reference data (Armato *et al.,* 2011) based on screen-recorded videos. Annotations were deemed accurate if they were within 30 pixels and two slices of the nodule's centre of mass. For the inattentional blindness stack, the location of the lung nodules was obtained from a previous study (Williams *et al*., 2021) and the same process applied.

Participants reviewed each of the seven chest CT stacks sequentially (one practice and six experimental) marking all nodules ≥3 mm using MicroDicom Viewer (MicroDicom Ltd, Sofia, Bulgaria) on a Microsoft Surface 7 tablet computer. The CT stacks were preloaded, and the screen's brightness set to full (104 nits). The Window Level (WL) and Window Width (WW) were configured to standard lung settings (WL = 400, WW = 1600) and kept constant throughout the task (*Figure 2*). Participants used a preselected ellipse measuring tool to the mark lung nodules. The screen activity was recorded using Snipping Tool (version 11.2, Microsoft Corporation, Redmond, USA)

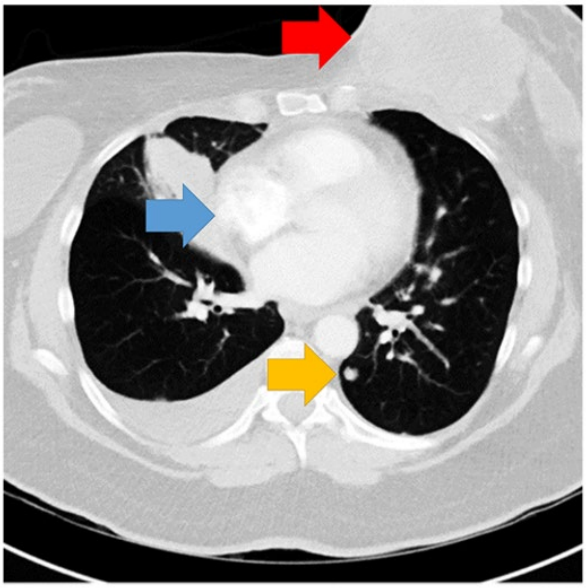

Figure 1: Annotated Image of the Inattentional Blindness CT Stack (note: the breast cancer mass is indicated by the red arrow, lymphadenopathy by the blue arrow, and a lung nodule by the yellow arrow. These arrows were not visible in the experimental display

