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EDITED BY

Jerrell C. Cassidy,
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REVIEWED BY

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Facultad de Educación,
Universidad de Extremadura,
Spain
Lindie Van Der Westhuizen,
Consultant, Luxembourg, Luxembourg

*CORRESPONDENCE

Christopher D. Huntley
✉ c.huntley@liverpool.ac.uk

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Metacognitive beliefs predict test anxiety and examination performance

Christopher D. Huntley^{1*}, Bridget Young², Catrin Tudur Smith³
and Peter L. Fisher⁴

¹School of Medicine, Institute of Life Course and Medical Sciences, University of Liverpool, Liverpool, United Kingdom, ²Public Health, Policy and Systems, Institute of Population Health, University of Liverpool, Liverpool, United Kingdom, ³Health Data Science, Institute of Population Health, University of Liverpool, Liverpool, United Kingdom, ⁴Primary Care and Mental Health, Institute of Population Health, University of Liverpool, Liverpool, United Kingdom

Test anxiety is common among university students and impairs examination performance. Existing interventions for test anxiety are not particularly effective. Prior to developing an effective intervention, the key psychological beliefs that predict test anxiety need to be identified. Two transdiagnostic models, the intolerance of uncertainty (IU) and Self-Regulatory Executive Function (S-REF) models, propose different beliefs that result in emotional disorder, with beliefs about uncertainty emphasized in the IU model, and metacognitive beliefs emphasized in S-REF model. This study examines if IU and metacognitive beliefs predict test anxiety, and, if the relationship between these beliefs and examination performance is mediated by test anxiety. Undergraduates ($n=134$) completed self-report questionnaires at two time points, approximately 3 months apart. At Time 1, during term time, participants completed questionnaires measuring their IU and metacognitive beliefs. At Time 2, participants completed a measure of “state” test anxiety immediately before their examination. IU and metacognitive beliefs were significantly positively correlated with test anxiety, but regression analyses found only the metacognitive belief domain “negative beliefs about the uncontrollability and danger of worry” predicted test anxiety. The relationship between “negative beliefs about the uncontrollability and danger of worry” and examination performance was mediated by the worry dimension of test anxiety. Overall, “negative beliefs about the uncontrollability and danger of worry” appear key to test anxiety. Modification of these metacognitive beliefs in the context of a well-being or study skills program for students could reduce test anxiety and ultimately improve academic performance.

KEYWORDS

test anxiety, metacognitive beliefs, intolerance of uncertainty, examination, university, student

1. Introduction

Tests are the principal source of concern for university students (Gerwing et al., 2015). Anxiety about examinations or *test anxiety* is associated with poorer academic performance (Hembree, 1988; Seipp, 1991; von der Embse et al., 2018) and poorer student mental health (Depreeuw and DeNeve, 1992; Herzer et al., 2014). Test anxiety is a situation-specific form of anxiety, consisting of cognitive and affective dimensions labeled “Worry” and “Emotionality” respectively (Spielberger and Vagg, 1995). Worry is characterized by excessive and repetitive negative thinking, particularly about the consequences of failing, while emotionality refers to the somatic symptoms and physiological arousal experienced in testing situations such as

increased muscle tension, excessive sweating, and dry mouth (Spielberger and Vagg, 1995). Worry is the key component of test anxiety, as it more strongly associated with poorer test and academic performance than emotionality (Hembree, 1988; Seipp, 1991; von der Embse et al., 2018).

