RUNNING HEAD: FEAR INHIBITION AND ADOLESCENCE

Factor analysis and validation of a self-report measure of impaired fear inhibition

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Abstract

Difficulties with inhibiting fear have been associated with the emergence of anxiety problems and poor response to cognitive-behavioural treatment. Fear inhibition problems measured using experimental paradigms involving aversive (or even mildly unpleasant) stimuli may be inappropriate for vulnerable samples and may not capture fear inhibition problems as manifested in everyday life. We present, the Fear Inhibition Questionnaire (FIQ), a novel self-report measure of fear inhibition problems, and assess its factor structure across two cultures and how well it correlates with fear inhibition indices derived experimentally.

Adolescent participants from Hong Kong and England completed the FIQ, with the English participants also completing a conditioning and extinction task to assess fear inhibition problem. The FIQ's factor structure and its relationship with the experimental measures of fear inhibition and self-reported anxious symptoms (Screen for Child Anxiety Related Disorders; SCARED) were examined.

Across both cultures, the FIQ showed a single factor structure and low FIQ scores, or worse fear inhibition problems, were associated with self-reports of heightened anxiety. Correlation of FIQ scores with experimental indices, whilst controlling for anxious symptoms, suggest that the FIQ represents a valid and unique measure of fear inhibition abilities.

The FIQ might be used to assess more ecologically-valid fear inhibition problems particularly amongst people who have or who are at risk of anxiety diagnoses.

Keywords: Anxiety; Adolescence; Fear; Safety; Extinction; Cognitive Behavioural Treatment

Introduction

Problematic fear inhibition has been found to predict the emergence, severity and treatment of anxiety disorders (Jovanovic, Kazama, Bachevalier, & Davis, 2012; Lommen, Engelhard, Sijbrandij, van den Hout, & Hermans, 2013; Waters & Pine, 2016). Such problems manifest when fear is expressed in situations where there is no direct or indirect (observed or instructed) experience of danger. They are also expressed where danger has been experienced but subsequent experiences have shown that this situation and others like it are safe. Currently these problems are assessed using experimental procedures where fear is conditioned using aversive (or even mildly unpleasant) stimuli. There are two limitations with this approach. First, fear inhibition is measured to a set of experimental stimuli that have been associated with a relatively artificial US, undermining the ecological validity of these fear processes. Second, for ethical reasons, this methodology can be problematic amongst those with anxiety disorders, and within populations where risks for pathological anxiety may be higher. Adolescence is a period of risk for anxiety, with many disorders emerging at this time (Kessler et al., 2012) and when brain circuits involved in fear inhibition are undergoing significant maturation (Lau et al., 2011). Being able to assess fear inhibition problems in everyday life in young people is therefore especially important for identifying those who may be at-risk for anxiety disorders. The current investigation presents a novel questionnaire for measuring individual differences in fear inhibition with cross-cultural data on its factor structure (and its reliability) and its association with anxiety and experimental measures of fear inhibition (its validity). This questionnaire has the potential to increase the ease with which fear inhibition problems can be assessed.

Problems with fear inhibition have typically been conceptualized and measured in several ways, all involving experimental tasks. In each of the methods used to quantify these problems, a neutral, conditional stimulus (CS+) is first paired with an aversive, unconditional

stimulus (US). Fear for this stimulus is then compared against a conditional stimulus that is presented repeatedly in the absence of the US (CS-). In such *differential conditioning* preparations, adolescents with anxiety disorders have shown elevated fear for CS-s relative to non-anxious controls (Lau et al., 2008) similar to differences found between adults with and without anxiety disorders (Duits et al., 2015; Lissek et al., 2005). Fear for novel, perceptually similar stimuli – so-called generalization stimuli (GS) – has also been measured. Data from these paradigms show enhanced *generalization* of fear from CS+s to GSs in anxious participants relative to non-anxious controls (Britton et al., 2013; Lau et al., 2008), again similar to adults with anxiety (Lissek et al., 2014). In *extinction* paradigms, relative to their non-anxious counterparts, clinically-anxious adolescents have shown evidence of sustained fear for CS+s even when it has been presented repeatedly in the absence of the US (Britton et al., 2013), again mirroring findings in adults (Duits et al., 2015; Lissek et al., 2005). Other tests of problematic fear inhibition are provided by measures of the extent of *return of fear* for CSs after extinction. Specifically, one might assess the extent to which the CS begins to evoke fear again after the mere passage of time following extinction (*spontaneous recovery*) or the extent to which the CS evokes fear following exposure to an aversive US that occurs after extinction (*reinstatement*). Also, conditioning and extinction can involve different contexts (e.g., the CS is shown in different rooms) or if they use stimuli that are similar but not the same (e.g., the conditioning stimulus is a large circle and the extinction stimulus is a smaller circle). Where the stimuli differ, one can assess the extent to which fear for the CS returns after extinction when the original CS is presented after extinction (*stimulus renewal*). Where the conditioning and extinction contexts differ, one can assess the extent to which fear for the CS returns when the CS is encountered in the original context after extinction (*context renewal*)(Bouton, 2004). While there have been no studies of these processes in anxious adolescents, anxious adults have shown heightened spontaneous recovery of fear after

