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The development of the Negative Mental Imagery Questionnaire (MIQ-N)

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Abstract

Background: Mental imagery plays a key role in the onset and maintenance of psychological disorders, and has become the target of psychological interventions for the treatment of several anxiety-related conditions. However, there are currently no transdiagnostic measures designed to assess the varied dimensions of mental imagery relevant to psychopathology.
Aim: To develop and validate a new measure assessing the experiences and appraisals of negative mental imagery.
Method: The initial item pool was generated through a comprehensive literature review and interviews with subject-matter experts. An online community sample provided data for the exploratory ($n = 345$) and confirmatory ($n = 325$) factor analyses.
Results: The new 16-item Negative Mental Imagery Questionnaire demonstrated four subscales (Intrusiveness, Controllability, Beliefs about Mental Imagery, and Realness). Reliability and validity were good to excellent for both the full- and sub-scales.
Conclusions: Appraisals of mental imagery captured by the new measure are consistent with previous research on mental imagery and psychopathology.

Keywords: intrusive images; mental imagery; negative images; questionnaire; trans-diagnostic

Introduction

Mental imagery has been defined as the experience of 'seeing with the mind's eye' or 'hearing with the mind's ear' in the absence of the actual perceptual information (Kosslyn *et al.*, 2001). Mental imagery can include any sensory modality and enables people to vividly recall past events as well as mentally simulate hypothetical future events ('flash-forwards') (Ji *et al.*, 2016; Laing *et al.*, 2016). The purpose of this internal mental simulation has been argued to be the generation of specific predictions based on past events (Moulton & Kosslyn, 2009). Advances in cognitive neuroscience and functional imaging have highlighted the shared underlying neural circuity within both perception and mental imagery, which helps us understand how imagery is often described as being experienced 'as it were real' (Kosslyn *et al.*, 2001).

Beck originally described cognitive theory in which cognitions could present in the form of verbal thoughts or mental images (Beck *et al.*, 1976). That is, an individual may experience themselves as 'in danger' both in the form of the verbal thought 'I am about to be attacked' or in the form of an internally generated image of themself in which they are 'being attacked'. Within this example, the emotional impact of the mental image will be higher than that of the verbal

thought (Holmes *et al.*, 2008b). The impact of the image will also vary depending on characteristics such as vividness, this being via the shared neural circuitry and the more vivid image being experienced as 'more real'. However, a cognitive approach allows us a wider understanding of the impact of mental imagery. First, as said, the image is a cognition and is imbued with meaning which can be exposed and explored within cognitive therapy. Second, just as metacognitive beliefs about verbal thought contribute to an emotional outcome (Wells, 2010), an individual's beliefs about their mental images are also important to understand. For example, a belief that a current mental image is an accurate prediction of a future event will have significant implications.

Whether a mental image is experienced as either 'positive' or 'negative' will, therefore, depend on a number of variables. Another important characteristic of mental imagery is an individual's belief about their control over the experience. This may range from a fully controlled mental simulation to an intrusive image which is experienced as involuntary, unwelcome and distressing. Whilst these emotional intrusive mental images are considered the 'hallmark' symptom of post-traumatic stress disorder (Ehlers and Clark, 2000), they are also present in the development and maintenance of a wide variety of other mental health problems (Çili and Stopa, 2015), including social phobia (Hackmann *et al.*, 2000), health anxiety (Muse *et al.*, 2010), and obsessive compulsive disorder (Coughtrey *et al.*, 2015). Such experiences overlap with many of the features of a hallucinatory experience within a psychotic presentation. Furthermore, when based on memories, these images may not always be accurate representations of past events (see Çili and Stopa, 2022). Consequently, intrusive negative mental imagery has been identified as a potential target for psychological interventions (Arntz, 2012; Skottnik and Linden, 2019).