Despite worry being the key component of test anxiety, a meta-analysis of psychological interventions for test anxious university students found that no interventions attempted to directly alleviate worry (Huntley et al., 2019). Most interventions were behavior-based (e.g., relaxation therapy) that primarily targeted somatic symptoms. The review concluded that there was significant scope for improvement of outcomes, given only medium effects for reducing test anxiety (Hedges' $g = -0.64$) and weak effects for improving academic performance ($g = 0.28$), with outlier studies removed, were found. A better understanding of the psychological processes involved in the development and maintenance of worry and anxiety is therefore required to improve outcomes of interventions for test anxiety. There are four primary psychological models for explaining worry and anxiety: cognitive avoidance (Borkovec et al., 2004), emotional dysregulation (Mennin et al., 2002), Intolerance of Uncertainty (IU) (Dugas et al., 1998; Hebert and Dugas, 2019) and Self-Regulatory Executive Function (S-REF) (Wells and Matthews, 1994; Wells and Matthews, 1996) models. All models initially focused on Generalized Anxiety Disorder (GAD) that is characterized by excessive worry. However, though there is empirical support for the cognitive avoidance and emotional regulation models in GAD, there is little evidence for their applicability in other anxiety and emotional problems. There is substantive and accumulating evidence for the applicability of the IU and S-REF models across emotional and mental health problems (Shihata et al., 2016; Sun et al., 2017), which augurs well for the application to test anxiety also. Moreover, the S-REF model was originally conceived as a transdiagnostic model of emotional disorder, while IU is now considered a transdiagnostic vulnerability factor for emotional disorder (Wells and Matthews, 1994; Wells and Matthews, 1996; Rosser, 2019). The IU and S-REF models propose different mechanisms that lead to worry and anxiety.

The IU model consists of five components: positive beliefs about worry, cognitive avoidance, negative problem orientation, "safety behaviors", and beliefs about the intolerability of uncertainty (i.e., IU; Dugas et al., 1998; Hebert and Dugas, 2019). Positive beliefs about worry concern beliefs that worry is useful for problem solving and coping. Cognitive avoidance refers to attempts to avoid or suppress distressing thoughts or mental imagery. Negative problem orientation refers to negative perceptions of one's problem-solving abilities. Safety behaviors are unhelpful coping attempts aimed at avoiding a feared outcome. Finally, IU is defined as the tendency to consider the possibility of a negative event happening as unacceptable and threatening, irrespective of the likelihood of its occurrence (Ladouceur et al., 2000b), and has been likened to a trait fear of the unknown (Carleton, 2012). IU is the central component of the IU model, influencing all other components. IU biases how an individual perceives, interprets, and responds to uncertain situations (Ladouceur et al., 2000b). Difficulty in tolerating uncertainty may lead to maladaptive coping, principally in the form of worry, to increase subjective control and reduce uncertainty (Boswell et al., 2013). To cope with uncertainty surrounding test situations, students with high IU will worry about the possibility of failing (and its consequences) and how they can mitigate it, whilst being reticent in engaging in situations that provoke anxiety (e.g., practice tests). IU is associated with worry and anxiety (Dugas et al., 1998, 2001; Berenbaum et al.,

2008) and IU-based psychotherapy reduces worry and anxiety (Ladouceur et al., 2000a; Dugas et al., 2003).

In contrast to the IU model, the S-REF model proposes that *how* a person thinks is the more important determinant of emotional distress than *what* a person thinks (e.g., that uncertainty is bad) (Wells and Matthews, 1994; Wells and Matthews, 1996). More specifically, maladaptive metacognitive beliefs (henceforth just referred to as metacognitive beliefs) drive an inflexible and self-focused style of thinking termed the Cognitive Attentional Syndrome (CAS). Metacognition refers to cognition involved in the monitoring, appraisal, and control of cognition (Flavell, 1979; Nelson and Narens, 1990). The CAS consists of perseverative thinking (e.g., worry), attentional bias toward threat (e.g., scanning the environment for potential danger), and maladaptive coping strategies (e.g., excessive checking of answers or re-reading of examination questions). In test anxiety, the CAS may manifest as worry about failure, self-focused attention on bodily signs of anxiety, scanning the external environment for signs of threat (e.g., the facial expression of the examiner in an observed test), and seeking reassurance from fellow students or academic staff regarding learning and test performance. A meta-analysis of metacognitive beliefs across psychopathologies found positive beliefs about the usefulness of worry, the difficulty controlling worry and the dangers this poses to one's mental state and confidence in one's memory, are consistently linked with anxiety and other emotional disorders (Sun et al., 2017). Negative beliefs about the uncontrollability and danger of worry are considered particularly important to emotional distress as these beliefs result in extended cycles of worry and overanalyzing (Wells, 2009). Metacognitive Therapy (MCT) based on the S-REF model reduces worry and anxiety by reducing maladaptive metacognitive beliefs (Wells, 2009; Nordahl et al., 2018).