extinction (McLaughlin et al., 2015; Milad et al., 2013; Milad et al., 2009) and heightened context renewal relative to non-anxious controls (McLaughlin et al., 2015).

In each of these paradigms, the fear that is expressed should be inhibited because either there has been no direct experience of anything aversive happening in the presence of a particular stimulus (e.g., in fear generalization from a CS to a GS, or in stimulus or context renewal where a novel stimulus or context are encountered after extinction) or because experience has shown that such stimuli are safe (e.g., in fear for CS-s, fear for CS+s in extinction, or in instances of reinstatement or spontaneous recovery of fear for CSs after extinction). In the case of return of fear phenomena, that fear can return at all and that it does so even when fear appears to have been extinguished, is evidence that during extinction fear comes to be inhibited rather than erased (Milad & Quirk, 2012). Although it is possible that in fear generalization paradigms other processes such as perceptual discrimination may contribute towards individual differences in fear expression (Struyf, Zaman, Hermans, & Vervliet, 2017), neuroscientific evidence in this area suggests that the fear expressed for generalization stimuli is associated with reduced inhibition of fear excitatory regions of the brain rather than merely heightened activity of these excitatory regions (Lissek et al., 2014; Milad et al., 2007). More specifically, in the case of fear generalization, stimuli that are increasingly dissimilar to a CS+ to which fear has been conditioned evoke greater vmPFC-mediated fear inhibitory activity and this is associated with changes in the activity of fear excitatory regions of the amygdala and insula (Lissek et al., 2014). Similarly, successful extinction of fear and continued inhibition of fear after extinction has been associated with increased activity in the vmPFC and its functional connection with the amygdala (Milad et al., 2007). A review of this literature, across human and non-human animal studies suggests that the vmPFC activates inhibitory cells in the amygdala which suppress the fear excitatory activity of other amygdala nuclei (Milad & Quirk, 2012). If reduced fear in these situations

were driven by reduced excitation in fear excitatory regions of the brain, rather than problematic inhibition of these regions, then we would instead expect to see only changes in the fear excitatory regions and no activity within areas such as the vmPFC.

In summary, there is growing evidence that fear generalization, extinction and return of fear after extinction involve activation within brain regions that are involved in fear inhibition. There is also evidence that problematic fear inhibition associates with anxiety in adolescence. However, most of this evidence involves testing participants in fear conditioning paradigms involving mildly unpleasant stimuli (for ethical issues, few studies use aversive stimuli such as electric shock as the US). This may mean that fear to the US and CS is at a 'floor' level during conditioning, thus also undermining the validity of fear inhibition responses during generalization and extinction. Furthermore, fear inhibition is assessed only to a set of relatively artificial conditional and unconditional stimuli. There is as yet no way to measure these problems in an easy-to-administer, self-report fashion, that capture the real-world manifestation of fear inhibition problems. Such a measure might be more acceptable to young participants particularly those who are already anxious. By improving acceptability, it might then be possible to assess fear inhibition problems in larger samples of participants who are more representative than the kinds of anxious participants who would consent to participating in a conditioning paradigm involving aversive stimuli. Alternatively, such a measure could be used to broadly screen for fear inhibition difficulties, and follow participants up for in-depth experimental testing.

