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DEVELOPMENT AND VALIDATION OF THE STRESS

Believing is seeing:

Development and validation of the STRESS (Subjective Thoughts REGARDing Stress Scale)

for measuring stress beliefs

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Abstract

The association between stress beliefs and stressor appraisals has been limited by the absence of a comprehensive stress beliefs scale. This paper aimed to develop a new stress belief scale (the Subjective Thoughts REgarding Stress Scale; STRESS) and assess the association between stress beliefs and stressor appraisals. Study 1: A pool of 75 Likert-type items assessing beliefs about stress and cognition, emotion, social factors, and behaviour, was piloted on an international sample ($N = 107$); all items were found to reflect commonly held beliefs. Study 2: Exploratory factor analysis ($N = 419$), reduced the scale to 19 items over three factors (Consequences, Social Factors, and Coping Efficacy), demonstrating acceptable construct validity and internal reliability. Study 3: Confirmatory factor analysis ($N = 300$) replicated the factor structure in a new sample and demonstrated acceptable convergent and divergent validity. Study 4: Predictive validity ($N = 137$) was demonstrated with stressor appraisals and acceptable test-retest reliability over two weeks. This study provides evidence for both good psychometric properties of the new STRESS measure and predictive validity in terms of an association between stress beliefs and stressor appraisals.

Keywords: stress, appraisals, scale construction, stress beliefs, transactional model of stress,

1. Introduction

Stress encapsulates four components: the stressor; the subjective processing of stressor-related information (appraisals); physiological/psychological arousal and behavioural responses (coping); and a feedback loop to assess the effectiveness of coping and reassess the situation (reappraisals; Lazarus & Folkman, 1984; Ursin & Eriksen, 2010). Interindividual differences in appraisals produce complex responses that can result in negative and positive

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outcomes (Folkman et al., 1986; Gaab et al., 2005). For example, the effects of stress on attention (Moore et al., 2015; Vine et al., 2015), memory (Pedraza et al., 2016), physical health (Lupien et al., 2007; Schneiderman et al., 2005), and mental health (Shallcross et al., 2015) can be facilitatory or detrimental. A recent review identified stress beliefs as one possible key predictor of appraisals that requires further research (Kilby et al., 2018). In this paper, a theoretical model of the stress response with relevant considerations for measurement will first be described. Then, by drawing on relevant theoretical and empirical work outside of stress, we propose a new theoretical stress belief-appraisal link that details why and how stress beliefs may influence the stress response by influencing appraisals. Finally, existing stress belief literature related to appraisals is discussed, along with a review of existing stress belief measures, leading to the development and validation of a new measure of stress beliefs over four empirical studies.

1.1 Stress Theory

According to the widely cited Transactional Model of Stress (Lazarus & Folkman, 1984), once individuals are faced with a stressor, they engage in appraisals, coping, and reappraisal processes. Appraisals can be partitioned into primary appraisals and secondary appraisals. Primary appraisals represent perceptions of challenge (i.e., possible tangible or intangible gains) or perceptions of threat (i.e., potential loss or harm). Challenge and threat appraisals can be measured either as separate constructs (e.g., Skinner & Brewer, 2002) or as a single continuum ranging from challenging to threatening (e.g., Schneider, 2008). On the other hand, secondary appraisals are perceptions of one's ability to cope with the stressor and the resources perceived as being available to assist in coping (Figuroa-Fankhanel, 2014; Schneider, 2008). Here, resources can be intrinsic (e.g., self-confidence) or extrinsic (e.g., finance) that may be called upon to cope with a situation. Secondary appraisals have typically been assessed by single items such as "do you have the ability/resources to cope with this

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task?" (Schneider, 2008), but an alternative approach uses a ratio of primary to secondary resources. This ratio is interpreted as a ratio of demands to resources (Figuroa-Fankhanel, 2014; Schneider, 2008). In this ratio appraisal, threat is thought to occur when demands exceed resources, whereas challenge occurs when resources are equal to or exceed demands (Figuroa-Fankhanel, 2014; Schneider, 2008).

Central to each of these conceptualisations and measurements of stressor appraisals is the assumption of individual differences. In all instances, these approaches assume that any two people will vary in how they appraise a stressful situation and that these differences in appraisals will influence the adoption of different coping strategies (Folkman et al., 1986; Schneider, 2008). For example, individual differences in appraisals have been associated with different emotional responses to stress (Searle & Auton, 2015; Skinner & Brewer, 2002), a range of positive (positive reinterpretation, social support, active coping, planning) and negative (venting, denial, behavioural disengagement, substance abuse) coping strategies in college students (Grawitch, 2009), and task engagement in sport (Doron et al., 2017). Conversely, the effectiveness of the coping strategy implemented can change the appraisals made of a stressor (a process known as reappraisal; Blascovich, 2008; Folkman et al., 1986; Folkman & Lazarus, 1980). Reappraisals evaluate the effectiveness of coping with the stressor and determine when the stressor has subsided (Lazarus & Folkman, 1984). The subjective nature of the appraisal process means that different appraisals of the same situation may lead to unique coping responses. These unique coping responses, in turn, lead to the myriad of possible negative and positive outcomes associated with stress. Therefore, understanding what leads to individual differences in appraisals may be key in promoting individuals to benefit, rather than suffer, under stress.

1.2 Stress Belief-Appraisal Link

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Despite evidence that differences in appraisals lead to differences in responses to stress (De Longis et al., 1988; Folkman et al., 1986; Tomaka et al., 1997), there is a lack of research investigating what underlies interindividual differences in appraisals (Kilby et al., 2018). One potential explanatory psychological construct is that of stress beliefs, a type of lay belief, that is, explanations people use to explain or rationalise the world around them. Lay beliefs are formed through a combination of socialisation and formal education processes, along with personal and vicarious experiences (Kilby & Sherman, 2018; Zedelius et al., 2017). They are known to influence general cognitive appraisals of stimuli and situations (Zedelius et al., 2017) and are not necessarily based on fact or scientific knowledge (Furnham, 1988; Zedelius et al., 2017). Applied to stress, lay beliefs about stress (i.e., stress beliefs) refer to lay explanations used to explain one's understanding of stress. A range of stress beliefs have been explored in the literature to date (for a review, see Kilby et al., 2020a). These include beliefs about the consequences of stress on emotion (Daniels et al., 2006) and health (Keller et al., 2012), and one's ability to control (Laferton et al., 2018) and alleviate (Furnham, 1997) stress. This concept of lay beliefs, applied to stress, also implies that stress beliefs should be used as kernels of subjective knowledge that motivate how individuals explain or appraise the stressful situations they encounter. For instance, if someone had the belief that stress makes them feel anxious, then they may be more likely to perceive stressful situations as threatening as the situation may become a cue to feelings of anxiousness. We refer to this theoretical link between stress beliefs and appraisals as the "stress belief-appraisal link". If stress beliefs influence stress appraisals, then stress beliefs should indirectly relate to individual differences in stress-related outcomes. Research into stress beliefs and stress-related outcomes has demonstrated that, after controlling for relevant health variables, believing stress is bad for health in the face of experiencing a high level of daily stress increases eight-year all-cause mortality risk (Keller et al., 2012) and risk for a

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coronary incident in the next 18 years (Nabi et al., 2013). Research has also linked differences in stress beliefs to differences in coping and has demonstrated that the association between stress beliefs and wellbeing following stress is mediated by these belief-based differences in coping (Keech et al., 2018). Despite evidence that stress beliefs are associated with both coping and outcomes following stress, research has failed to fully substantiate the link between stress beliefs and stress appraisals (Crum et al., 2017; Kilby & Sherman, 2016).