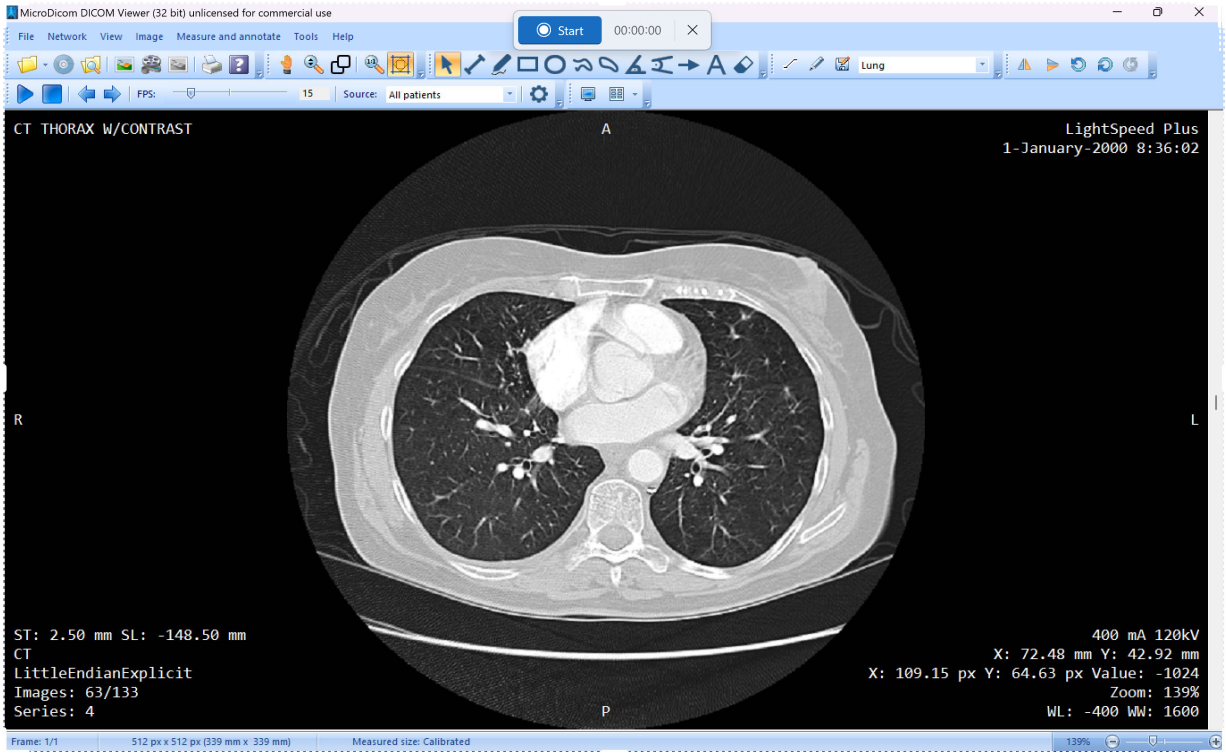

Figure 2: A screenshot from CT Stack 1 illustrating the WL and WW settings (note: The displayed image illustrates commonly used lung windowing parameters (WL = 400, WW = 1600)).

Concise medical checklist

The checklist (Table 1) was developed in consultation with an expert radiologist with over 30 years of clinical and research experience, along with strategies for minimising potential misdiagnoses (Busby *et al*., 2018). The questions were designed to be simple yet comprehensive, covering a range of possible findings without the need to enumerate all of them nor significantly increase radiologists' workloads (Cankurtaran *et al.,* 2023).

Table 1: concise medical checklist questions

Question	Response
1. Did you adhere to your primary and secondary search patterns?	Yes / No
2. Did you remember to check your blind spots?	Yes / No
3. Are you satisfied with your searching?	Yes / No

Question 1 was intended to ensure that the radiologist followed a structured and systematic approach during the scan, ensuring that no areas were missed; Question 2 served as a reminder for radiologists to check areas that might not have been immediately visible or were typically overlooked, reducing the chance of inattentional blindness; and Question 3 encouraged self-reflection, prompting radiologists to assess whether they felt confident in their diagnostic process.

Post-task survey

All participants answered a post-task survey (Table 2) that assessed their awareness of the breast cancer mass and lymphadenopathy in CT stack 7. The post-task survey used the same questions as a previous study (Williams *et al*., 2021).

Table 2: post-task survey questions

Question	Response
1. Did the final case seem any different than any of the other trials?	Yes / No
2. Did you notice any other medically relevant findings on the final case	Yes / No
3. Did the final case show signs of breast cancer?	Yes / No
4. Did the final case show signs of lymphadenopathy?	Yes / No

Questions 1 and 2 were presented in the same order for all participants, as in a previous study (Williams *et al.,* 2021). Questions 3 and 4, could not be randomized without displaying the questions on the same page concurrently, which could have impacted the truthfulness of the participants' responses. Instead, they were presented one per page, in the order above.

All materials were originally written in English and translated into Mandarin by a certified translator. A back translation was also conducted using an online platform. This was performed by a member of the research team (C.L.) whose native language is English and who was not fluent in Mandarin, allowing for an unbiased comparison.

Procedure

Data collection took place at participants' workplaces. All study measures, including the pre-task survey, concise medical checklist and post-task survey, were completed electronically on participant smartphones using Qualtrics XM (Qualtrics, Provo, UT). After providing consent, participants completed the pre-task survey. Next, participants reviewed each of the seven chest CT stacks sequentially (one practice and six experimental) marking all nodules. Participants in the experimental group completed the concise medical checklist after reviewing each CT stack before moving on to the next one. After completing the CT task, all participants answered the post-task survey. Finally, participants received a debrief sheet, and the researcher (C.L.) was available to answer any questions.