We present the Fear Inhibition Questionnaire (FIQ) which assesses individual differences in fear inhibition. The FIQ's items were designed to tap into the same fear inhibition processes that have been studied experimentally, such as the generalization of fear to safe stimuli (e.g., item 11 "If I've had a stressful experience in the past, similar situations make me anxious even though I know they're not the same.") and deficits in extinguishing

fear (e.g., item 7 “No matter how many times I expose myself to things that make me anxious, I still find that I get anxious.”) (see Table 1 for a full list of items). However, unlike experimental tasks, real-life situations are described.

In two studies, we examined the psychometric properties of the FIQ amongst healthy adolescents from the community in two cultures, Hong Kong (study 1) and London (study 2). Although the FIQ includes several different kinds of items, we expected that the FIQ would possess a single factor that captures overall fear inhibition problems. We also sought to establish the extent to which scores in the FIQ corresponded with individual differences in anxious symptoms and also experimental measures of fear inhibition. In line with experimental evidence in this area, we expected that lower FIQ scores or worse fear inhibition problems would be associated with higher anxious symptoms and that this relationship would hold even when accounting for the relationship between anxiety and age and gender. We also expected that the FIQ would correlate with experimental measures of fear inhibition problems, or more specifically, that lower FIQ scores would be associated with poorer discrimination between a CS+ and CS- (due to elevated threat anticipation for the safe CS-), elevated fear for a safe, perceptually similar, GS, slower extinction and heightened return of fear, measured in terms of stimulus renewal and reinstatement. Although experimental measures of fear inhibition are suboptimal given that they often use mildly unpleasant stimuli and only assess fear to a circumscribed set of experimental stimuli, nonetheless these measures are the typical means for assessing fear inhibition. As such we decided to assess the validity of the FIQ in relation to these experimentally-derived indices. Our inclusion of samples from two countries was intended to support the generalizability of our findings across cultures. We had no reason to expect that fear inhibition problems would manifest differently between these cultures. As such, we expected that the factor structure of the FIQ and its relationship with anxiety symptoms would be replicated across our study

samples. Study 1 explores the factor structure of the FIQ in a Hong Kong sample and then correlates FIQ scores with anxiety symptoms. In study 2 we confirm the factor structure of the FIQ in a larger, UK sample whilst also validating it as a measure of fear inhibition abilities and replicating its association with anxiety symptoms.

Study 1

Method

Participants

104 youths (Females = 36; 34.6%), aged 11 to 16 (*M* = 13.65; *SD* = 1.34) were recruited from grades 5-8 of several schools in Hong Kong. Although there is disagreement over how to make *a priori* assumptions about sample sizes in factor analysis, given the exploratory nature of our investigation the sample size reflected some established rules of thumb. Namely, we sought to have at least 100 participants and approximately 5-10 participants per item (MacCallum, Widaman, Zhang, & Hong, 1999).

Measures

Fear Inhibition Questionnaire (FIQ). The FIQ includes 18 items. The items of the FIQ were generated by TJB and JL by examining the literature base (e.g., Lissek et al., 2005; Duits et al., 2015) and generating items that matched the presumed real-world manifestation of each of the ways fear inhibition problems have been quantified. The authors then consulted other experts in this field for their feedback on the items and recommendations for new items. Participants respond to the final list of items on a 5-point Likert-scale from 1 (*never*) to 5 (*always*). After participants made their responses, their scores were reversed such that scores can range from 18 to 90 and a lower score represents worse fear inhibition. The FIQ was translated from English into Chinese by a graduate student, and back-translated by a professional translator. The back-translation was reviewed and cross-checked with the original version to ensure that the translation retained the intended meaning of each item.

Screen for Childhood Anxiety Related Disorders questionnaire (SCARED). The SCARED is a 41-item measure that screens for anxiety disorder symptoms (Birmaher et al., 1999). Participants rate how true each item is on a 3-point Likert-scale from 0 (*not true or hardly ever true*) to 2 (*very true or often true*). The SCARED was translated and back-translated through the process described above. Cronbach's alpha was .92.

Procedure

Upon obtaining parents' consent and youths' assent, participants were invited to attend a test day where they completed a battery of questionnaires whilst sat individually in a laboratory. They were reminded that they could ask any questions if they were unclear about the questionnaire instructions or items, and that their responses would be kept anonymous and confidential.

Analysis procedure

Analyses were carried out using STATA 14.1. The fapara package was used for factor analyses.