Interestingly, the proposition that lay beliefs are linked to cognitive appraisals is not a new concept outside of the stress literature. Theoretical models across diverse sub-disciplines within psychology (e.g., development, health, cognition, clinical) have repeatedly highlighted the link between lay beliefs and cognitive appraisals [e.g., Schema Theory (Pace, 1988), Explanatory Models and Belief Systems (Blumhagen, 1981), the Schema, Propositional, Associative, and Analogical Representation Systems (Khetrapal & Khetrapal, 2007), the Extended Process Model of Emotion Regulation (Gross, 2015b), the Common-Sense Model of Self-Regulation (Leventhal et al., 2016), and the Confirmation Bias (Nickerson, 1998) just to name a few]. Although each theory or model serves a different purpose, they all contain some argument that a form of belief (sometimes referred to across these theories as schemas, representations, explanatory models) is essential in developing cognitive appraisals. Furthermore, these theories argue that beliefs are measurable phenomena that are targetable by psychological intervention. While it is beyond the scope of this paper to review each of these theories, they provide theoretical support for the existence of a stress belief-appraisal link.

1.3 Empirical Evidence for the Stress Belief-Appraisal Link

Despite there being theoretical scope for the stress belief-appraisal link within common models of stress response (Folkman & Lazarus, 1980), and research demonstrating

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the existence of stress beliefs (Kilby et al., 2020a), there has been little research exploring the stress belief-appraisal link. One study, measuring primary appraisals of threat and challenge independently, found a positive relationship between stress beliefs and challenge appraisals but no relationship with threat appraisals (Kilby & Sherman, 2016). Another study found no association between stress beliefs and primary appraisals measured as a single construct (Crum et al., 2017). Moreover, no study has examined the link between stress beliefs and secondary appraisals. Therefore, more research is needed to understand the role of stress beliefs and both primary and secondary appraisals; however, a limiting factor, is that current measures of stress beliefs may not be appropriate for uncovering these relationships.

Research into stress beliefs has been characterised by a lack of unity in measurement, with a range of study-specific unvalidated measures of stress beliefs being utilised (Kilby et al., 2020a). To date, only two validated measures of stress beliefs have been developed, the Stress Mindset Measure (Crum et al., 2013) and the Beliefs About Stress Scale (Laferton et al., 2018). Both scales measure beliefs about the consequences of stress, while the Beliefs About Stress Scale additionally measures beliefs about control over stress (Laferton et al., 2018). A recent scoping review of the stress belief literature (Kilby et al., 2020a), as well as a qualitative study examining the range of stress beliefs that people commonly endorse (Kilby et al., 2020b), highlighted that the current measures of stress beliefs appear to focus on beliefs about the consequences of stress (e.g., for health) and on the control of stress (e.g., how much control one has over feeling stressed), but have missed other kinds of stress beliefs in the initial pool of items, for example beliefs about stress and cognition, causes of stress, or factors relating to socialising or social support during stressful situations. Therefore, there is a need for a more comprehensive stress beliefs measure that considers all previously identified beliefs about stress in its development. Such a comprehensive measure may be able to identify the stress belief-appraisal link.

1.4 The Current Study

This paper reports on the development and validation of a new measure of stress beliefs - the Subjective Thoughts REgarding Stress Scale (STRESS) - over four studies. Study One reports on the item development and piloting of the STRESS. Study Two was an exploratory factor analysis (EFA) to reduce the number of scale items and to identify a statistically meaningful factor structure for the scale. Study Three reports on a confirmatory factor analysis (CFA) to assess the replicability of the factor structure identified in Study Two in an independent sample. Study Four examines the validity of the STRESS in predicting stress response in a standardised laboratory stressor.

2. Study 1 – Piloting the STRESS

2.1 Introduction

Existing stress belief measures have demonstrated adequate validity with coping and health outcomes (Crum et al., 2013; Laferton et al., 2018), although their associations with stressor appraisals has been inconsistent (Crum et al., 2017; Kilby & Sherman, 2016). Using the Common-Sense Model of Self-Regulation (Leventhal et al., 2016) as a guiding framework, a scoping review of stress beliefs recently found that current stress belief measures only focused on beliefs relating to the consequences or control of stress, leaving open the possibility for there to be additional beliefs about the identity, cause, and timeline of stress that might be important in determining the stress response (Kilby et al., 2020a). Supporting this notion, a qualitative study (Kilby et al., 2020b) revealed additional themes of stress beliefs including beliefs about the relationship between stress and cognition, emotion, behaviour, and social factors (for details, see Kilby et al., 2020b). However, existing measures of stress beliefs (Crum et al., 2013; Laferton et al., 2018) did not incorporate aspects of beliefs about cognition and social factors in their initial item pools (Kilby et al.,

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2020a). Therefore, the absence of the measurement of these additional stress belief themes may reduce the ability of existing stress belief measures to predict stress appraisals and coping. Given the need for a more rigorously developed measure of stress beliefs, we developed an initial 75 items for the STRESS that covered the major domains of stress beliefs identified in previous research (see Supplemental File A for item wording). Study 1 aimed to pilot these initial items for readability and appropriateness, both of which are essential aspects of the item piloting phase to ensure face validity (MacKenzie et al., 2005).

2.2 Method

2.2.1 Participants. Participants from the public ($N = 107$) self-enrolled into the study via online advertisements in exchange for entry into an AUD\$100 gift voucher raffle. The sample exceeded the recommended minimum ($N = 20$) for item piloting (Johanson & Brooks, 2009). All participants were ≥ 18 years old and resided within Australia, the US, or the UK for reimbursement purposes.

2.2.2 Procedure. Following online consent, participants completed a demographics questionnaire and rated the 75 items of the scale. Text boxes allowed participants to provide feedback. The item pilot was approved by the Macquarie University Human Research Ethics Committee (REF #5201700422).

2.2.3 Measures

2.2.3.1 STRESS. The STRESS was developed based on prior qualitative and scoping review research into stress beliefs (Kilby et al., 2020a, 2020b). This prior research informed an initial set of 75 beliefs about stress and cognition, emotion, behaviour, and social factors were identified (21 cognition items, 19 emotion items, 17 behaviour items, and 18 social factors items). To meet the aims of Study 1, participants categorised each of the 75 self-report items of the STRESS (presented in random order) on a 4-point scale as either “This describes

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me”, “This describes the opposite of me”, “This does not describe me at all”, or “I do not understand this phrase” (see Supplemental File A for the full original scale).

2.2.3.2 Descriptives. Participants self-reported age, country of residence, country of birth, gender, years of education, and highest education level.

2.2.4 Statistical Analysis. All analyses were conducted in SPSS version 25 (IBM, 2016). Univariate descriptives outlined sample characteristics (see Supplemental File B). For each item, two percentages were calculated. The first is an endorsement percentage that represented the percentage of the sample that indicated that the item reflected either them or the opposite of them. The second was an unreadability rating which represented the percentage of the sample that indicated that they did not understand the phrasing of the item. Individual item endorsement and unreadability ratings are reported, along with the mean, standard deviation, and range of endorsement and unreadability ratings for each thematic group of items. An item was deemed a common stress belief based upon a majority endorsement vote ($\geq 50\%$ endorsement of “this describes me” or “this describes the opposite of me”). Item wording was revised if an item received $\geq 20\%$ unreadability rating (that is, $\geq 20\%$ of participants indicated that they did not understand the item). This 20% cut-off was chosen to identify items that were generally written poorly without creating a situation in which the responses of very few participants would result in the rewriting of an otherwise readable item.