Within a cognitive behavioural framework (Harvey *et al.*, 2004), both content and appraisals of emotional mental imagery have been shown to play key roles in the development and maintenance of distress (Kelly *et al.*, 2017; Reimer and Moscovitch, 2015). Psychological interventions have therefore focused on these specific mechanisms. One example of an imagery based psychological intervention is 'imagery rescripting', a widely used approach that involves the vivid recall of past events, including trauma and other adverse life experiences, in all modalities and then using a 'rescript' of these events to modify their meaning (e.g. Arntz, 2012; Luppino *et al.*, 2020; Ritter and Stangier, 2016). This approach has been developed to work with people suffering from trauma reactions who have received varied diagnoses (e.g. Paulik *et al.*, 2019). Interventions have also been developed to target an individual's beliefs about mental images. People who suffer distress in relation to their images often report that they believe that they are not in control of the experience. If these experiences are not trauma memories, then some basic imagery manipulation exercises can teach people that they can take control of the content of the image, which has a positive impact (Steel *et al.*, 2023). For example, an individual may be troubled by a repetitive image of a future event in which they are attacked. This image can be held in mind, and then manipulated through changing colour, context, wind and rewind, so the person increases their beliefs about their control over the image.

There are numerous imagery measures and tasks available to assess individual differences in mental imagery experiences (for a review, see Pearson *et al.*, 2013). However, clinically relevant measures are limited to specific aspects of emotional mental imagery such as re-experiencing trauma memories in PTSD (e.g. Impact of Events Scale-Revised; Weiss and Marmer, 1997) and prospective intrusive imagery (e.g. Impact of Future Events Scale; Deeprose and Holmes, 2010). A semi-structured interview developed by Hackmann and colleagues (Hackmann *et al.*, 2000) has been used to assess the frequency, nature and meaning of recurrent imagery in social anxiety, and subsequently adapted for use in relation to other disorders (Hales *et al.*, 2011; Holmes *et al.*, 2007). However, despite the increasing evidence for the role of mental imagery in psychopathology, there are currently no transdiagnostic measures which aim to measure the experience of clinically relevant aspects of mental imagery. Moreover, although measures have been used to assess the

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appraisals of mental imagery within specific disorders, e.g. depression (Starr and Moulds, 2006), there are no transdiagnostic measures for this purpose.

Although both negative and positive mental imagery have been shown to drive mood instability in bipolar disorder (Holmes *et al.*, 2008a), and a lack of future positive images is associated with low mood (Morina *et al.,* 2011), it is commonly the presence of negative intrusive images that are thought to maintain symptomatology in other mood and anxiety disorders (Çili and Stopa, 2015). Therefore, the aim of the present study was to develop a transdiagnostic measure of visual mental imagery that captures negative mental imagery experiences and appraisals commonly experienced within mental health problems, e.g. a belief that imagery is uncontrollable. The measure is based on, and intended to be used within, a cognitive behavioural framework. Although imagery is a multi-modal phenomenon, we have focused on visual images as this is the modality where most clinical and research developments have occurred, and therefore the modality within which a measure is most needed.

Method

Design

The study used a cross-sectional design, with exploratory factor analysis (EFA; sample 1) and confirmatory factor analysis (CFA; sample 2) used to determine the factor structure of the new measure. Convergent and divergent validity was evaluated using correlational analyses, and discriminant validity was established through independent *t*-tests using data from the combined EFA sample. Finally, a third sample was used to assess test–retest reliability.

Participants

Sample 1: Exploratory factor analysis

The community sample for the EFA was recruited via social media, email circulation to known contacts (not specific groups), and through advertisements placed on research recruitment websites (e.g. Psychological Research on the Net). Participants were required to be aged 18 and above, with no other inclusion or exclusion criteria. No reward was offered in exchange for participation.

The online survey was accessed by 978 participants, of which 676 (69%) completed the consent form, 634 (64.8%) completed the demographic information questions, and 364 (37%) completed all measures. Cases where the response time was less than 10 minutes ($n = 19$) were removed, response times were also screened for excessive time taken ($n = 0$) to ensure that only genuine responses were included. The final sample used for data analyses consisted of $n = 345$ participants, a subject to item ratio of >7:1.