Despite considerable empirical research supporting the utility of IU and S-REF models in anxiety and emotional disorders, only one study has compared predictions derived from these models in test anxiety (Huntley et al., 2021). Here, both IU and the metacognitive beliefs "negative beliefs about the uncontrollability and danger of worry" and "cognitive confidence" were significantly associated with test anxiety, with "negative beliefs about the uncontrollability and danger of worry" being most strongly associated (Huntley et al., 2021). However, this study used a cross-sectional design so directional inferences could not be drawn. The aim of the current study is to address this limitation by examining the extent to which IU and metacognitive beliefs are prospectively associated with test anxiety. Moreover, we also extend prior research by examining the relationships between IU/metacognitive beliefs, test anxiety, and examination performance. We make the following predictions: (1) IU and metacognitive beliefs will be prospectively associated with test anxiety, (2) metacognitive beliefs will contribute to test anxiety over-and-above IU, (3) IU, "negative beliefs about the uncontrollability and danger of worry" and "cognitive confidence" will make independent contributions to test anxiety, and (4) test anxiety dimensions (i.e., worry and emotionality) will mediate the relationship between IU/metacognitive beliefs, and examination performance.

2. Methods

2.1. Participants and procedure

This study was approved by the University's ethics committee (reference: 201602153). Participants were undergraduate medical

students from the University of Liverpool, who undertake a 5-year degree program, with clinical placements first commencing in Year 2. Objective Structured Clinical Examinations (OSCEs) are the main form of assessment in undergraduate medical education (Patrício et al., 2013). In OSCEs, students demonstrate their clinical skills and underpinning knowledge across a series of tasks, usually while being observed by an examiner (Gormley, 2011). OSCEs are considered to have good reliability and validity (Gormley, 2011). Students sit formative and summative OSCEs in Years 2–4 at the university (i.e., on campus) where this study was conducted. At the time of the study, each yearly cohort consisted of approximately 300 students.

A time-ordered cross-sectional design was used (Menard, 2002), i.e., unlike a true longitudinal design, not all measures were administered at each time point. This design was chosen as temporal causal ordering between IU and metacognitive beliefs and emotional disorders has been established in prior studies (e.g., Rosser, 2019; Nordahl et al., 2022). Students completed self-report questionnaires at two time points, approximately 3 months apart ($M=96$ days). At Time 1, during term time, students completed online questionnaires assessing IU and metacognitive beliefs. At Time 2, students completed a paper copy of a questionnaire assessing their “state” test anxiety (i.e., how test anxious the person feels *at the moment* of completing the questionnaire), approximately 30 min prior to sitting their summative OSCE. Participation was voluntary and students could withdraw at any time, with no impact on their studies.

2.2. Measures

2.2.1. State–trait inventory for cognitive and somatic anxiety – State subscale

(STICSA-S; Ree et al., 2008). The STICSA-S consists of 21 items assessing an individual’s state anxiety. It has two subscales: (i) Cognitive State Anxiety (STICSA-Cog), which consists of 10 items (e.g., “I think the worst will happen”), and (ii) Somatic State Anxiety (STICSA-Som), which consists of 11 items (e.g., “My breathing is fast and shallow”). Participants indicate how much they agree with each statement on a 4-point scale from 1 (“*not at all*”) to 4 (“*very much so*”). Scores can range from 21 to 84, with higher scores indicating greater state anxiety. Internal consistency of the STICSA-S in this study, as measured by Cronbach’s alpha, was 0.94. The STICSA-S has excellent internal reliability and factorial validity, and has previously been used to measure state test anxiety (Gros et al., 2007; Ree et al., 2008). Internal consistencies of the STICSA-S and its Cognitive and Somatic components in this study were excellent, with Cronbach’s alphas of 0.94, 0.91, and 0.90, respectively. Henceforth, and to ensure consistency of terms with prior test anxiety research, we will refer to the Cognitive and Somatic components as Worry and Emotionality, respectively.