The factor structure of the FIQ was first established. The procedure of (Barry, Hermans, Lenaert, Debeer, & Griffith, 2013) was replicated wherein Parallel Analysis was used to select the number of factors within the FIQ to be extracted for the exploratory factor analysis (EFA). The EFA was conducted on FIQ responses with quartimin factor rotation. Frequency distributions, factor loadings and correlations between items were used to select items for inclusion within a FIQ total score for subsequent analyses.

FIQ total scores were then correlated against age and compared between males and females and then the extent to which FIQ scores correlated with scores on the SCARED was examined. A hierarchical regression analysis was performed to explore whether fear inhibitory difficulties (FIQ scores) independently explained variability in anxiety symptoms (SCARED scores), whilst controlling for age and gender.

Results

Exploratory Factor Analysis

Parallel Analysis revealed one factor with an eigenvalue of 9.82, greater than the eigenvalue generated randomly, 1.82. The Kaiser-Meyer-Olkin was .92 suggesting that the data were suitable for factor analysis. The items correlated significantly with one another ($p < .001$) in the expected directions. Overall the EFA suggested that items in the FIQ shared a substantial amount of variance and that they loaded on a single factor (see Table 1 for factor loadings). The FIQ showed strong internal consistency ($\alpha = .95$). Item-test correlations were also strong, ranging from .49 (item 16) to .84 (item 11). Mean sample-wide total FIQ score was 68.55 ($SD = 15.53$). Total FIQ scores correlated negatively with age ($r = -.26$, $p = .008$) such that older adolescents showed lower scores on the FIQ. Males ($M = 66.63$; $SD = 14.76$) and females ($M = 61.17$; $SD = 15.04$) showed a significant difference in their FIQ scores, $t(102) = 1.79$, $p = .04$.

Analysis of the FIQ and anxiety

Mean sample-wide total score for the SCARED was 22.06 ($SD = 12.14$). Scores on the FIQ correlated strongly with total scores on the SCARED ($r = -.69$, $p < .001$). Participants who reported worse fear inhibition also reported higher anxious symptoms.

In a regression predicting total SCARED scores in the first step gender but not age was a significant positive predictor of SCARED scores such that being female was associated with higher SCARED scores (Table 2). This model explained a significant amount of the variance in SCARED scores, however, adding FIQ scores as a predictor in the second step explained significantly more variance in SCARED scores. In this second step, FIQ scores explained a substantial amount of variance in SCARED scores (Table 2).

Discussion

This study presented the FIQ, a novel self-report measure of individual differences in fear inhibition abilities, and examined its factor structure and relationship with anxious symptoms in healthy adolescents in Hong Kong. The FIQ was comprised of a single factor and had strong internal consistency. The correlational analyses showed that participants who reported having weaker fear inhibition abilities in a range of different situations also reported higher anxious symptoms. This finding corresponds with experimental evidence suggesting that problems in fear inhibition are associated with elevated anxious symptoms (Britton et al., 2013; Lau et al., 2008). However, it remains unclear whether the association between FIQ and SCARED scores is because the FIQ is measuring the same construct as experimental indices of fear inhibition. In study 2 we sought to confirm the factor structure of the FIQ whilst also validating it as a measure of fear inhibition abilities and replicating its association with anxiety symptoms in a larger sample of adolescents from a different culture. As such study 2 tested whether scores on the FIQ corresponded with differences in experimental indices of the situations that the FIQ was designed to tap into. One might conclude from study 1 that the only reason why FIQ and SCARED scores correlated with one another is because they were both measures of anxiety. Therefore, we examined whether FIQ scores correlated with experimental measures of fear inhibition, even when controlling for anxious symptoms. Study 2 uses a fear conditioning and extinction paradigm to capture some of the various ways in which fear inhibition problems have been operationalized within existing research. We hypothesized that lower FIQ scores, or problems inhibiting fear, would be associated with reduced differences in anticipation of the US threat during an aversive stimulus relative to a safe stimulus (differential conditioning) due to increased threat anticipation during the safe stimulus. We also expected that lower FIQ scores would be associated with increased anticipation of the US in the presence of a safe stimulus perceptually similar to an aversive stimulus (generalization), as well as continued US

anticipation even at the end of extinction and then a return of US anticipation after extinction, measured in terms of reinstatement and stimulus renewal. In this study fear was assessed in terms of self-reported ratings of anticipation of the US. For ethical reasons, we employed a mildly unpleasant rather than aversive US.