Approximately two-thirds of participants were female (73%), predominantly White (77.4%), and educated to undergraduate (28.1%) and postgraduate level (33.2%). Age ranged from 18 to 74, with more than half of the sample aged between 18 and 34 (64.4%). Further information regarding sample characteristics can be found in Table 1.

Sample 2: Confirmatory factor analyses

The sample for CFA was recruited via an undergraduate recruitment system (SONA) and word of mouth via social media. Usable data were obtained from 325 individuals (84.6% female) aged 18–54, with 93% of individuals aged between 18 and 24. The sample was predominantly white (81.2%), single (81.8%) and currently in education (83.4%; see Table 1 for full participant characteristics).

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Table 1. Sample socio-demographic characteristics

		EFA sample	CFA sample
		n (%)	*n* (%)
Sample size		345	325
Gender	Male	86 (24.9)	46 (14.2)
	Non-binary	5 (1.4)	3 (.9)
	Female	252 (73)	275 (84.6)
	Prefer not to say	1 (0.3)	1 (.3)
	Prefer to self-describe	1 (0.3)	0 (0)
Age	18–24	91 (26.4)	303 (93.2)
	25–34	131 (38)	15 (4.6)
	35–44	49 (14.2)	6 (1.8)
	45–54	39 (11.3)	1 (.3)
	55–64	24 (7)	0 (0)
	65–74	11 (3.2)	0 (0)
	75–84	0 (0)	0 (0)
	85+	0 (0)	0 (0)
Ethnicity	Asian or Asian British	27 (7.8)	28 (8.6)
	Black, Black British, Caribbean or African	9 (2.6)	7 (2.2)
	Mixed or multiple ethnic groups	21 (6.1)	18 (5.5)
	White	267 (77.4)	264 (81.2)
	Prefer not to say	5 (1.4)	0 (0)
	Other ethnic group	16 (4.6)	8 (2.5)
Marital status	Single	133 (38.6)	266 (81.8)
	Married/civil partnership	100 (29)	2 (.6)
	Cohabiting/long-term relationship	93 (27)	46 (14.2)
	Separated/divorced	12 (3.5)	4 (1.2)
	Widowed	3 (0.9)	0 (0)
	Prefer not to say	4 (1.2)	7 (2.2)
Education	GCSE or equivalent	29 (8.4)	1 (.3)
	A-levels or equivalent	56 (16.2)	309 (95.1)
	Undergraduate degree	97 (28.1)	13 (4.0)
	Postgraduate degree or Diploma	115 (33.3)	1 (.3)
	Doctoral degree	29 (8.4)	0 (0)
	Other professional qualification	19 (5.5)	1 (.3)
Employment	In education	80 (23.2)	271 (83.4)
	Employed part-time	61 (17.7)	39 (12.0)
	Employed full-time	153 (44.3)	2 (.6)
	Not currently in paid employment	28 (8.1)	10 (3.1)
	Seeking opportunities	8 (2.3)	3 (.9)
	Retired	15 (4.3)	0 (0)

Sample 3: Test–retest reliability

Participants were recruited via an undergraduate recruitment system (SONA) for assessment of test–retest reliability. Participants were required to be aged 18 or above, and willing to complete two test sessions, approximately 6 weeks apart (mean = 46.1 days, $SD = 5.3$ days). No other inclusion or exclusion criteria were used. The survey was accessed by 167 respondents at Time 1, with usable data obtained from 163 people. Data were removed from three people who withdrew consent, and one person due to extensive missing data. Retention for Time 2 was 60.7%, with 99 participants completing the second survey ($M_{age} = 20.26$, $SD_{age} = 4.30$; 79.8% female; 84.8% British). There were no significant differences in age ($t_{127.14} = 1.67$, $p = .10$), gender ($\chi^2(2,N = 163) = 3.27$, $p = .19$) or nationality ($\chi^2(2,N = 163) = 2.59$, $p = .27$) between those who completed both assessments and those who did not return for Time 2.

Measures

Measures were selected for the assessment of convergent, divergent and discriminant validity from the limited number of scales available. Divergent validity was assessed using a general mental

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health measure with discriminant validity assessed using mental health scales related to specific presentations in which distressing mental imagery is prevalent.