2.2.2. Intolerance of uncertainty scale – 12

(IUS-12; Carleton et al., 2007) The IUS-12 consists of 12 items assessing IU (e.g., “When I am uncertain, I cannot function very well”). Participants indicate how much they agree with each statement on a 5-point scale from 1 (“*not at all characteristic of me*”) to 5 (“*entirely characteristic of me*”). Scores range from 12 to 60, with higher scores indicating greater IU. The IUS-12 has excellent internal reliability and factorial validity (Carleton et al., 2007; Roma and Hope,

2017; Huntley et al., 2020a). Internal consistency of the IUS-12 in this study was good, with a Cronbach’s alpha of .89.

2.2.3. Metacognitions questionnaire – 30

(MCQ-30; Wells and Cartwright-Hatton, 2004). The MCQ-30 consists of 30 items assessing metacognitive beliefs. It has five subscales: (i) “Positive beliefs about worry” (MCQ-POS; e.g., “Worrying helps me cope”); (ii) “Negative beliefs about uncontrollability and danger of worry” (MCQ-NEG; e.g., “When I start worrying, I cannot stop”); (iii) “Cognitive confidence” (MCQ-CC; e.g., “I have a poor memory”); (iv) “Need to control thoughts” (MCQ-NC; e.g., “I should be in control of my thoughts all the time”); and (v) “Cognitive self-consciousness” (MCQ-CSC; e.g., “I monitor my thoughts”). Participants indicate how much they generally agree with each statement on a 4-point scale from 1 (“*do not agree*”) to 4 (“*agree very much*”). Subscale scores range from 6 to 24, with higher scores indicating greater metacognitive beliefs. The MCQ-30 has excellent internal reliability and factorial validity in both general population and university student samples (Wells and Cartwright-Hatton, 2004; Huntley et al., 2020b). Internal consistencies of the MCQ-30 subscales (POS, NEG, CC, NC, and CSC) in this study ranged from acceptable to good, with Cronbach’s alphas of .89, 0.89, 0.87, 0.71, and .77, respectively.

2.3. Data analysis

Data were first screened. Normality was checked by visual inspection of histograms and kurtosis and skewness statistics. Box plots were inspected for outliers. Females report greater test anxiety than males (von der Embse et al., 2018), so we examined for gender score differences on variables using independent *t*-tests. Correlations between IU, metacognitive beliefs, test anxiety, and examination scores were examined using Pearson’s *r*. Hierarchical multiple linear regression analyses were used to test our hypothesis that metacognitive beliefs at Time 1 would explain additional variance in Time 2 test anxiety, after first controlling for gender and Time 1 IU. Specifically, variables were entered in the regression model in the following order: (Step 1) gender, (Step 2) Time 1 IU (IUS-12), and finally (Step 3) Time 1 metacognitive beliefs (MCQ; POS, NEG, CC, NC, and CSC). Steps 2 and 3 were then reversed to see if IU explained additional variance over-and-above metacognitive beliefs. The entry method was used to enter variables into the model. The statistical significance of R^2_{change} was used to assess if additional variance had been explained. Inspection of the final regression model was performed to identify variables making a unique contribution to test anxiety severity. Analyses were conducted in SPSS version 26 (IBM, 2019).

The PROCESS plugin version 4 (Hayes, 2017) was used to test the hypotheses that worry and emotionality will mediate the relationship between IU/metacognitive beliefs, and OSCE performance. As the mean scores for Year 2–4 examination varied, OSCE scores across each year (2–4) were first transformed so that the mean for each cohort was a score of 50% (and SD of 15%). This enabled examination scores to be combined and then linked to participant questionnaire data. The significance of the indirect relationships between metacognitive beliefs and IU, and examination performance *via* worry or somatic symptoms was assessed by Aroian test statistic (i.e., this statistic tests if the mediator “carries” the effect from the predictor to

the outcome variable). The Aroian test has the advantage over the traditional Sobel mediation test as it does not assume that the product of the standard errors between the predictor-mediator and mediator-outcome variable are vanishingly small (MacKinnon et al., 2002).