Study 2

Method

Participants

287 adolescents from two schools from England's Midlands area were invited to take part. All participants provided informed consent; for participants younger than 16, consent was obtained from parents. As with study 1, our sample size was based on the maximum number of available students within participating schools. Participants were awarded £5 in Amazon vouchers. One participant was excluded due to their age (22 years) and one participant withdrew after data collection leaving 285 participants (Females = 158, 55%; *age range* = 11-18; *mean age* = 13.69; *SD* = 1.67). Two hundred and fifty-four (89%) completed more than 90% of the conditioning procedure, among whom 225 (79%) completed both questionnaire measures.

Measures

Questionnaires. The FIQ (α = .96) and SCARED (α = .95) were administered as in study 1.

The Balloon Task. Expectancy of the unconditional stimulus (US) was conditioned and extinguished within the 'balloon task'. This task was based on other existing conditioning paradigms used with adolescent participants such as the 'screaming lady' (Haddad, Lissek, Pine, & Lau, 2011; Lau et al., 2008) where fear is conditioned using a mildly unpleasant, loud scream as a US. Participants were instructed to imagine they were invited to a party and had been asked to inflate balloons. The balloons served as CS and GS. Each balloon had different colours and shapes presented centrally on them (Figure 2). One balloon, a CS+, was

green with two squares (A), a second CS+, B1, was blue with two upward facing triangles on the centre, and another balloon, the CS- was purple with two stars (C). In each trial a fixation cross was presented for one second, followed by a single uninflated CS for two seconds. While the CS remained on the screen, participants then made threat anticipation ratings on a 10-point Likert scale at the bottom of the screen (1 = certain will not burst, 10 = certain will burst). The scale left the screen once participants made a rating. Participants were then instructed to press the spacebar to inflate the balloon. An image of an inflated balloon or a US was then shown for two seconds after which there was an interval of one second whilst the screen was blank (see Figure 1). Inflated versions of these balloons possessed the same colour but with no central patterns. Uninflated balloons measured 5x7.5cm whereas inflated balloons measured 9.5x13cm.

A secondary aim within our investigation was to explore whether adolescents found it easier to acquire fear for socially-relevant USs relative to a US that was a loud sound. As such, for participants in the socially-relevant US group, a burst balloon was presented along with the angry faces of 'partygoers' and verbal disapproval as the participants were told that partygoers would be upset if the balloons for their party were burst. For participants in the other group, the images of burst balloons were accompanied by a loud bursting sound (approximately 95db). The experiment included five phases: Habituation, Acquisition, Extinction, Stimulus Renewal Test and Reinstatement Test. In Habituation participants received two trials of A, B1 and C where each inflated fully. In Acquisition, participants received eight of each of these stimuli. C inflated on 100% of trials and A and B inflated on 25% of trial and were followed by a US on 75% of trials. In Extinction, participants received twelve presentations of A, B2 and C, with a 100% inflation ratio. B1 and B2 were perceptually similar, which meant that the transition from B1 in Acquisition, to B2 in Extinction allowed us to test to what extent threat anticipation generalized between these

stimuli. During Stimulus Renewal Test, participants received eight presentations of A, B3 and C, with a 100% inflation-ratio. In the Reinstatement Test phase, the screen was blank for one second then the US for A was presented once for two seconds, followed by four trials of A where it inflated in every trial. The order of trials was pseudo-random such that the same stimulus was not shown on more than two consecutive trials.

General procedure

Participants provided informed consent and completed the questionnaires one week prior to completing the balloon task. Participants completed the balloon task in groups of 30 under experimental conditions. On commencement of the balloon task, participants were given instructions and were given the opportunity to ask questions. They completed each phase of the experiment consecutively and were then compensated for their time. Participants also completed another conditioning task and a spatial cueing task to assess relationships between fear learning and attention, but these data formed separate investigations and will be reported elsewhere. The assessment battery took one hour to complete.

Analysis procedure

Computation of experimental indices. In order to justify our computation of experimental indices of conditioning we performed several ANOVA to assess the extent to which US anticipation was conditioned and extinguished. These analyses are included in the online supplemental materials. There were no differences between the US groups (social vs. burst) groups in conditioning or extinction in our overall analyses of variance (ANOVA) of conditioning and extinction. As such, our analysis of individual differences was collapsed across groups. Nevertheless, across groups, participants acquired US anticipation in the presence of the aversive stimulus relative to the safe stimulus; this anticipation then generalized to a perceptually similar stimulus; and, it then extinguished and then returned

following extinction (see supplement for a full outline of this analysis – at the bottom of this manuscript but, to be presented online if accepted for publication).