Convergent validity

The Spontaneous Use of Imagery Scale (SUIS; Reisberg et al., 2003). The SUIS is a 12-item unidimensional self-report measure of spontaneous visual non-emotional mental imagery use in daily life. Rated on a 5-point scale from 'never appropriate' to 'completely appropriate', the SUIS has good reliability (corrected item-total correlations >.98; Reisberg *et al.*, 2003) and good internal consistency (α = .83; McCarthy-Jones *et al.*, 2012), also demonstrated in the current sample (α = .84). The total score is obtained by summing the scores for all items, and ranges from 12 to 60, where higher scores suggest more mental imagery use in everyday life (Nelis *et al.*, 2014). This measure was chosen within the context of limited transdiagnostic imagery measures being available and it being expected that more frequent imagery experiences overlapping with the aims of the current measure.

Divergent validity

The General Health Questionnaire 12-item version (GHQ-12; Goldberg and Williams, 1988). The GHQ-12 is a widely used and validated screening tool for general mental health problems in primary care settings. The 12 items are rated on a 4-point Likert scale (0–3) and assess the severity of mental health problems for the past month. Total scores on the GHQ-12 range from 0 to 36 and higher scores indicate more severe difficulties. It has demonstrated good reliability, specificity, and internal consistency and high sensitivity (Anjara *et al.*, 2020). Cronbach's alpha in the current sample was excellent (α = .90). This measure was adopted for divergent validity as although there will be some convergence of both measures in relation to general wellbeing, the new imagery measure will be distinct in its target to the level that the convergence should be low.

Discriminant validity

The Obsessive-Compulsive Inventory-Revised (short version, OCI-R; Foa et al., 2002). The OCI-R is an 18-item self-report measure for assessing distress associated with obsessive-compulsive disorder (OCD) symptoms. The items are rated on a 5-point scale (0–4) generating a total score, which ranges from 0 to 72, and six subscales (Washing, Obsessing, Hoarding, Ordering, Checking, Neutralising) with scores ranging from 0 to 12. Total scores above 21 are indicative of OCD. The OCI-R has excellent psychometric properties and differentiates well between individuals with and without OCD (Foa *et al.*, 2002). Cronbach's alpha in the current sample was excellent (α = .93).

Altman Self-Rating Mania Scale (ASRM; Altman et al., 1997). The ASRM is a 5-item self-report questionnaire assessing the presence and severity of manic and hypomanic symptoms. The scale includes five groups of statements, with associated scores ranging from 0 to 4, asking participants to choose one statement from each group that best describes their experience for the previous week. A total score is obtained by summing items 1–5, with scores of 6 and above suggesting a high probability of mania/hypomania. The scale has shown significant correlations with the Clinician-Administered Rating Scale for Mania and Mania Rating Scale, good sensitivity and specificity (Altman *et al.*, 1997), and adequate (α = .73; Kim and Kwon, 2017) to good internal consistency (α = .90; Skokou *et al.*, 2021). In the current sample, Cronbach's alpha was acceptable (α = .65).

Procedure

The development of a version of the measure to be used for data collection included three phases: (i) item generation from the existing literature, (ii) consultation with clinical experts, and

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(iii) feedback on proposed items from a community sample. All stages were applied to the development of both a positive and negative mental imagery questionnaire. Given the more significant role of negative images in clinical settings, the negative scale is disseminated first.

Phase 1 involved a literature search that identified nine existing measures of mental imagery and relevant thought-related questionnaires (e.g. Impact of Events Scale: Weiss and Marmar, 1997; Impact of Future Events Scale: Deeprose and Holmes, 2010). This generated an item pool that could be adapted to capture different aspects of mental imagery. Additional novel items were generated based on published research articles on the role of mental imagery in bipolar disorder and unipolar depression (Hales *et al.*, 2011), social phobia (Hackmann *et al.*, 2000), PTSD (Clark and Mackay, 2015), and psychosis (Chadwick and Birchwood, 1995). The items considered relevant were retained for inclusion and reviewed independently by the second and third authors (J.B. and C.S.).