2.3 Results

Sample characteristics are provided in Supplemental File B and the percentage of participants indicating each item as describing them (or the opposite of them) and percentages of participants identifying items as not readable can be found in Supplemental File A. All items received $>50\%$ endorsement and $<20\%$ rated as unreadable. For cognition

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items, all 21 items received an endorsement above 50%. Specifically, for cognition items, there was a mean endorsement of 80% across all items ($SD = 10\%$) with item endorsements ranging from 62% (item 1) to 94% (item 21). On average, cognition items were rated as unreadable by 1% of the sample ($SD = 1\%$), with unreadability ratings ranging from 0% (items 2, 3, 5, 6, 10, 12, 13, 14, 15, 16, 18, and 21) to 5% (item 1) suggesting that all items were under the 20% cut-off for readability.

All 19 emotion items received endorsements above 50%. There was a mean endorsement for emotion items of 77% ($SD = 11\%$). The range of endorsement for emotion items ranged from 59% (item 30) to 94% (item 22). Emotion items were rated as unreadable, on average, by 0% of the sample ($SD = 1\%$). The range of readability ratings for emotion items were from 0% (items 22, 24, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, and 39) to 2% (item 23) suggesting that all items were under the 20% cut-off for readability.

For behaviour items, all 17 items received endorsement ratings above 50%. There was a mean endorsement of 75% ($SD = 12\%$). Endorsements for behaviour items ranged from 55% (item 64) to 96% (item 75). Behaviour items were, on average, rated as unreadable by 1% of the sample ($SD = 1\%$). The range of unreadability ratings for items went from 0% (items 64, 67, 74, and 75) to 5% (item 62).

Finally, for social items, all 18 items received an endorsement above 50%. There was a mean endorsement of 74% ($SD = 11\%$). Endorsements for social items ranged from 53% (item 53) to 90% (items 40 and 48). Social items were, on average, rated as unreadable by 2% of the sample ($SD = 2\%$). The unreadability ratings for social items ranged from 0% (items 41, 43, 44, 45, 47, 48, 49, 55, and 56) to 7% (item 46) suggesting that all items were under the 20% cut-off for readability.

2.4 Discussion

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Study 1 set out to pilot the endorsement and readability of the 75 initial items of the STRESS. In all cases, items received a majority endorsement, with no item being indicated as needing its wording revised. The initial pool of items from the STRESS covers similarly themed items as the Stress Mindset Measure (Crum et al., 2013) and the Beliefs About Stress Scale (Laferton et al., 2018) by including control (e.g., item 74) and consequences-related beliefs (e.g., item 3) items. However, the initial pool of items for the STRESS also includes items that tap into beliefs not considered by these pre-existing scales, such as social factors and cognition items. Beyond this, the initial pool of items for the STRESS also includes items about the identity of stress (e.g., item 9) and cause of stress (e.g., item 47).

However, the thematic groupings of stress beliefs used to generate the initial item pool of the STRESS (i.e., cognition, emotion, behaviour, and social factors) have been conceptualised based on face validity rather than psychometric methods. As such, there is need to refine the groupings of items in the STRESS further. This will help to identify key factors or subscales that can be used in the scale. Moreover, a scale with 75 items may be too long for practical use in psychological research. As such, there is a need to reduce the number of items in the STRESS down to arrive at a more parsimonious scale. Both of these objectives can be achieved through an exploratory factor analysis.

3. Study 2 – Exploratory Factor Analysis

3.1 Introduction

The initial item pool of the STRESS was based upon broad groupings of thematically related beliefs identified in prior stress belief research based upon face validity alone (Kilby et al., 2020b, 2020a) rather than any psychometric analysis. As such, the next step in the scale development was to evaluate whether these nominally applied groupings were supported through statistical analyses, specifically, an Exploratory Factor Analysis (EFA). This will

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allow for the identification of any possible redundancy between groupings and rule out any alternative groupings of these beliefs. For example, if someone believes stress has negative consequences, this may also predispose them to believe that stress elicits negative emotional states, suggesting that beliefs about consequences and emotions may be redundant from a statistical standpoint. This is an important point to consider as a measure containing subscales of pure redundancy can result in analytic issues due to multicollinearity. Alternatively, a single grouping of beliefs may contain statistically distinct groupings of items that may be better served as separate subscales (for an example where statistical inference provided greater insight into a scales structure over theoretically identified groupings, see: Moss-Morris et al., 2002).

As such, Study 2 aimed to reduce the items of the STRESS via EFA to arrive at the most statistically parsimonious scale. Study 2 also aimed to identify the factor loading of the STRESS that will be used to create subscales of the STRESS, as well as to examine the construct validity of the STRESS with existing stress belief measures (i.e., Stress Mindset Measure, Beliefs About Stress Scale). Given the lack of psychometric analyses into the factor structure of stress beliefs, we made no hypotheses about the number or nature of factors that would arise from the factor analysis. However, given that, on face value, stress beliefs have been collated into thematic groupings, we did expect more than one factor to arise. It was also expected that factors of the STRESS would show logical relationships with the other stress belief scales that were weak to moderate ($r = .30-.70$) in strength (e.g., stronger positive beliefs of a particular factor of the STRESS were expected to be associated with stronger positive relevant beliefs of other measures). A weak to moderate effect was anticipated as this would demonstrate that the STRESS was similar to existing scales (Hajjar, 2018) but would also demonstrate a differentiation of the STRESS from the existing scales (Field, 2013).

3.2 Method

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3.2.1 Participants. MTurk participants ($N = 302$) were recruited into this study for USD\$3. Additionally, 133 first-year psychology students from Macquarie University participated for course credit (Total $N = 435$). All participants were at least 18 years of age. First-year students are demographically different from MTurk users (Mortensen & Hughes, 2017) and were included to improve sample diversity. The total sample size of 435 satisfies current recommendations for powering an EFA. Specifically, EFAs with moderate-to-low loadings and few factors (the scenario requiring the largest sample size) require approximately 300 participants; ratio-based estimates (number of participants to number of items) recommend a ratio of at least 5:1 (435 participants to 75 items = 5.80:1; Beavers et al., 2013).

3.2.2 Procedure. Following online consent, participants completed a demographics survey, followed by the Stress Mindset Measure (Crum et al., 2013), the Beliefs About Stress Scale (Laferton et al., 2018), and the STRESS (in random order). This study was approved by the Macquarie University Human Research Ethics Committee (REF #5201800297).

3.2.3 Measures.

3.2.3.1 Stress Mindset Measure. Assesses beliefs about stress consequences (Crum et al., 2013). Participants rate their agreement on eight items such as “Experiencing stress improves my health and vitality” on a 5-point Likert-type scale (0 “Strongly Agree” to 4 “Strongly Disagree”). Higher mean scores (range 0-4) represent stronger beliefs that stress produces positive consequences. Internal reliability was acceptable ($\alpha=.88$).

3.2.3.2 Beliefs About Stress Scale. This scale measures the extent to which people hold positive (range 4-16), negative (range 7-28), and control-related beliefs (range 3-12) about stress (Laferton et al., 2018). Participants rate their agreement with 15 items on a 4-point Likert-type scale (1 “Completely Disagree” to 4 “Definitely Agree”) on items such as

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“Being stressed is, for me, a predominantly negative thing”. Items are summed with higher scores representing stronger endorsement in that subscale’s belief. Internal reliability was acceptable for all subscales ($\alpha \geq .74$).

3.2.3.3 STRESS. The 75-item STRESS was administered. For this study, the full 6-point Likert-type scale (1 “Completely not like me” to 6 “Completely like me”) was used.

3.2.3.4 Demographics. Participants self-reported age, gender, country of residence, birthplace, self-reported ethnicity, highest level of education, and employment status.

3.2.3.5 Attention Checkers. Two attention checkers were used (e.g., “If you are reading this, select 0 – Strongly Agree”); one in the Stress Mindset Measure and one in the Beliefs About Stress Scale. Placement of the attention checker within the scales was randomised.