Data analysis

To assess if the concise medical checklist would improve lung nodule detection by facilitating a more vigilant search strategy (hypothesis 1), continuous variables, including lung nodule detection accuracy and task duration, were examined. The Mann-Whitney *U* test was applied to these variables, as the data distribution did not meet the assumptions for parametric tests. To assess if the checklist increased the detection rate of incidental findings (hypothesis 2), categorical variables were analysed. These included participants' responses to the checklist questions ('yes/'no') and whether they noticed signs of breast cancer or lymphadenopathy in the final case ('yes/'no'). A chi-square test was used to analyse these categorical data. Between-groups effect sizes were interpreted as $d = .1$ for a small effect size, $d = .3$ for a medium effect size and $d = .5$ for a large effect size (Fritz *et al.,* 2012). All statistical analyses were carried out using SPSS (version 28).

Results

Participant demographics are summarised in Table 3.

Table 3: participant demographics

	Control (*n* = 14)	**Experimental (*n* = 18)**
Gender (male / female; *n* (%)	6 male (43) / 8 female (57)	5 male (28) / 13 female (72)
Profession (*n* (%))	10 Residents (71) / 4 Attendings (29)	16 Residents (89) / 2 Attendings (11)
Specialisation (%)	Abdominal Radiology (21) / Neuroradiology (21) / Thoracic Radiology (14) / Musculoskeletal Radiology (7) / Other (36)	Abdominal Radiology (39) / Breast Imaging (17) / Neuroradiology (11) / Interventional Radiology (6) / Other (28%)
Age (years; M / SD)	27.79 (8.92)	28.00 (7.30)
Experience (years; M / SD)	4.64 (9.06)	3.39 (6.51)
Scans/week (years; M / SD)	181.43 (105.01)	180.00 (105.01)

Abbreviations: F: female; M: mean; SD: standard deviation

Task duration

The task duration was equivalent across the groups (experimental: M = 22.82 mins, SD = 8.00 mins; control: M = 22.17 mins, SD = 4.90 mins; $p > .05$).

Lung nodule detection accuracy

When including the practice case (CT1) with CT stacks 4, 6, and 7, the mean nodule identification score for the control group was 30.57 (SD = 6.13) out of 49 (62%), while the experimental group scored M = 27.16 (SD = 7.53) out of 49 (55%). The Mann-Whitney *U* test indicated no significant between-group difference ($U = 82.50$, $Z = -1.65$, $p > .05$), accompanied by a medium effect size ($r = -.29$). Excluding the practice case yielded similar results (control group: M = 25.50, SD = 5.04) out of 41 (62%), experimental group: (M = 22.88, SD = 6.03) out of 41 (55%), $U = 80.50$, $Z = -1.73$, $p > .05$, $r = -.30$). Performance on CT stacks 1 and 4 was lower than on stacks 6 and 7, with both groups scoring similarly on the inattentional blindness stack (CT7), as shown in Table 4.

Table 4: control and experimental group lung nodule detection scores

	CT Stack 1	**CT Stack 4**	**CT Stack 6**	**CT Stack 7**
Control (M / SD)	5.07 (1.43)	10.43 (3.00)	8.07 (2.01)	7.00 (0.87)
Control (%)	63	45	80	88
Experimental (M / SD)	4.28 (2.13)	8.28 (3.83)	7.61 (2.20)	7.00 (1.02)
Experimental (%)	54	35	76	88

Abbreviations: CT: computed tomography; SD: standard deviation

Additional markings

All participants made additional markings on the CT stacks that were not classified as lung nodules according to the reference data, including duplicate markings, visibility of lung nodules across multiple image slices, lung nodules ≤ 3mm, and other suspected abnormalities. The experimental group made numerically more additional markings compared with the control group across five CT stacks, although all group differences were not statistically significant (all *p*-values >.05; Table 5).