Phase 2 involved individual semi-structured interviews conducted online and individually with four clinical psychologists with extensive expertise in using imagery-based interventions across a range of disorders. Insights from their experience provided a broad perspective on relevant mental imagery dimensions to consider in developing the current measure. The expert clinicians were also consulted on the item pool regarding item relevance, amendments required, or further additional items to be included.

Interviews were recorded and reviewed noting the key aspects of mental imagery highlighted by clinicians as relevant. Following each interview, clincians were asked to review the intial item pool and feedback on whether the items captured aspects relevant to mental imagery. Clinicians could also make suggestions for further items to be included. To reduce the data, a visual 'map' was created looking to identify any relationships between these aspects of mental imagery. This approach was complemented by a further search of the literature to identify potentially relevant additional mental imagery dimensions. To account for potential data interpretation bias and omission of relevant information, the interviews were also reviewed by the second and third authors. Items were added to those developed in Phase 1 to produce a new item pool.

Phase 3 involved consulting a community sample on the appropriateness and clarity of the item pool generated from Phases 1 and 2. Five participants from the general population (two males, three females; age range 34–45) individually provided feedback on the items as part of a cognitive interview (Boateng *et al.*, 2018). They were asked to read each item and describe how they interpreted the questions, whether they were easy to read and understand, how they would answer them, and whether they would make any changes to the item phrasing. The suggestions made were reviewed in consultation with the second and third authors.

The version of the measure to be used in data collection and psychometric development included 44 items rated on a 7-point scale from 'very untrue of me' to 'very true of me'.

Survey administration and data collection

Data collection for the EFA and CFA was completed between July and September 2021, using an online survey platform (Qualtrics; https://www.qualtrics.com). To account for order effects, the items within the new measure were randomly presented to participants. The mental imagery measure (MIQ-N) was presented first, followed by the SUIS, GHQ-12, OCI-R and ASRM. All questions were made mandatory to avoid incomplete or missing data.

Data collection for the test–retest reliability assessment was completed between February and April 2023, also using Qualtrics (https://www.qualtrics.com). The final version of the questionnaire was presented along with demographic information (age, gender, nationality), at two time points approximately 6 weeks apart (mean = 46.1 days, $SD = 5.3$ days).

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Statistical analyses

Statistical analyses for EFA were conducted using the Statistical Package for Social Sciences (SPSS) for Mac version 28. Data were checked for anomalous responses and only cases with complete data were retained for analysis ($n = 345$). The full range of answer options were endorsed across all items.

To account for data non-normality, the EFA was performed using principal axis factoring (PAF) with oblique (promax) rotation, which allows for inter-factor correlations (Costello and Osborne, 2005). Initial factor extraction was conducted based on Kaiser's criterion of Eigenvalues >1. The recommended number of factors to be extracted, however, was inconsistent with the scree plot, which suggested a smaller number of factors. Subsequent EFAs, after removing items based on low commonalities, produced a factor solution consistent with the scree plot.

The new measure subscales were constructed by retaining the four highest loading items for each factor and subscale reliability was assessed using Cronbach's alpha. Normality tests indicated that data were not normally distributed for any of the measures, except for MIQ-N total scale scores. Therefore, Spearman's rho correlations were conducted to determine the convergent and divergent validity of the new measure. Discriminant validity was established using independent-samples *t*-tests.

The factor structure of the new measure was evaluated using CFA in a new sample ($n = 325$). All analyses were conducted in RStudio (version 2023.06.0) using the Lavaan package (Rosseel, 2012). Model fit was assessed using comparative fit index (CFI), root mean square error of approximation (RMSEA) and standardised root mean square residual (RMSR). Good model fit was confirmed if CFI>.95 and SRMSR is below .06 (Hu and Bentler, 1999), and RMSEA <.06 (Shi *et al*., 2019). Robust values for all measures were interpreted to allow for data non-normality.