3.2.4 Statistical Analysis. All analyses were conducted in SPSS version 25 (IBM, 2016). Participants who failed both attention checkers were not included in the study for analysis. Descriptives outlined sample characteristics. ANOVA and chi-square analyses (as appropriate) compared MTurk and first-year students on all variables. Negatively worded items were reverse scored before being entered into the EFA.

EFA using a principal axis factoring extraction method with direct oblimin rotation was conducted with the 75 items of the STRESS. An iterative approach was taken to item reduction. The determinant of the matrix, Bartlett’s Sphericity test, and the Kaiser-Meyer-Olkin test were used to assess each iteration's factorability. In each iteration, all items with communalities ≤ 0.40 or ≥ 0.80 , and those that cross-loaded with loadings ≥ 0.40 were removed (Tabachnick & Fidell, 2019). This process was repeated until no additional items needed to be removed. The number of factors to be extracted was determined via the Kaiser criterion (number of extracted factors with eigenvalues above 1; Costello & Osborne, 2005),

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scree plot (number of extracted factors before the second elbow of the plot; Beavers et al., 2013), and variance extraction (number of extracted factors that explain at least 75% of the variation in item responses; Beavers et al., 2013). In EFA, each metric available to determine the number of factors to extract has its limitations. However, current recommendations imply that using a combination of metrics provides a more detailed perspective on the number of factors to extract rather than using any one metric in isolation. This is even more the case when all metrics report the same number of factors to extract (Costello & Osborne, 2005). For this reason, we opted for three indicators (Kaiser criterion, scree plot, and variance extraction) to triangulate on the number of factors to extract.

Cronbach's internal reliability was calculated for all identified subscales. If the EFA produced thematically similar factors, these factors were combined, and their integrity was assessed with Cronbach's alpha. If the item reliability was acceptable, then a combined factor was retained. This approach was taken to minimise the number of subscales identified to promote scale parsimony. "Alpha if item was removed" statistics were used to identify items negatively affecting internal reliability and were removed. This not only improves the internal reliability of each subscale but further aids in the item reduction process.

Following the identification of subscales via the EFA and internal reliability analyses, subscale scores (means) were calculated for each participant. Correlations were then conducted between subscales for inter-factor associations, and with the Stress Mindset Measure and Beliefs About Stress Scale for construct validity.

3.3 Results

3.3.1 Sample Characteristics. Sixteen participants failed the attention checkers and were also removed from the study. Supplemental File B contains the characteristics of the final analysable sample of 419 participants (ratio participants:item = 5.59:1). MTurk

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participants were older, more likely to be male, more educated, in more full-time employment or self-employed positions, more likely to identify as Caucasian and being born and residing within either USA or India than the student sample. MTurk participants also reported more negative beliefs about stress on the Stress Mindset Measure and more negative and less positive beliefs on the Beliefs About Stress Scale; albeit these differences were of a small magnitude and within one standard deviation. There were no between-sample differences in control beliefs on the Beliefs About Stress Scale.

3.3.2 Exploratory Factor Analysis. Nine iterations were needed to arrive at a final 6-factor structure containing 24 items (see Table 1 for EFA statistics and Online Supplemental C for factor structure and item loadings): Factor 1 (5 items) - consequences of stress (e.g., “I find it harder to remember things when I am stressed”); Factor 2 (6 items) - coping efficacy (e.g., “I do lots of different things to cope with stress”); Factor 3 (3 items) - unique experience of stress (e.g., “Nobody feels stress like I do”); Factor 4 (4 items) - being around other stressed people (e.g., “I do not mind being in the same room as someone who is stressed”); Factor 5 (4 items) – interactions with others when feeling stressed (e.g., “I do not like socialising when I am stressed”); and, Factor 6 (2 items) - social support beliefs (e.g., “When I am feeling stressed, there are people who can help me”).

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3.3.3 Internal Reliability. Internal reliability was acceptable for Factors 1 ($\alpha=.86$) and 2 ($\alpha=.85$). Factors 3, 4, 5, and 6 were all related to social factors. Given these were thematically similar social factors related items, coupled some factors having very few items, the factors were combined and labelled “Social Factors”. The internal reliability for Social Factors was acceptable ($\alpha=.82$). Alpha if item was removed statistics suggested that Factors 1 and 2 could not be improved. However, Social Factors was improved by removing five of the items, leaving 8 items for the Social Factors scale ($\alpha=.87$). As such, the STRESS now contained 19 items over three subscales: Consequences (5 items), Coping Efficacy (6 items), and Social Factors (8 items; see Table 2 for final scale).

3.3.4 Subscale Score Computation. To calculate each subscale, the items of the Consequences subscale and the negatively worded items on the Social Factors subscale were reverse-scored (see Table 2 for identification of reverse-scored items). This ensured that higher scores represent more positive or less negative views of stress. Subscale items are averaged, producing scores from 1 to 6. Higher Consequence scores represent a stronger belief that stress is associated with less negative consequences. Higher Coping Efficacy scores represent a stronger belief in one’s ability to cope with stressful situations. Higher Social Factors scores represent a stronger belief that one can socialise when they are stressed or when others are stressed.

3.3.5 Construct Validity. Correlation analyses revealed that the Consequence and Social Factors subscales demonstrated acceptable construct validity with the Stress Mindset Measure and all subscales of the Beliefs About Stress Scale. However, the Coping Efficacy subscale only demonstrated acceptable construct validity with the Positive and Control subscale of the Beliefs About Stress Scale. Inter-factor correlations between the STRESS subscales revealed that these factors are weakly to moderately associated with each other (see Table 3 for all correlations).

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Table 1. Results of each iteration of the exploratory factor analysis

Iteration	Factorability			Number of factors			Reason items were removed		
	Determinant ^a	Sphericity ^b	KMO ^c	Kaiser Criterion ^d	Scree plot	Variance extraction ^e	Low communalities ^f	Low loading ^g	Cross loading ^h
First	1.22E ⁻²¹	p<.0005	0.93	15	4 or 7	15	9	12	2
Second	1.04E ⁻¹⁵	p<.0005	0.93	10	4 or 7	7	4	6	4
Third	1.61E ⁻¹¹	p<.0005	0.92	8	3 or 7	7	2	1	2
Fourth	3.00E ⁻¹⁰	p<.0005	0.91	8	3 or 6	6	1	0	0
Fifth	4.65E ⁻¹⁰	p<.0005	0.91	7	3 or 6	6	0	1	5
Sixth	4.62E ⁻⁸	p<.0005	0.88	7	3 or 6	6	0	0	2
Seventh	1.65E ⁻⁷	p<.0005	0.88	7	3 or 6	6	0	0	2
Eight	5.39E ⁻⁷	p<.0005	0.88	6	3 or 5	5	0	0	1
Ninth	2.98E ⁻⁶	p<.0005	0.87	6	6	6	0	0	0

Note. ^a Determinant = Determinant of the Matrix test for factorability. Scores above 0 (no matter how small) indicate a factorisable scale. ^b

Bartlett’s Test of Sphericity for factorability. Significant results indicate a factorisable scale. ^c KMO = Kaiser-Meyer-Olkin test for factorability.

Scores above 0.80 indicate that a scale is factorisable. Scores between 0.80 to 0.89 are Meritorious while scores above 0.90 are Marvellous. ^d

Kaiser Criterion = the number of factors extracted from an EFA with an eigenvalue above 1. ^e Variance extraction = the number of factors that explains at least 75% of the variance. ^f Low communalities = an indicator of items that do not fit with the other items. Scores below 0.40 indicate a low communality and therefore a poor-fitting item. ^g Low loading = item with loadings all below 0.40. ^h Cross loading = items that cross-loaded onto two or more factors with loadings above 0.40. Some items were removed for multiple reasons in a single iteration (e.g., low communalities and low loadings).