Robust estimation, using bias corrected and accelerated bootstrapping techniques, which adjust for bias and skewness in the bootstrap distribution, were used in both regression and mediation analyses (based upon 5,000 samples).

3. Results

Of the 174 participants who took part in Time 1, 134 (77%) did so again at Time 2 (see Table 1). Of those who completed measures across both time points, 95 (71%) were female and 38 (29%) were male, with one participant not responding. The mean age of the sample was 21.12 years ($SD=2.33$). With regards to ethnicity, 95 (71%) identified as White, 13 (10%) as from the Asian subcontinent, eight (6%) as Chinese, seven (5%) as Black, seven (5%) as dual heritage, three (2%) as being from another ethnic group, and one participant did not respond.

Data screening revealed all variables were normally distributed except “positive beliefs about worry”, “negative beliefs about the uncontrollability and danger of worry”, and “cognitive confidence” which were positively skewed. Inspection of box plots revealed no univariate outliers. There were five (< 1%) missing questionnaire data points across participants who completed Time 1 and Time 2, which were missing completely at random ($\chi^2(310)=325.42$, $p=0.262$). Multiple imputation (regression method) was used to replace missing data points.

Descriptive statistics and correlations are presented in Table 2. Independent t -tests revealed significant gender differences in scores, with females reporting significantly greater test anxiety ($M_{\text{female}}=49.91$ vs. $M_{\text{male}}=42.87$, $t(131)=2.81$, $p=0.006$), and “negative beliefs about uncontrollability and danger of worry” ($M_{\text{male}}=14.09$ vs. $M_{\text{female}}=11.37$, $t(131)=2.98$, $p=0.003$), while males reported significantly greater “cognitive self-consciousness” ($M_{\text{female}}=14.81$ vs. $M_{\text{male}}=16.26$,

$t(131)=-2.04$, $p=0.044$). No significant gender differences were found on examination performance ($t(131)=0.84$, $p=0.401$). All correlations were statistically significant except between “cognitive confidence” and the following variables: IU, “positive beliefs about worry”, and “cognitive self-consciousness”. Neither age nor examination scores significantly correlated with any study variable. One-way ANOVAs found no significant differences in study variable scores based on the year of study.

Hierarchical regressions examined the unique contribution of IU and metacognitive beliefs in predicting test anxiety, as measured by the STICSA-S (see Table 3). On Step 1, gender explained 6% of the variance in state test anxiety. On Step 2, IU explained an additional 10% of variance. Finally, on Step 3, metacognitive beliefs explained a further 27% of the variance in test anxiety. When Steps 2 and 3 were reversed, metacognitive beliefs explained an additional 36% of variance on Step 2, while IU did make a statistically significant contribution on Step 3. In the final regression model, only “negative beliefs about uncontrollability and danger of worry” (MCQ-NEG) was a significant independent predictor. The final model explained 43% of the variance ($R^2=0.43$). Regression diagnostics revealed one multivariate outlier; removal of this outlier did not change the pattern of results. A post-hoc power analysis using G*Power 3.1.3 (Faul et al., 2007) revealed observed statistical power to be adequate (i.e., power = 0.99, with $f^2=0.23$, $\alpha=0.05$, $n=134$, and 7 predictor variables).