Test–retest reliability was evaluated using a third sample ($n = 99$). Intra-class correlation coefficients (ICCs) were used to examine the test–retest consistency for the scale total and each subscale, and a *t*-test was used to compare mean values of the full-scale at Time 1 and Time 2. ICC values were calculated using SPSS (version 25), based on a mean-rating, absolute agreement, two-way mixed effects model. ICC values between .5 and .75 were considered moderate, between .75 and .9 good, and above .9 excellent test–retest reliability (Koo and Li, 2016).

Results

EFA and item reduction

Inter-item correlations ranged from low to moderate and no items correlated at $r>.80$. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity suggested that data were appropriate for EFA (KMO = 0.934; $\chi^2 = 9168.02$, $p<.001$). As no items had commonalities above .80 (to suggest singularity), multi-collinearity was addressed by removing items with commonalities <.50 (Field, 2013). This improved the determinant, suggesting that multi-collinearity was potentially driven by the large number of initial items.

Following removal of items based on commonalities <.50 ($n = 15$), the EFA including the 29 remaining items generated a 5-factor solution based on Eigenvalues >1. Only two items loaded onto factor 5 and were therefore removed, while an additional two were removed as they closely cross-loaded onto factors 1 and 2. A stable model was obtained by specifying a 4-factor solution. Based on the content of the items and mental imagery dimensions being captured, the four factors were named *Intrusiveness*, *Controllability*, *Beliefs about Mental Imagery*, and *Realness*. Items loadings ranged from .50 to 1.0 (Table 2).

Internal consistency

The newly developed Mental Imagery Questionnaire (MIQ-N; 16 items) showed good internal consistency and reliability. Cronbach's alpha was in the good to excellent range ($\alpha = .91$) and subscale alphas ranged from .84 to .90 (see Table 2).

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Table 2. EFA factor loadings for Negative Mental Imagery Questionnaire items

Negative Mental Imagery Questionnaire (MIQ-N)	EFA factor loadings			
Item	Intrusiveness	Controllability	Beliefs about Mental Imagery	Realness
There are negative images from my past that keep coming to mind	1.0			
I had images about the past come to mind when I did not mean them to	.87			
I keep seeing negative images from my past in my mind's eye, without wanting to	.85			
There are images that come to mind that I cannot forget	.79			
Once negative images come to mind, I find it easy to control them		.96		
Once negative images come into mind, I find it easy to make them stop		.93		
I can control my negative images		.92		
I don't get overwhelmed by negative images		.57		
I believe that if I don't control my negative images, they will become real events			.95	
If I become absorbed in the negative images that I get, they will become real			.80	
If I don't control a negative image and then something happened, I would be responsible			.80	
I believe that something bad will happen when I have negative images come to mind			.67	
When I have negative images come to mind, I notice changes in my body e.g. faster breathing or racing heart				.96
Images of the future cause me to have physical reactions, such as sweating, faster breathing, or racing heart				.93
When I have these images, I find myself acting or feeling like the event is really happening				.56
When I have negative images, I feel as though I am actually experiencing the event				.50
Cronbach's alpha	.90	.88	.85	.84

Total scores for the measure were obtained by summing the scores for the four subscales. For the *Controllability* subscale, items were reverse scored prior to computing the total scale score as they were all negatively correlated to the remaining MIQ-N items. A total scale score was used to indicate an overall measure of impact associated with mental imagery that is experienced as vivid, intrusive and uncontrollable.

Means, standard deviations and Spearman's rho correlation coefficients for the MIQ-N subscales and the SUIS, GHQ-12, OCI-R and ASRM are presented in Table 3. Subscales within the MIQ-N were weakly to moderately inter-correlated and strongly correlated with the total scale score ($p<.001$).

Convergent validity

The convergent validity of the new measure was determined by computing Spearman's rho correlations between the MIQ-N and the SUIS. The results showed weak significant correlations ($p<.01$) between three of the MIQ-N subscales and the SUIS (*Intrusiveness*, *Beliefs about Mental Imagery*, *Realness*). This indicates poor convergent validity.