Table 5: control and experimental group additional markings (lung nodule) detection scores

	Control (*n* = 14)		**Experimental (*n* = 18)**			
Stack	Mean	SD	Mean	SD	*p*-value	Effect size (*r*)
CT1 (8)	3.50	1.74	4.78	3.82	.47	.12
CT2 (0)	0.64	1.15	1.06	2.10	.93	.01
CT3 (0)	1.86	1.70	2.28	5.37	.24	.20
CT4 (23)	5.93	3.73	5.00	5.41	.15	.25
CT5 (0)	1.14	1.87	0.28	0.75	.09	.29
CT6 (10)	13.07	7.45	17.39	11.84	.31	.17
CT7 (8)	2.36	2.56	2.39	3.97	.66	.07

Note: the number of lung nodules for each CT stack is provided in brackets
Abbreviations: CT: computed tomography; SD: standard deviation

Concise medical checklist

The experimental group's frequency of and percentage of responses to the medical checklist questions are shown in Table 6.

Table 6: Concise Medical Checklist responses

	Question 1		**Question 2**		**Question 3**	
Stack	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
CT1 (*n* / %)	17 (94)	1 (6)	12 (67)	6 (33)	16 (89)	2 (11)
CT2 (*n* / %)	17 (94)	1 (6)	14 (78)	4 (22)	13 (72)	5 (28)
CT3 (*n* / %)	15 (83)	3 (16)	14 (78)	4 (22)	13 (72)	5 (28)
CT4 (*n* / %)	17 (94)	1 (6)	16 (89)	2 (11)	17 (94)	1 (6)
CT5 (*n* / %)	16 (89)	1 (6)	15 (83)	2 (11)	11 (61)	6 (33)
CT6 (*n* / %)	16 (89)	2 (11)	15 (83)	3 (17)	17 (94)	1 (6)
CT7 (*n* / %)	18 (100)	0 (0)	16 (89)	2 (11)	17 (94)	1 (6)

Notes: Question 1: Did you adhere to your primary and secondary search patterns?; Question 2: Did you remember to check your blind spots?; Question 3: Are you satisfied with your searching? One participant did not complete the medical checklist for CT stack 5.
Abbreviations: CT: computed tomography

Post-task survey

Question 1: Did the final case seem any different than any of the other trials?

In the experimental group, 94% of participants reported that the last case appeared different, while it was 86% in the control group. A chi-square test revealed no statistically significant difference between the groups, with a small effect size ($\chi^2(1) = .70$, $p > .05$, $V = .14$).

Question 2: Did you notice any other medically relevant findings on the final case?

In the experimental group, 78% of participants did not report seeing signs of breast cancer, while in the control group, 79% did not report seeing signs. A chi-square test revealed no statistically significant difference between the groups, with a negligible effect size ($\chi^2(1) = .00$, $p > .05$, $V = .01$).

Question 3: Did the final case show signs of breast cancer?

In the experimental group, 78% of participants did not report seeing signs of breast cancer, while in the control group, 79% did not report seeing signs. A chi-square test

analysis revealed no statistically significant difference between the groups, with a negligible effect size ($\chi^2(1) = .00$, $p > .05$, $V = .01$).

Question 4: Did the final case show signs of lymphadenopathy?

Fifty-eight percent of participants in the experimental group and 50% of the control group noticed signs of lymphadenopathy. One response was missing for this question in the experimental group. A chi-square test revealed no statistically significant difference between the groups, with a negligible effect size ($\chi^2(1) = .24$, $p > .05$, $V = .08$).