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Table 2. Reduced items for the STRESS

Item Number	Subscale	Item
1R	Consequences	It is harder for me to make decisions when I am stressed
2R	Consequences	I cannot think clearly when stressed
3R	Consequences	I find it harder to remember things when I am stressed
4R	Consequences	I feel immobilised by stress
5R	Consequences	Being stressed always ends badly
6	Coping Efficacy	There are things that I can do to control my stress
7	Coping Efficacy	There is always a way to respond when stressed
8	Coping Efficacy	I change my coping strategies to match the situation
9	Coping Efficacy	I know how to deal with stressful situations
10	Coping Efficacy	I do lots of different things to cope with stress
11	Coping Efficacy	I can respond to stress in many different ways
12R	Social Factors	Being around other people who are stressed makes me feel stressed
13	Social Factors	I do not mind being in the same room as someone who is stressed
14R	Social Factors	I can't be around other people when they are stressed
15	Social Factors	I do not become stressed if I am around other stressed people
16R	Social Factors	I tend to avoid people when I am stressed
17	Social Factors	I am comfortable around others when I am stressed
18R	Social Factors	I do not like socialising when I am stressed
19	Social Factors	I am happy to be around other people when I am stressed

Note. R indicates a reverse-scored item.

Table 3. Correlations for construct validity in Study 2

	STRESS subscales		
	Consequences	Coping Efficacy	Social Factors
STRESS Coping Efficacy	.39		
STRESS Social Factors	.56	.39	
Stress Mindset Measure	.59	.28	.48
BASS - Negative	-.68	-.25	-.60
BASS - Positive	.52	.30	.44
BASS - Control	.43	.64	.42

Note. BASS: Beliefs About Stress Scale. All correlations were significant at the $p < .0005$ level.

3.4 Discussion

EFA and internal reliability analyses produced a 19-item scale best represented by three factors: Consequences, Social Factors, and Coping Efficacy. The Consequences and Social Factors subscales of the STRESS demonstrated construct validity with the Stress Mindset Measure (Crum et al., 2013) and all subscales of the Beliefs About Stress Scale (Laferton et al., 2018). The Coping Efficacy subscale demonstrated acceptable concurrent validity with positive and control belief subscales of the Beliefs About Stress Scale (Laferton et al., 2018). This suggests that the Coping Efficacy subscale is capturing coping-specific aspects of stress beliefs, rather than focusing on consequences or negative beliefs about stress. Given the reliance on statistical inference to arrive at this structure, a CFA was needed to confirm this factor structure in a separate sample. Furthermore, an assessment of convergent and divergent validity is needed across a broader range of variables related to stress.

4. Study 3 – Confirmatory Factor Analysis

4.1 Introduction

Following the identification of the final items and subscale structure via statistical inference, the next step in the STRESS scale development was to validate the factor structure from Study 2 in a new sample. This ensured the factor structure arising from the EFA was stable and not simply resulting from sampling variation.

Evaluation of convergent and divergent validity of the STRESS was also needed. For this study, convergent validity was assessed against emotion reappraisal (Shallcross et al., 2015), resiliency (Windle, 2011), trait anxiety (Hemenover & Dienstbier, 1996), perceived stress (Cohen et al., 1983), and neuroticism (Gallagher, 1990). Each of these constructs has been associated with the stress response in some way. Specifically, emotion reappraisal is a

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process by which an individual moderates their emotion by changing how they see a situation (Gross, 2015a). Those who are more able to reappraise their emotions report lower levels of perceived stress during stressful situations compared to those who cannot reappraise their emotions (Shallcross et al., 2015). Resiliency is a resource used to cope with stress (Fletcher & Sarkar, 2013), with greater resiliency associated with lower levels of perceived stress during stressful situations (Shallcross et al., 2015). Trait anxiety is a well-known negative affective state that shares a consistently positive relationship with stress. However, while there is overlap between the two constructs, current models of stress do not position emotions (and therefore, do not position anxiety) as part of stress itself, but rather as an outcome of experiencing stress (De Longis et al., 1988; Ursin & Eriksen, 2010). Perceived stress, simply, is the level of stress that an individual perceives themselves as having experienced over a certain amount of time, typically over one week or one month (Cohen et al., 1983).

Neuroticism demonstrates consistent positive relationships with threat appraisals (for a review, see Kilby et al., 2018). Given that stress beliefs are also expected to influence the stress response, there should be some correlation between these constructs and the subscales of the STRESS.

Divergent validity was assessed against trait altruism (Rushton et al., 1981) and trait religiosity (Plante & Boccaccini, 1997), as these constructs that should not influence the experience of stress. Rather, religiosity may be called upon as a coping strategy (Pargament & Park, 2019), whereas altruism may be influenced by having experienced stress in the past (Davis et al., 2019).

It was hypothesised that the three-factor structure identified in Study 2 would provide an adequate fit to the data in a confirmatory factor analysis. For Study 3 to demonstrate convergent validity, it was hypothesised that all subscales of the STRESS would demonstrate weak-to-moderate ($.30 < r < .70$) correlations in a positive direction with emotion reappraisal

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and resiliency. A negative correlation of the same magnitude was expected between all subscales of the STRESS with neuroticism, perceived stress, and trait anxiety. For divergent validity it was expected that the correlation between the STRESS subscales with religiosity and altruism would be smaller than .30. It was further expected that the STRESS would replicate the correlations from Study 2 with the Stress Mindset Measure and the Beliefs About Stress Scale.

4.2 Method

4.2.1 Participants

There were 301 MTurk participants (paid USD\$3) who completed this online study, meeting current CFA sample size recommendations (Tabachnick & Fidell, 2019).

Participants were all at least 18 years of age and did not participate in Study 2.

4.2.2 Procedure

Participants provided online consent, completed the Study 2 demographics survey, then the STRESS, Perceived Stress Scale (Cohen et al., 1983), Stress Mindset Measure (Crum et al., 2013), Beliefs About Stress Scale (Laferton et al., 2018), Emotion Regulation Questionnaire (Gross & John, 2003), Brief Resilience Scale (Smith et al., 2008), Trait Anxiety subscale of the State Trait Anxiety Inventory (Spielberger et al., 1970), Neuroticism subscale of the Mini International Personality Inventory Protocol (Donnellan et al., 2006), Self-Reported Altruism Scale (Rushton et al., 1981), and Strength of Religious Faith Scale (Plante & Boccaccini, 1997) in random order. All scales, except for the STRESS, contained one attention checker item. This study was approved by the Macquarie University Human Research Ethics Committee (REF #5201800297).

4.2.3 Measures Not Previously Described

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4.2.3.1 Perceived Stress Scale. This scale captures the subjective level of stress participants believe they have experienced over the last month. Over 13 items, participants rate their agreement with statements such as “In the last month, how often have you felt that things were going your way?” on a 5-point Likert-type scale (0 “Very often” to 4 “Never”). Higher summed scores (range 0-52) represent greater subjectively perceived stress levels. Internal reliability was acceptable ($\alpha=.90$).

4.2.3.2 Emotion Regulation Questionnaire. The 6-item reappraisal subscale of the Emotion Regulation Questionnaire (Gross & John, 2003) assessed self-reported levels of an individual’s ability to change their emotions. Participants respond with their agreement to statements such as “I control my emotions by changing the way I think about the situation I’m in” on a 7-point Likert-type scale (1 “Strongly Disagree” to 7 “Strongly Agree”). Higher averaged scores (range 1-7) represent greater ability to reappraise emotions. Internal reliability was acceptable ($\alpha=0.88$).

4.2.3.3 Brief Resilience Scale. This scale assessed participants’ ability to return to life as usual following a stressful situation (Smith et al., 2008). Participants respond with their agreement to six statements such as “I tend to bounce back quickly after hard times” on a 5-point scale from 1 “Strongly Disagree” to 5 “Strongly Agree”. Higher average scores represent greater resiliency. Internal reliability was acceptable ($\alpha=0.94$).