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Table 3. Descriptive statistics and Spearman's rho correlations between MIQ-N total scores, MIQ-N subscales, SUIS, GHQ-12, OCI-R and ASRM

			Mean (*SD*)	1	2	3	4	5
1	MIQ-N	Total	61.38 (18.10)	—				
2		Intrusiveness	18.68 (5.88)	.73**	—			
3		Controllability	16.62 (5.70)	.73**	.46**	—		
4		Beliefs about Mental Imagery	11.32 (5.96)	.73**	.33**	.35**	—	
5		Realness	14.76 (5.95)	.85**	.51**	.51**	.55**	—
6	SUIS	Total	41.18 (8.81)	.17**	.18**	.05	.16**	.17**
7	GHQ-12	Total	14.01 (6.82)	.45**	.31**	.41**	.31**	.37**
8	OCI-R	Total	17.39 (13.64)	.53**	.35**	.46**	.47**	.38**
9		Washing	2.03 (2.66)	.29**	.14**	.23**	.35**	.21**
10		Obsessing	3.49 (3.28)	.69**	.52**	.61**	.49**	.50**
11		Hoarding	3.27 (2.81)	.30**	.22**	.24**	.30**	.20**
12		Ordering	3.69 (3.20)	.28**	.17**	.28**	.25**	.20**
13		Checking	3.03 (3.06)	.43**	.27**	.35**	.38**	.33**
14		Neutralising	1.87 (2.57)	.32**	.15**	.23**	.37**	.25**
15	ASRM	Total	4.00 (3.17)	−.02	−.03	−.12*	.09	−.04

MIQ-N, Mental Imagery Questionnaire; SUIS, Spontaneous Use of Imagery Scale; GHQ-12, General Health Questionnaire-12; OCI-R, Obsessive Compulsive Inventory-Revised; ASRM, Altman Self-Rating Mania Scale. **$p<.01$; *$p<.05$.

Divergent validity

Spearman's rho correlations showed a weak to moderate positive relationship between MIQ-N subscales and GHQ-12 ($\rho<.5$, $p<.001$), indicating adequate divergent validity.

Discriminant validity

To establish whether there were any differences in MIQ-N scores between high and low scorers on GHQ-12, OCI-R and ASRM, the top and bottom quartile for each measure were compared on MIQ-N total scores. Applying this criterion, OCI-R and ASRM top quartile respondents scored within the clinically meaningful range (OCI-R≥24; ASRM≥6). Independent *t*-tests showed statistically significant mean score differences for MIQ-N between low and high scorers on the OCI-R ($t_{177} = -10.17$, $p<0.001$) and GHQ-12 ($t_{191} = -8.36$, $p<0.001$), but not ASRM ($t_{177} = 1.60$, $p = .06$). The results indicate good discriminant validity.

Confirmatory factor analysis

Confirmatory factor analyses were conducted using the Lavaan Package in RStudio (Rosseel, 2012). Robust maximum likelihood estimations were conducted to account for non-normality within the data. While χ^2 was significant ($\chi^2(98) = 273.45$, $p<.001$), this is known to be over-sensitive at high sample sizes, thus additional fit models were also considered. Data from the CFI (.96), RMSEA (.06; 90% CI [.05, .07]) and SRMR (.05) all indicated that the 4-factor solution obtained via EFA provided a good model fit for the scale data.

Test–retest reliability

Full scale scores at Time 1 ($M = 34.18$, $SD = 17.16$) and Time 2 ($M = 32.83$, $SD = 18.13$) did not significantly differ ($t_{98} = 1.00$, $p = .32$), and the ICC = .75 (95% CI: .75–.89) indicated good overall test–retest reliability. Subscale ICCs also ranged from moderate (Controllability: ICC = .64, 95% CI: .47–.76) to good (Intrusiveness: ICC = .75, 95% CI: .63–.83; Beliefs: ICC = .78, 95% CI: .67–.85; Realness: ICC = .80, 95% CI: .70–.86).