Discussion

This study aimed to assess whether a concise medical checklist could mitigate inattentional blindness among radiologists when interpreting chest CT stacks. The findings suggest that, contrary to the hypotheses, the medical checklist did not lead to any noticeable benefits in the detection of lung nodules (hypothesis 1), nor breast cancer symptoms (hypothesis 2).

Notably, the control group had a higher mean identification score compared with the experimental group (62% vs. 55%), though the difference was not statistically significant. The performance of both groups was also similar to the findings in a previous study (Williams *et al.,* 2021). Considering the slightly higher detection rate in the control group, the checklist used by the experimental group may have potentially had a negative impact on performance. For instance, the experimental group tended to make more additional markings, but at the same time, detected numerically fewer lung nodules. This warrants further investigation to explore the checklist's influence on detection outcomes.

Equally, the checklist showed no superior performance in detecting the lymphadenopathy or breast cancer. This was despite the majority of participants reporting a perceived difference in the last CT stack (control group 85%, experimental group 94%). Nearly 80% of participants in both groups failed to notice the breast cancer mass, a rate higher than the 66% reported in a previous study (Williams *et al.,* 2021). It is possible that the checklist primed radiologists in the experimental group to anticipate something different about the final CT stack; however, it failed to yield favourable outcomes in detecting the incidental findings.

While the checklist appeared to influence the behaviour of some participants, this effect was not universally observed across the experimental group. Although the responses indicated a gradual shift from “no” to “yes” this may have been due to socially desirable responding. A small minority still reported not adhering to their primary search patterns nor checking their blind spots as they progressed through the CT stacks. This suggests the checklist may have been treated as a checkbox exercise by some participants. It could also indicate satisfaction of search bias, which refers to

the tendency for some radiologists to curtail their search efforts after identifying one or several abnormalities. While this can be seen as a strategy to conserve cognitive resources, it can also leave room for oversight (Berbaum, 1990; Busby *et al.,* 2018).

A potential explanation for these non-significant findings could be that the checklist was not sensitive enough. A more explicit and systematic checklist may have resulted in improved performance, as seen in Williams *et al*.'s (2021) second study, where 97% of radiologists noticed the breast cancer mass when they were specifically prompted to check for it. Yet, more detailed checklists can be time-consuming (Kok *et al.* 2017). Given the multitude of potential abnormalities, a comprehensive systematic checklist would likely necessitate categorisation based on importance, ultimately complicating the already rocky landscape of incidental findings (see Booth *et al*., 2016). Moreover, participants in this study reported reading an exceptionally high number of scans per week, rendering a lengthy checklist impractical as a clinically useful tool. In a previous study (Williams *et al*., 2021), radiologists reported reading an average of 41 CT scans per week. In contrast, radiologists in this study read approximately 180 scans per week. This discrepancy is likely due to the excessive patient workloads in China (Li & Xie, 2013).

Based on the performance results above, it raises the question of whether the concise medical checklist was actually competing for the radiologists' attention instead of aiding it. It may have inadvertently added to their cognitive demands by introducing an additional task. This diversion from the primary task may have obscured not only their ability to find lung nodules but also their capacity to detect other possible abnormalities. This aligns with Grissinger's perspective on medication errors and inattentional blindness, in which the author dismisses the use of "*error reduction strategies*" (Grissinger, 2012, p. 542), which would include the use of an intervention like a checklist. Instead, Grissinger (2012) advocates two methods: those that seek to minimize potential distractions and those that seek to enhance the visibility of important information. This is because splitting our attention may increase errors, irrespective of whether one of the things dividing our attention is actually a reminder to remain visually attentive, as was the case in this study.