4.2.3.4 State Trait Anxiety Inventory. This inventory's trait subscale evaluated self-reported anxiety experienced over the last week (Spielberger et al., 1970). Participants rate the extent they have experienced each of 20 statements such as “I feel nervous and restless” on a 4-point Likert-type scale from 1 “Not at all” to 4 “Very much”. Higher total scores (range 20-80) represent greater trait anxiety. Internal reliability was acceptable ($\alpha=0.96$).

4.2.3.5 Neuroticism subscale of the mini IPIP. Measures participant emotionality levels (Donnellan et al., 2006). Participants respond to 20 statements such as “I get upset easily” on a 5-point scale (1 “Very inaccurate” to 5 “Very accurate”). Higher average scores (range 1-5) represent higher neuroticism levels. Internal reliability was acceptable ($\alpha=0.83$).

4.2.3.6 Self-Reported Altruism Scale. Assesses the extent an individual perceives themselves as being altruistic (Rushton et al., 1981). Participants answered 20 items such as “I have offered my seat on a bus or train to a stranger who was standing” on a 5-point Likert-type scales ranging from 1 “Never” to 5 “Always”. Higher total scores (range 20-100) represent greater altruism. Internal reliability was acceptable ($\alpha=0.93$).

4.2.3.7 Strength of Religious Faith Scale. This scale measured levels of religiosity over 10 items such as “I pray daily” where participants rate their agreement on a 7-point Likert-type scale (1 “Strongly Disagree” to 7 “Strongly Agree”; Plante & Boccaccini, 1997). Higher total scores (range 10-70) represent a greater strength of religiosity. Internal reliability was acceptable ($\alpha=0.99$).

4.2.4 Statistical Analysis. Descriptive statistics outlined sample characteristics. Pearson’s correlations assessed construct, convergent, and divergent validity. Descriptive statistics and correlations were conducted in SPSS version 25 (IBM, 2016). Given that the study was overpowered for correlations and that external validity is assessed via Pearson’s r magnitude and not statistical significance, p -values were not interpreted.

Confirmatory factor analyses (CFA) using a Robust Maximum Likelihood estimator were conducted in Mplus version 6 (Muthén & Muthén, 2011). The CFA assessed the three-factor model of Study 2. The model was refit using modification indices to allow error terms to correlate between items where appropriate. RMSEA, CFI, SRMR were used as fit indices

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in this study; good fitting models are represented by an RMSEA statistic above .05, CFI above 0.95, and SRMR below 0.08 (Kenny, 2015).

4.3 Results

4.3.1 Sample Characteristics and Confirmatory Factor Analysis. One participant made more than two errors on the attention checkers and was removed, resulting in a final sample of 300 participants. See Supplemental File B for all sample characteristics. The CFA assessed the appropriateness of the three-factor model. Figure 1 contains a graphical representation of the model. The initial fit was used to extract modification indices. The model was refit with error term correlations identified in the modification indices; no error term correlated between items across factors (see Supplemental File D for error terms). The model demonstrated acceptable RMSEA statistics (RMSEA = .06, 95%CI: .05-.07, $p = .03$), the model CFI was .94 (within .01 of the 0.95 threshold), and had an acceptable SRMR of .07.

4.3.2 Convergent and Divergent Validity. All three subscales demonstrated acceptable convergent validity with resiliency, perceived stress, trait anxiety, and neuroticism; however, only Coping Efficacy demonstrated acceptable convergent validity with emotional reappraisal. All subscales shared weak ($r < 0.30$) to non-existent correlations with religiosity. Consequences and Social Factors shared weak to non-existent relationships with altruism; however, Coping Efficacy marginally surpassed the 0.30 threshold ($r = 0.35$). Construct validity with the Stress Mindset Measure, and the Beliefs About Stress Scale were reproduced in this study. Table 4 contains all correlations.

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Table 4. Pearson’s correlations between the STRESS and convergent, divergent, and construct validity variables

	STRESS		
	Consequences	Coping Efficacy	Social Factors
	Convergent Validity		
Reappraisal	.21	.59	.23
Resilience	.69	.55	.59
Trait Anxiety	-.66	-.52	-.57
Neuroticism	-.66	-.49	-.56
Perceived Stress	-.65	-.52	-.49
	Divergent Validity		
Altruism	.09	.35	.18
Religiosity	.02	.16	.16
	Construct Validity		
Stress Mindset	.44	.25	.39
BASS			
Positive	.38	.30	.35
Negative	-.61	-.25	-.49
Control	.53	.64	.48

Note. BASS: Beliefs About Stress Scale. All *p*-values < .0005.

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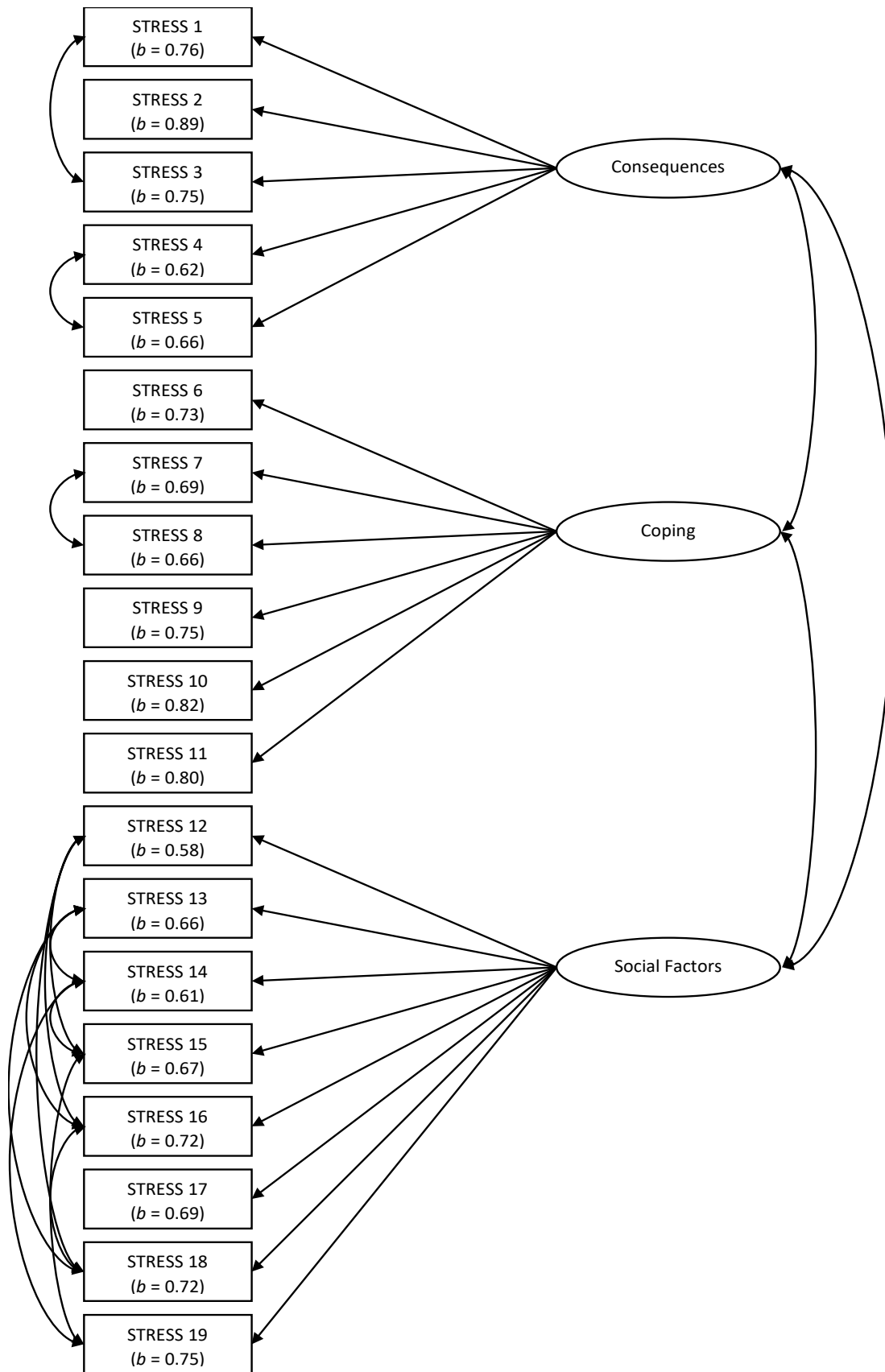


Figure 1. Graphical representation of the final three-factor model with standardised betas. All $ps < .0005$.