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Discussion

This study has produced a reliable measure for assessing people's experience and appraisals of past and future oriented visual mental imagery. The measure includes 16 items and contains four factors (Intrusiveness, Controllability, Beliefs about Mental Imagery and Realness). The subscales of the new measure are consistent with the mental imagery domains identified as significant in the development and maintenance of psychopathology, such as vividness/realness and intrusiveness, but also perceived controllability (Cloos *et al.*, 2020). The MIQ-N subscales were moderately correlated with each other and strongly correlated with the total scale score, suggesting clinical utility is most likely to occur when considering the subscale scores, but the total score also represents a meaningful outcome. The divergent validity demonstrated in the current study indicates that distinct mental health problems will 'map onto' the MIQ-N subscales in a manner that will inform clinical interventions. For example, some disorders may be closely associated with issues of 'controllability' such as generalised anxiety disorder, whereas the 'realness' subscale maybe more of a focus during trauma-focused work.

Mental imagery and mental imagery-based interventions for the treatment of psychological disorders have received increasing attention in recent years. Intrusive negative imagery is frequently associated with negative emotions, leading to disorder-specific behavioural responses which can maintain distress (Çili and Stopa, 2015; Kadriu *et al.*, 2019; Wild *et al.*, 2008). The MIQ-N is a promising new tool for use in imagery research and as part of assessment in clinical settings. Future developments of the measure include reporting on psychometric properties within diagnosed clinical populations. The measure may also be complemented with the development of a tool designed to measure the negative 'beliefs about self' often associated with negative mental imagery, such as 'I am worthless' or 'I am disgusting'.

There are some limitations of the current study which have implications for our findings. First, the inclusion of the SUIS as a measure of convergent validity produced low correlations with the MIQ-N total and subscales. The SUIS is a measure of spontaneously occurring or non-emotional voluntary imagery experiences, unlike the MIQ-N which is a broader measure including the involuntary experiences found in clinical groups. This was a known limitation prior to starting the study and reflects the lack of current measures in the field with which a meaningful assessment of convergence can be conducted. However, the use of a measure of emotional imagery would be better suited for accessing convergent validity. Second, although the sampling method provided a sufficiently large sample size for conducting EFA, this had an impact on the demographic composition of the current sample and its representativeness of the general population. Notably, a significant proportion of respondents were White and female. This has implications for the cross-cultural use of the new measures and the applicability of the items to people from different ethnic and cultural backgrounds. Third, the current study did not include people with lived experience of psychological difficulties at the item development stage of the project. While consultation with experts by profession provided a broad range of perspectives, relevant to the transdiagnostic utility of the measure, interviews with experts by experience may have provided additional insights into people's experience of mental imagery. Furthermore, due to time constraints and limited resources, the qualitative data collected from interviews with clinicians were not analysed using a systematic method of qualitative analysis, e.g. thematic analysis. Although the interview data were reviewed by the three authors independently, not applying a systematic method of qualitative analysis may have introduced bias in the interpretation of the data. Finally, it is noted that the test–retest reliability was lowest for the 'controllability' subscale, which may indicate some variance in this concept over relatively short periods of time.

The current study was motivated by the growing interest in mental imagery and the lack of a transdiagnostic clinically relevant mental imagery measure. As such, the MIQ-N was developed and validated to assess experiences and appraisals of negative visual imagery in a community sample. Using an exploratory approach, the factor structure MIQ-N comprised of mental imagery

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domains is consistent with the literature. Although convergent validity was found to be inadequate in this study, the measure demonstrated good divergent and discriminant validity, and test–retest reliability, and will be a useful measure in future clinical and research practice.

Data availability statement. The data that support the findings of this study are available on request from the corresponding author, C.S.

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Competing interests. C.S. provides training for clinicians that involves the use of imagery based approaches.

Ethical standards. The authors have abided by the Ethical Principles of Psychologists and the Code of Conduct as set out by the BABCP and BPS. Ethical approval for recruiting the community sample for the EFA and CFA was obtained from the Central University Research Ethics Committee, University of Oxford (ethical approval reference number R75759/RE001) and Research Ethics Committee, University of East Anglia. Ethics approval for the test–retest assessment was granted by the Research Ethics Committee, University of East Anglia. Ethical approval included informed consent for the results to be published.

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