To index differential conditioning and the US expectancy for A, scores for C in late Acquisition were subtracted from scores for A. The same computation was performed for B1 relative to C. Generalization to B2 was indexed by subtracting the mean of C in early Extinction from B2 at the same time-point. Extinction for A and B2 was indexed by subtracting the mean for C at the end of Extinction from the mean for these stimuli at that time-point. Stimulus renewal was indexed by subtracting the mean for C in early Stimulus Renewal Test from B3. Finally, reinstatement was indexed by subtracting responses for A at the end of Stimulus Renewal Test from A in Reinstatement Test.

FIQ analysis. The factor structure of the FIQ was further established with Confirmatory Factor Analysis (CFA). The analytical procedure of study 1 was then replicated wherein scores on the FIQ were compared between males and females and were correlated with age and SCARED scores. Following this we performed a hierarchical linear regression predicting SCARED scores on the basis of age, gender and FIQ scores. Then, to test the validity of the FIQ as a measure of individual differences in fear inhibition, we correlated the FIQ with the experimental indices whilst controlling for SCARED scores. To probe any correlation between our differential conditioning index and FIQ scores, we also explored the correlation with the CS+ and CS- separately to see whether the correlation is explained by ratings for the aversive CS+ or the safe CS-.

Results

The FIQ

The single factor model of the FIQ had a strong fit with the data (*CFI* = .95; *TLI* = .94; *RMSEA* = .08) (see Table 1 for factor loadings) and again the FIQ showed strong internal consistency (α = .97). Sample-wide total scores for both questionnaire measures, their

correlation with one another and the relationship of the FIQ with age and gender were like those in study 1. Sample-wide total FIQ scores were 61.45 (*SD* = 18.09). Total FIQ scores correlated negatively with age (r = -.23, p < .001) and males (*M* = 66.93; *SD* = 17.57) and females (*M* = 57.07; *SD* = 17.34) showed a significant difference in their FIQ scores, $t(275)$ = 4.68, p < .001. Mean sample-wide total score for the SCARED was 22.85 (*SD* = 16.11). Scores on the FIQ correlated strongly with total scores on the SCARED (r = -.76, p < .001). As in study 1, participants who reported worse fear inhibition reported higher anxious symptoms.

In a regression predicting total SCARED scores (see Table 2) in the first step both gender and age were significant positive predictors of SCARED scores such that being female and being older were associated with higher SCARED scores. This model explained a significant amount of the variance in SCARED scores. However, as in study 1, adding FIQ scores as a predictor in the second step explained significantly more variance in SCARED scores as FIQ scores explained a substantial amount of variance in SCARED scores.

The relationship between the FIQ and experimental indices

Full and partial correlation results are presented in Table 3. When correlating the FIQ with each of the experimental indices, scores on the FIQ correlated significantly and negatively with most of the indices for threat anticipation ratings (differential conditioning, generalization, GS (B2) extinction and renewal), even when controlling for the relationship between self-reported anxiety (SCARED scores) and these indices. The FIQ did not correlate significantly with the index of CS (A+) extinction or the index of reinstatement.

To examine whether the negative correlation with the differential conditioning indices was due to heightened US expectancy for the CS+s or CS-s amongst people with lower FIQ scores, we correlated the FIQ with the late Acquisition indices for A+, B1+ and C- separately. Heightened US expectancy for A+ and B+ in late Acquisition was associated with

lower FIQ scores (both *r*'s = -.13, *p's* = .040). There was no relationship between US anticipation for C- and FIQ scores (*r* = .00, *p* = 962).

Discussion

Study 2 sought to add further support to the findings of study 1 by confirming the factor structure of the FIQ and its relationship with anxious symptoms. We also sought to expand on the findings from study 2 in our examination of the validity of the FIQ as a measure of fear inhibition problems. Specifically, we correlated FIQ scores with common experimental indices of fear inhibition problems (e.g., differential conditioning, generalization, extinction and return of fear).