In the mediation analyses, only “negative beliefs about the uncontrollability and danger of worry” was included in our model, as it was the only significant predictor of test anxiety. Prior to running analyses, we checked if examination performance differed between males and females; no significant differences were found ($t(131)=0.84$, $p=0.401$). However, significant differences in scores based on gender were revealed for worry ($M_{\text{female}}=24.22$ vs. $M_{\text{male}}=19.89$, $t(131)=2.67$, $p=0.009$) and emotionality ($M_{\text{female}}=26.33$ vs. $M_{\text{male}}=22.97$, $t(131)=2.52$, $p=0.013$), with females reporting greater severity than males in both dimensions of test anxiety. Given there were also significant gender differences in scores for “negative beliefs about the uncontrollability and danger of worry”, we controlled for gender in these analyses. We also checked correlations between age and examination scores; no significant relationship was found. The mediation model found “negative beliefs about the uncontrollability and danger of worry” significantly predicted test anxiety worry and emotionality, while only worry significantly and negatively predicted examination performance (see Figure 1). Tests of the indirect pathways found a significant indirect pathway between “negative beliefs about the uncontrollability and danger of worry” and examination performance *via* test anxiety worry (Aroian = -3.07 , $p=0.002$) but not *via* emotionality (Aroian = 1.19 , $p=0.235$).

4. Discussion

This study extends past research by examining if IU and metacognitive beliefs are prospectively associated with test anxiety, and by also then examining if test anxiety mediates the relationship between these beliefs and examination performance. Both IU and metacognitive beliefs were significantly and positively correlated with test anxiety. However, metacognitive beliefs explained significant variance (27%) in test anxiety, after first controlling for gender and

TABLE 1 Sample characteristics at Time 1 ($n=175$) and Time 2 ($n=134$).

Variable		Time 1 ($n=175$)	Time 2 ($n=134$)
Age:	M (SD)	20.98 (2.37)	21.12 (2.33)
Gender:	Female % (n)	72.0% (126)	70.9% (95)
	Male % (n)	26.9% (47)	28.4% (38)
Year of study:	Year 2	54.9% (96)	50.7% (68)
	Year 3	28.6% (50)	28.4% (38)
	Year 4	16.0% (28)	20.1% (27)
Ethnicity:	White (British, Irish, other)	74.3% (130)	70.9% (95)
	Indian subcontinent	9.7% (17)	9.7% (13)
	Chinese or Asian	5.1% (9)	6.0% (8)
	Black (British, other)	4.6% (8)	5.2% (7)
	Other ethnic group	1.7% (3)	2.2% (3)
	Mixed heritage	4.0% (7)	5.2% (7)

Missing at Time 1: age, $n=2$; gender, $n=3$; year of study, $n=1$; ethnicity, $n=2$; Missing at Time 2: age, $n=0$; gender, $n=1$; year of study, $n=1$; ethnicity, $n=1$.

TABLE 2 Descriptive statistics, zero-order correlations between study variables.

Variable	1.	2.	3.	4.	5.	6.	7.	Female (<i>n</i> =95) <i>M</i> (SD)	Male (<i>n</i> =38) <i>M</i> (SD)	Gender difference (<i>t</i> -test)	
1. T2 STICSA-S	–	0.34***	0.18*	0.64***	0.18*	0.21*	0.19*	49.91 (12.54)	42.87 (14.24)	2.81	**
2. T1 IUS-12		–	0.38***	0.45***	0.16	0.52***	0.30**	31.86 (9.23)	30.87 (8.97)	0.57	
3. T1 MCQ-30-POS			–	0.30***	0.01	0.24**	0.18*	12.43 (4.35)	13.55 (5.11)	–1.28	
4. T1 MCQ-30-NEG				–	0.28**	0.45***	0.31***	14.09 (4.94)	11.37 (4.30)	2.98	**
5. T1 MCQ-30-CC					–	0.26**	0.02	11.28 (4.14)	10.63 (4.61)	0.79	
6. T1 MCQ-30-NC						–	0.38***	11.76 (3.40)	12.42 (3.66)	–0.99	
7. T1 MCQ-30-CSC							–	14.81 (3.55)	16.26 (4.12)	–2.04	*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Missing data: gender, $n = 1$; T1, Time 1; T2, Time 2; STICSA-S, State-Trait Inventory of Cognitive and Somatic Anxiety – State version; MCQ, Metacognitions Questionnaire – 30; POS, “Positive beliefs about worry”; NEG, “Negative beliefs about uncontrollability and harm of worry”; CC, “Cognitive Confidence”; NC, “Need to control thoughts”; CSC, “Cognitive Self-Consciousness”; IUS-12, Intolerance of Uncertainty Scale – 12.