4.4 Discussion

The CFA results confirm the fit of the three-factor model. Convergent validity was demonstrated in all cases, except for emotional reappraisal, which correlated only with Coping Efficacy. This may be due to emotional reappraisal being used as a coping strategy (Sammy et al., 2017). Specifically, those who believe they are more able to cope may be more likely to employ this emotion-based coping strategy. These findings highlight that Coping Efficacy is uniquely associated with coping-based aspects of stress, while beliefs unrelated to coping are not.

There were acceptable levels of divergent validity on all accounts except for Coping Efficacy marginally surpassing the 0.30 cut-off with Altruism. Although yet to be empirically verified, people who believe that they can cope with stress may be inclined to enact altruistic behaviour toward others who cannot cope. However, given this weak effect is approaching 0.30, it may be a statistical artifact.

Concurrent validity from Study 2 was reproduced with Coping Efficacy correlating with all scales except stress mindset and the negative beliefs subscale of the Beliefs About Stress Scale. Studies 2 and 3 confirmed the structure, item reliability, and concurrent, convergent, and divergent validity of the STRESS. It was then possible to assess whether the STRESS could overcome the shortcoming of existing stress belief scales (Crum et al., 2013; Laferton et al., 2018): the ability to predict individual differences in appraisals of a stressful situation. This was addressed in Study 4.

5. Study 4 – Predictive validity

5.1 Introduction

Despite there being a strong rationale for expecting stress beliefs to influence stressor appraisals (as outlined in Section 1.2), prior research with stress belief measures has failed to

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demonstrate this relationship (Crum et al., 2017; Kilby & Sherman, 2016). Demonstrating that stress beliefs predict the appraisals made of a stressful situation will position stress beliefs as a possible target for future interventions to improve the stress response.

Accordingly, a final study was conducted to assess whether the STRESS could predict the stressor appraisals made in a standardised stress induction; Trier Social Stress Test (Kirschbaum et al., 1993). The employment of a standardised stress induction allowed for control of stressor-specific variations in appraisals. To account for the multiple approaches to measuring stressor appraisals (as outlined in Section 1.1; Kilby et al., 2018), predictive validity was assessed against primary (capturing challenge and threat separately and as a single construct), secondary, and ratio appraisals. Moreover, there was an outstanding need to assess the test-retest reliability of the STRESS. As such, the intraclass correlations of the STRESS were calculated over a two-week period (Gregory, 2011).

All subscales of the STRESS were expected to have significant positive associations with challenge and secondary appraisals, and negative associations with primary, threat, and ratio appraisals. It was also expected that test-retest reliability over two weeks would be adequate by accepted thresholds (intra-class correlations above 0.50; Koo & Li, 2016).

5.2 Method

5.2.1 Participants. First-year psychology students ($N = 137$) from Macquarie University were recruited into this study for course credit. All participants were 18 years or older and self-reported being free of any current or previous psychological or stress-related condition. This study was approved by the Macquarie University Human Research Ethics Committee (reference: 5201600554).

5.2.2 Procedure. Participants provided online informed consent and completed a demographics survey, the STRESS, and a self-reported momentary measure of perceived

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stress before being shown a standardised set of instructions for a modified version of the Trier Social Stress Test developed for administration by a single researcher (Kudielka et al., 2007).

The instructions informed participants that, after 2 minutes to prepare, they would deliver a 5-minute speech about why they deserved their dream job. Following this speech, they would have to complete a 5-minute serial subtraction task. If an error was made, participants were told to restart. Participants were informed that they would be completing the induction in front of the researcher, who would be taking notes on a clipboard, and in front of a camera that would record the task and be sent to a panel of experts for evaluation. No notes, pen, or paper were allowed. Unbeknown to participants, the camera was turned off, there was no panel of experts, and the researcher scribbled to create the illusion of writing.

After reading task instructions, participants completed the two measures of stress appraisals and another momentary perceived stress measure. Participants then completed the speech task, completed a third momentary perceived stress measure, and then the mathematics task before completing a post-induction momentary perceived stress measure. Participants were debriefed on study deception and completed a final post-debrief momentary perceived stress measure. Momentary perceived stress was measured at five points as a manipulation check. Two weeks later, participants completed the STRESS again.

5.2.3 Measures Not Previously Described.

5.2.3.1 Stressor Appraisal.

Two different stressor appraisal scales were employed. The Cognitive Appraisals Measure is a valid and reliable measure of primary appraisals designed in a student population for performance-based stressful situations (Skinner & Brewer, 2002). This scale measures challenge and threat appraisals in separate subscales. Participants respond with their

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agreement to 18 statements such as “I am concerned others will not approve of me” on a 6-point Likert-type scale (1 “Strongly disagree” to 6 “Strongly agree”). Higher averaged scores (range 1-6) represent a stronger challenge and/or threat appraisals. Internal reliability was acceptable for both subscales (α s > .87).

The Stress Appraisal Scale (Schneider, 2008) is a general stressor appraisal scale that treats challenge and threat appraisals as opposite ends of one construct labelled “primary appraisal” and also measures secondary appraisals. The ratio of primary to secondary appraisals can also be taken as a measure of demands vs resources. Participants respond with their agreement to 10 items such as “How threatening do you expect the upcoming task to be?” on a 7-point Likert-type scale (1 “Low” to 7 “High”). Higher averages (range 1-7) imply stronger threat (primary appraisal) or greater perceived resources. Internal reliability was acceptable for both subscales (α s > .77).

5.2.3.2 Momentary Perceived Stress. Participants completed the Distress Thermometer (Mitchell, 2007) adjusted to read ‘stress’ rather than ‘distress’ with “Please slide the scale to change the thermometer to describe best how much stress you are experiencing right now” on an 11-point visual analogue scale (0 “no stress” to 10 “extreme stress”).

5.2.4 Statistical Analysis. Analyses were conducted in SPSS version 25 (IBM, 2013). Descriptive data outlined sample characteristics. A manipulation check was conducted via a Friedman’s test on all momentary perceived stress scales due to each thermometer's ordinal and non-normally distributed data (Harpe, 2015). Correlations between appraisal scales and the STRESS assessed bivariate predictive validity. Across five separate multiple regressions, each stressor appraisal (challenge, threat, primary, secondary, ratio) was regressed onto all three STRESS subscales for combined predictive validity. Test-retest reliability was assessed

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with a two-way mixed intra-class correlation (Koo & Li, 2016). Significance was defined at $p = .05$ for all analyses. Power calculations in G*Power (Faul et al., 2007) revealed a minimum sample size of 119 participants was required to find a medium effect size with three predictors while maintaining Type I error at 0.05 and power at 0.95.