Regarding Grissinger's (2012) first point on minimising distractions, it is well-established that multitasking often compromises task performance because when we attempt to multitask, we merely end up switching between tasks. This overwhelms the demands placed on the neurocognitive systems that support and control sustained attention, making tasks longer to complete (Madore & Wagner, 2019). Similarly, it may be that the introduction of the medical checklist increased both the perceptual load — the number of items that needed to be attended to — and the cognitive load, increasing the difficulty of the primary task (Matias *et al*., 2022). It may have also heightened uncertainty, as reflected in the higher number of additional markings in the experimental group. This may have made it more challenging for observers to detect the unexpected stimuli, as they juggled lung nodule detection and completing the

checklist, which may have been further compounded by having to jump between electronic devices (computer and smartphone). This is supported by evidence indicating that distractions from a primary task — whether walking, driving, or using a mobile phone — can increase inattentional blindness (Chen *et al*., 2016; Strayer *et al*., 2011). Additionally, the implementation of distraction-free practices and zones in the administration of medication among nurses, has shown a significant reduction in errors of up to almost 80% in some instances (Connor *et al*., 2016; Westbrook *et al*., 2017). Thus, the cognitive and perceptual demands of managing multiple tasks, such as marking lung nodules and completing the checklist, may not yield benefits in performance when compared with not using the checklist. If this is the case, it could render the concise checklist defunct, or worse, unintentionally lead to reduced awareness and decreased sensitivity to unexpected stimuli, making it detrimental to performance.

To address this, one approach to sustaining attention on a primary task while minimizing internal noise and remaining receptive to unexpected stimuli is said to be mindfulness. This method shifts the focus from relying on external aids to fostering an internal strategy for combating inattentional blindness (see Schofield *et al.,* 2015; Burton *et al*., 2016). Some support for this comes from a controlled pilot study among young neurosurgeons, which revealed that those who underwent an eight-week mindfulness-based intervention programme had a lower incidence of inattentional blindness errors compared with a control group (Pandit *et al*., 2022).

Regarding to Grissinger's (2012) second point on enhancing the visibility of potentially important stimuli, success in the field of medical imaging inevitably depends on developments in artificial intelligence and machine learning. This is because, while changes in medical imaging technology have become more advanced, the shift from X-rays to more advanced imaging like CT scans, the human brain and eye remain unchanged (Robinson, 1997). Artificial intelligence is already being utilised in some hospitals to assist radiologists. These systems typically highlight potential regions of interest in a bright colour for the radiologists to review, with some detecting lung nodules even years in advance (Lovelace Jr *et al*., 2023). The performance of such tools in the field of lung nodule detection is often equivalent to or better than human observers (Gu *et al*., 2021a, 2021b; Li *et al*., 2022). However, future studies are essential to explore their full potential with respect to inattentional blindness, as increased luminescence is unlikely to eliminate inattentional blindness because it still requires human verification, ultimately leaving it at risk of oversight despite brightly coloured potential abnormalities appearing unmissable.

This study has several limitations, most notably the small sample size. A larger sample is essential to thoroughly assess the efficacy of various medical checklists among radiologists when examining CT stacks. Some scholars have highlighted the need for larger sample sizes to ensure the generalizability and reliability of findings in radiological research (Blackmore, 2001). Additionally, the absence of eye-tracking

data limited the ability to correlate participants' observations of the breast cancer mass with their gaze patterns, as in a previous study (Williams *et al.,* 2021). The translation of the written materials is also a further limitation. Although they were translated by a certified translator, the back translation was conducted by a member of the research team rather than by someone unfamiliar with the study's purpose. Lastly, despite the considered methodology used for calculating lung nodule detection accuracy, it was done manually, introducing the potential for human error, namely inattentional blindness. The impact of manual error on diagnostic accuracy is well-documented in the literature (Berbaum *et al*., 1990; Kim & Mansfield, 2014).

Overall, the findings suggest that a concise medical checklist may not effectively reduce inattentional blindness among radiologists evaluating chest CT scans. The checklist showed no clear benefits in marking lung nodules and may even lead to similar or worse performance than not using it. Instead, efforts might be better focused on helping radiologists reduce internal noise and finding ways to enhance the importance of unexpected stimuli. However, further research is needed before fully dismissing the potential of checklists in addressing inattentional blindness in medical imaging.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

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