TABLE 3 Hierarchical linear regression, predicting Time 2 state test anxiety (STICSA-S).

Step	Variable	ΔR^2	ΔF	p	<i>b</i> (95% BCa CIs)	β	p
1		0.06	7.90	0.006			
	Gender				–7.04 (–12.11, –1.73)	–0.24	0.010
2		0.10	16.17	< 0.001			
	Gender				–6.57 (–11.41, –1.63)	–0.22	0.012
	T1 IUS-12				0.47 (0.26, 0.68)	0.32	< 0.001
3		0.27	11.59	< 0.001			
	Gender				–1.92 (–6.77, 3.12)	–0.07	0.438
	T1 IUS-12				0.20 (–0.08, 0.45)	0.14	0.154
	T1 MCQ-30-POS				–0.06 (–0.55, 0.39)	–0.02	0.791
	T1 MCQ-30-NEG				1.67 (1.17, 2.18)	0.61	< 0.001
	T1 MCQ-30-CC				0.09 (–0.33, 0.48)	0.03	0.669
	T1 MCQ-30-NC				–0.56 (–1.34, 0.22)	–0.15	0.150
	T1 MCQ-30-CSC				0.09 (–0.51, 0.64)	0.02	0.780

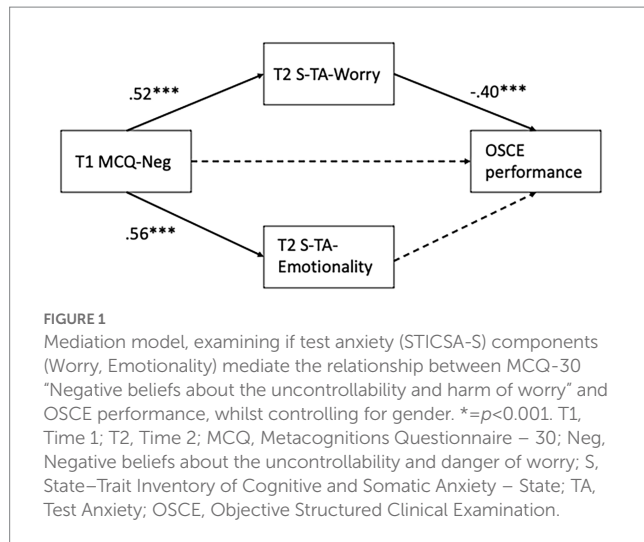
T1, Time 1; STICSA-S, State-Trait Inventory of Cognitive and Somatic Anxiety – State version; MCQ, Metacognitions Questionnaire-30; POS, “Positive beliefs about worry”; NEG, “Negative beliefs about uncontrollability and harm of worry”; CC, “Cognitive Confidence”; NC, “Need to control thoughts”; CSC, “Cognitive Self-Consciousness”; IUS-12, Intolerance of Uncertainty Scale – 12.

IU. When the order of entry was reversed IU did not explain additional variance in test anxiety after controlling for gender and metacognitive beliefs. In the final regression model, only the metacognitive belief domain of “negative beliefs about the uncontrollability and danger of worry” was a significant predictor of test anxiety. Finally, concerning the mediation model, worry but not emotionality was a significant and negative predictor of examination performance. There was a significant indirect pathway from “negative beliefs about the uncontrollability and danger of worry” to examination performance via the worry dimension of test anxiety.

Findings here show metacognitive beliefs, but not IU, play an important role in the manifestation of test anxiety. This supports predictions made by the S-REF model that metacognitive beliefs, involved in the regulation of thinking, are more important to the manifestation of sustained distress than beliefs in the ordinary cognitive domain. In particular, “negative beliefs about the uncontrollability and danger of worry” made the largest contribution in predicting state test anxiety. This latter result is consistent with prior meta-analytic findings which found “negative beliefs about the uncontrollability and danger of worry” significantly elevated among

those with an emotional disorder compared to healthy individuals (Hedges’ $g = 1.52$), and this was a stronger effect compared to the other metacognitive belief domains (Hedges’ g s from 0.49 to 1.19) (Sun et al., 2017). Students with high “negative beliefs about the uncontrollability and danger of worry” may believe they are unable to terminate or suspend their worry. For example, a student may have the thought “what if I fail?”; this thought only becomes problematic if the student engages with it, and where it becomes a trigger for a cycle of worry that they then cannot disengage from. This may have the effect of elevating and maintaining their test anxiety, and therefore interfere with their examination performance.