5.3 Results

5.3.1 Sample Characteristics and Manipulation Check. Supplemental File B outlines sample characteristics. The manipulation check revealed that perceived stress changed throughout the induction in expected directions. Bonferroni adjusted comparisons revealed that perceived stress scores increased from before instructions (Median = 3, interquartile range [IQR]: 1-6) to after instructions (Median = 7, IQR: 5-8; $p < .0005$), remained stable through to mid-induction (Median = 7, IQR: 4-9; $p = 1.00$) and began to decline from mid-induction to post-induction (Median = 5, IQR: 3-7; $p < .0005$) and post-debrief (Median = 3, IQR: 1-4; $p < .0005$). Post-debrief levels were equivalent to levels before instructions ($p = 1.00$).

5.3.2 Predictive Validity. The Consequences and the Social Factors subscales were weakly to moderately significantly correlated with all appraisal scales. The Coping subscale was weakly to moderately correlated with all appraisal scales except for Primary Appraisal (see Table 5 for correlations).

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Table 5. Correlations between the STRESS subscales and stress appraisals

	Consequences	Coping Efficacy	Social Factors
Challenge Appraisal	.29*	.41*	.20*
Threat Appraisal	-.43*	-.34*	-.40*
Primary Appraisal	-.29*	-.13	-.34*
Secondary Appraisal	.36*	.38*	.25*
Ratio Appraisal	-.40*	-.27*	-.25*

Note. * $p \leq .05$

Regression analyses revealed that at least one subscale uniquely predicted each stressor appraisal. The STRESS explained between 14% (Primary Appraisal) and 29% (Threat Appraisal) of the variance. For Challenge Appraisal, only the Coping Efficacy was uniquely related, whereas, for Threat Appraisal, all three subscales were uniquely related. For Primary Appraisal, only the Social Factors subscale was uniquely related. For Secondary Appraisal, Consequences and Coping Efficacy were related. For the Ratio Appraisal, only Consequences was related. See Table 6 for all regression statistics.

Table 6. Regression results of the STRESS and appraisals.

	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% <i>CI</i>	
					Lower	Upper
Challenge Appraisal – $F(3,133)=10.86, p < .0005, R^2 = .20$						
Consequences	.10	.09	1.10	.273	-.08	.28
Coping Efficacy	.42	.10	4.17	<.0005	.22	.63
Social Factors	.12	.09	1.38	.171	-.05	.28
Threat Appraisal – $F(3,133)=17.71, p < .0005, R^2 = .29$						
Consequences	-.251	.10	-2.60	.010	-.44	-.06
Coping Efficacy	-.302	.11	-2.79	.006	-.52	-.09
Social Factors	-.313	.09	-3.47	<.001	-.49	-.14
Primary Appraisal – $F(3,133)=7.32, p < .0005, R^2 = .14$						
Consequences	-.18	.10	-1.83	.070	-.37	.01
Coping Efficacy	-.03	.11	-0.32	.751	-.25	.18
Social Factors	-.27	.09	-2.94	.004	-.44	-.09
Secondary Appraisal – $F(3,133)=12.14, p < .0005, R^2 = .22$						
Consequences	.23	.11	2.05	.042	.01	.45
Coping Efficacy	.43	.13	3.48	.001	.19	.68
Social Factors	.18	.10	1.68	.095	-.03	.38
Ratio Appraisal – $F(3,133)=10.19, p < .0005, R^2 = .19$						
Consequences	-.24	.07	-3.27	.001	-.38	-.09
Coping Efficacy	-.12	.08	-1.54	.126	-.28	.04
Social Factors	-.09	.07	-1.33	.186	-.22	.04

5.3.3 Test-Retest Reliability. Intra-class correlations ($N = 117$) revealed all subscales had acceptable test-retest reliability (Consequences ICC = .68, Coping Efficacy ICC = .53, and Social Factors ICC = .74).

5.4 Discussion

Study 4 aimed to assess the stress belief-appraisal link using the newly developed STRESS. This was achieved through employing a standardised stress induction task and multiple approaches to measuring appraisals. Correlations revealed that all three stress belief subscales shared logical bivariate correlations with all approaches to measuring appraisals in all cases except for coping efficacy and primary appraisals. In addition, multiple regression analyses where all three subscales were included as predictors of each appraisal confirmed that at least one belief subscale from the STRESS was uniquely related to each way of measuring appraisals. These results provide the first line of empirical evidence to support the

existence of the stress belief-appraisal link. Finally, two-week test-retest reliability analyses revealed that the STRESS demonstrated acceptable levels of stability.

6. General Discussion

This sequence of four studies set out to demonstrate evidence for the stress belief-appraisal link, by developing a new scale, the STRESS. Focusing on the first three studies in which the STRESS was created, the STRESS was developed using a large pool of stress belief items, piloted on a large and global sample. The EFA and CFA revealed a stable three-factor structure for the STRESS spanning beliefs about Consequences, Coping Efficacy, and Social Factors. Of note, while the Consequences and Coping Efficacy share face validity to domains captured in the Stress Mindset Measure (Crum et al., 2013) and the Beliefs About Stress Scale (Laferton et al., 2018), correlations revealed that these subscales are only moderately correlated. The STRESS also includes a new domain that is not present in existing measures, Social Factors. Across the last three studies in which the validity and reliability of the STRESS was assessed, the three-factor STRESS demonstrated acceptable internal and test-retest reliability levels and evidence for convergent, divergent, concurrent, and, of note, predictive validity for the stress belief-appraisal link.

Predictive validity was demonstrated against all major self-report approaches to measuring stressor appraisals (Kilby et al., 2018; Schneider, 2008; Skinner & Brewer, 2002). The STRESS is the first stress belief scale to demonstrate consistent support for the stress belief-appraisal link in primary (threat and challenge, measured both independently and as a single construct) and secondary appraisals in a standardised stressful situation. As such, regardless of the approach to operationalising appraisals, stress beliefs may be important factors that influence interindividual differences in how we appraise stressful situations. Moreover, the specific factor of the STRESS related to stress appraisals differed depending

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on the type of appraisal. This suggests that different stress beliefs will be important for promoting different types of appraisals, and in turn, suggesting that stress beliefs need to be treated as a multidimensional construct to appropriately understand the connection between stress beliefs and the subjective stress response. The predictive validity study results support earlier work in stress beliefs (Kilby et al., 2020a; Kilby & Sherman, 2016), suggesting an extension of the Transactional Model of Stress to include a stress belief-appraisal link be warranted.

Despite the STRESS's success in overcoming limitations of previous scales, some limitations of these four studies should be highlighted. The STRESS is self-report and is, therefore, susceptible to limitations common to self-report scales. Implicit association tests have been successfully used to access other kinds of beliefs without self-report (De Houwer et al., 2009), yet research has failed to support the validity of this approach with stress beliefs (Keech et al., 2018), suggesting that self-reported measures are a more optimal approach for measuring stress beliefs. Moreover, the present body of work did not assess whether the STRESS predicts coping or stress-related outcomes. Other stress belief measures (Crum et al., 2013; Fischer et al., 2016; Laferton et al., 2018) have already demonstrated such relationships, and the relationship between appraisals, coping, and outcomes has been well established (Folkman et al., 1986; Folkman & Lazarus, 1980; Lazarus & Folkman, 1984; Tomaka et al., 1997). Therefore, it was not deemed pertinent to examine these as part of the construction and psychometric testing of the STRESS. Nevertheless, future studies should explore whether the STRESS indirectly predicts these aspects of the stress response via appraisals. Finally, these studies did not include measurement invariance analyses to identify cultural or social differences in the scale. While this is an important aspect of psychometric analyses, it was beyond the scope of the initial development of the scale. Future work using the STRESS should consider such analyses.

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In summary, this sequence of studies has demonstrated the STRESS has sound psychometric properties, which stands as the first stress belief measure that demonstrates theorised relationships with stressor appraisals. The use of this scale by researchers will further the understanding of the complexity of the stress response and provide insight into new approaches to improving the way individuals respond to everyday stress.

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