We replicated the single factor structure of the FIQ and the resulting model had a strong fit. Also, FIQ scores showed a strong association with individual differences in anxiety symptoms. Lower FIQ scores, or difficulties inhibiting fear, were associated with higher anxious symptoms even when controlling for differences in age and gender. Regarding, the relationship between the FIQ and experimental indices of fear inhibition, lower FIQ scores were associated with greater threat anticipation ratings for an aversive stimulus, greater generalization of this anticipation to a safe stimulus, deficits in extinction of threat anticipation, and enhanced renewal of anticipation after extinction. It is of note that these correlations were evident even when controlling for variability in anxious symptoms and their relationship with these indices. These findings offer support to the claim that the FIQ is a valid measure of individual differences in the ability to learn to inhibit anticipation of aversive outcomes across a range of different situations.

Three unexpected findings are of note. Lower FIQ scores were associated with greater differential conditioning and this relationship was due to elevated expectancy for the CS+s amongst lower FIQ scorers. Previous research in this area suggests that we might have expected the opposite finding – that lower FIQ scores would be associated with less

difference between the CS+ and CS- and that this would be due to elevated fear for the safe CS- stimulus, as this pattern of results is typical amongst people with high anxiety symptoms who are expected to have fear inhibition problems (Duits et al., 2015; Lissek et al., 2005). As Haddad, Lissek, Pine, and Lau (2011) remark, the association between reduced CS+/- difference and anxious symptoms in other studies may be because anxious people are generalizing their fear from the CS+ to the CS- because of their perceptual similarity. In our paradigm the CS- was perceptually dissimilar to our CS+s in that they were different colours and had different shapes on them, which may have restricted generalization between them. In previous studies showing generalization from CS+ to CS-, these stimuli differed in terms of only one dimension, for example, circles of different size. This view is supported by an association between FIQ scores and elevated fear for the perceptually similar stimulus shown in the Extinction phase which differed from the CS+ in terms of only one stimulus dimension, the central shape. It is also of note that we did not find any relationship between the FIQ and the indices of CS+ extinction or reinstatement. These findings are also likely to be the result of the design of our experiment. Regarding the extinction finding, it is possible that extinction for the CS+ proceeded so quickly that there was insufficient variability between participants for this variability to be explained by FIQ scores. In a design with less trials in extinction, or an index computed with data from earlier in extinction, we might have found a relationship with FIQ scores. Regarding our reinstatement finding, for our other indices, we compared threat anticipation ratings for a threat-related stimulus and a safe stimulus. However, for our reinstatement index the comparison was drawn between the CS+ following the reinstating presentation of the US, relative to scores for the same stimulus prior to reinstatement. It is also of note that our study only included a single reinstatement trial, whereas more robust reinstatement effects may have been evident if we had included more US presentations prior to Reinstatement Test. Future studies should increase the number of

US presentations during reinstatement and include a CS- in the Reinstatement Test phase and then compute their index of reinstatement relative to this stimulus.

Nevertheless, the broader implications and limitations of our findings and recommendations for future research will now be discussed.

General discussion

Although problems with inhibiting fear have been implicated in the emergence, maintenance and treatment of anxiety disorders, until now they have only been measurable using experimental procedures with aversive stimuli. To measure similar processes in a more accessible and acceptable manner, we developed the FIQ, a novel self-report measure of individual differences in fear inhibition problems. In study 1 we provided an initial assessment of the factor structure of the FIQ and its relationship with individual differences in anxiety symptoms amongst healthy adolescents from Hong Kong. In study 2 we sought to cross-culturally replicate and expand upon the findings of study 1 in a larger sample of adolescents from the UK. Specifically, we sought to replicate the factor structure from study 1 and the relationship between FIQ scores and anxiety symptoms. In study 2, we also sought to validate the FIQ as a measure of fear inhibition problems by correlating it with an experimental measure of these problems.

Across both studies the items of the FIQ loaded similarly in our London sample as they did in our Hong Kong sample and it also showed strong internal consistency in both samples. In both samples, FIQ scores were reliably associated with a substantial amount of variance in SCARED scores, over and above the variance explained by age and gender. These findings attest to the cross-cultural validity of the FIQ and its ability to predict variance in anxiety symptoms.