Finally, mediational analyses that showed worry was associated with significantly poorer examination performance, and that worry was predicted by “negative beliefs about the uncontrollability and danger of worry”. No significant relationship between emotionality and examination performance was found. To our knowledge, no previous study had examined the differential effects of worry and emotionality on OSCE performance (Martin and Naziruddin, 2020), so results here add to the long list of research that shows that worry is the core feature of test anxiety and a major contributor to poorer



performance in test situations (Cassady and Johnson, 2002; von der Embse et al., 2018). Excessive worry interferes with information processing by using mental resources best deployed toward the test (Eysenck et al., 2007). Here, “negative beliefs about the uncontrollability and danger of worry” were found to be significantly prospectively associated with worry and therefore reducing these beliefs may help reduce student distress and aid test performance.

The current study has several limitations. The primary limitation of this study was the use of a time-ordered cross-sectional design, in which the effects of unmeasured variables at each time point cannot be controlled. A true prospective longitudinal panel design would more firmly permit causal inferences by allowing for examination of inter-individual variability in intra-individual change over time (e.g., latent growth curve modeling). Sampling bias is indicated as most of the sample was female, and females in this study reported greater state test anxiety than males. Although the central components of both the IU and S-REF models were examined (i.e., IU and metacognitive beliefs respectively), it is necessary to examine the models of in their entirety (e.g., assessing aspects of the CAS in the S-REF model). Other factors have been implicated in academic performance, such as self-efficacy (Richardson et al., 2012), and it is important to examine how IU and metacognitive beliefs may interact with such predictors. Baseline anxiety and mood were not assessed, and future studies that control for these variables would offer a more stringent test of the IU and S-REF models. This study was conducted within the context of an OSCE, and students find OSCEs more anxiety provoking than other forms of assessment, so it is important confirm if the findings here are replicated across other test formats (Guraya et al., 2018).

Overall, metacognitive beliefs appear an important determinant of test anxiety. What are the implications of these findings for wellbeing and support services within medical schools and universities? First, as test anxiety impacts upon examination performance, there is an acute need to identify and help reduce test anxiety. Secondly, findings here supported predictions derived from the S-REF model. Therefore, professionals helping test anxious students may wish to challenge and reduce metacognitive beliefs, particularly “negative beliefs about the uncontrollability and danger of worry”. Helping students identify and reduce faulty thinking

styles could also be done in the context of study skills sessions or within interventions offered through wellbeing services. Interventions could draw upon strategies used in Metacognitive Therapy (MCT; Wells, 2009) a transdiagnostic psychological intervention based upon the S-REF model that aims to modify metacognitive beliefs that drive the unhelpful worry-based thinking styles. For example, students may be taught to recognize potential triggers for their worry (e.g., negative thoughts like “I am going to fail”) and also elicit their negative beliefs about the uncontrollability and harm of worry through controlled behavioral exercises. However, a necessary first next step is to examine the complete S-REF model as applied to test anxiety to confirm that the CAS mediates the relationship between metacognitive beliefs and test anxiety, before developing and creating S-REF derived interventions. Examination of the S-REF model should be done with the context of a prospective longitudinal panel design, which would permit greater insight into cause-and-effect relationships, through scrutiny of change at both individual and group level. Ultimately, successful reduction of test anxiety will improve examination performance and mental wellbeing of students.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by University of Liverpool Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

CH and PF primarily conceived and designed the study, with input from BY and CTS. CH collected data and performed data analyses and wrote the first draft of the study. All authors contributed to manuscript revision, and read and approved the final version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial of financial relationships that could be construed as a potential conflict.

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