The validity of the FIQ as a measure of fear inhibition problems is also supported by our comparison of the FIQ with experimental indices of these problems from our

conditioning and extinction paradigm. As has been noted, even when controlling for individual differences in anxious symptoms, lower FIQ scores were associated with greater threat anticipation ratings for an aversive stimulus, greater generalization of this anticipation to a safe stimulus, deficits in extinction of threat anticipation, and enhanced renewal of anticipation after extinction. That these findings were evident even when controlling for anxious symptoms add support to the claim that the FIQ is measuring fear inhibition problems and is not merely another measure of anxious symptoms. It is of note, however, that our sample involved unselected adolescents from the community. Healthy adolescents with elevated anxious symptoms may show similar patterns of fear inhibition problems as clinically anxious adolescents – informing our understanding of the processes involved in clinical anxiety. However, research should clarify whether there are similar FIQ scores between clinically anxious samples and healthy samples with elevated anxious symptoms, or whether these groups differ in their scores, and also whether a similar factor structure is evident when using the FIQ with clinical populations. Such an investigation would inform our understanding of whether fear inhibition problems are a marker for the presence of or risk for anxiety pathology. Future research could also assess the utility of the FIQ by replicating other studies showing that fear inhibition problems are prospectively associated with risk for anxiety disorders (Lommen et al., 2013) and for responding poorly to treatment (Waters & Pine, 2016).

We also presented a unique experimental paradigm which provides multiple indices of fear inhibition problems (e.g., differential conditioning, perceptual generalization, extinction and stimulus renewal and reinstatement after extinction). Some limitations are evident. First, there are questions over whether the learning paradigm used here was valid. While we lacked tests of external validity, US expectancy ratings during the various phases were in line with our expectations, that is, participants showed greater fear for the CS+ versus

the CS- in acquisition, this expectancy then extinguished and there was evidence of stimulus renewal. Relatedly, using an experimental measure of conditioning that does not involve an aversive US to establish the validity of a questionnaire that captures fear inhibition in real-life may not be an appropriate choice. However, ethical reasons constraint the use of aversive US in fear conditioning studies conducted in adolescents. Thus, most experimental paradigms use mildly unpleasant USs such as loud, unexpected noises and negative peer feedback. Moreover, as there are no other questionnaire measures of fear conditioning in the literature, validity needed to be established with conventional lab-based measures. In study 2 our experiment was conducted in a format with many participants undergoing the procedure at once, although they were each at their own computer station and were not allowed to communicate with one another. This is likely to have introduced some noise into our data that will have limited the effectiveness of the experimental procedure and the relationship between the indices derived from this procedure and our other questionnaire measures. Future research must replicate the findings herein using single-participant format. The data and conclusions presented here would also benefit from replication using psychophysiological measures of fear (e.g., fear potentiated startle). That is not to invalidate the findings presented here. The cognitive or conscious aspect of fear that underlie subjective self-reports of threat anticipation bear important implications for understanding fear (Boddez et al., 2013) and also bear particular relevance to clinical practice (LeDoux & Pine, 2016).

Conclusion

We have presented a novel questionnaire for assessing individual differences in the extent to which people can learn to inhibit fear. Across two studies with samples from two different cultures, problems with fear inhibition assessed using these measures corresponded with heightened anxious symptoms among unselected adolescents from the community. Research must now explore whether fear inhibition problems, assessed using the FIQ, are associated

with the later emergence of anxiety disorders, as well as whether these problems are particularly marked amongst clinically anxious participants relative to healthy controls.

Table 1. Factor Analyses

	Factor Loadings Study 1 (*N*=104)	Factor Loadings Study 2 (*N*=274)
1. I feel hesitant in situations that previously made me nervous even when it's unlikely anything bad will happen to me.	.73	.80
2. After stressful situations, my heart rate stays elevated for a long time.	.62	.72
3. After I've been in a stressful situation, I still think about it for a long time afterwards.	.82	.77
4. Even when stressful situations have passed, I worry that they might happen again.	.77	.81
5. I worry about situations that I know shouldn't bother me anymore.	.82	.82
6. After I've been in an anxiety-provoking situation, I find it difficult to be relaxed in these situations in the future.	.82	.84
7. No matter how many times I expose myself to things that make me anxious, I still find that I get anxious.	.81	.82
8. Even if I prepare a lot for a stressful situation, I still get really anxious when that situation arrives.	.76	.83
9. Repeated experience of situations that make me anxious doesn't seem to be enough to change the way these situations make me feel.	.78	.86
10. I find it hard to get anything done after I have been in situations where I was anxious.	.68	.78
11. If I've had a stressful experience in the past, similar situations make me anxious even though I know they're not the same.	.83	.83
12. It takes a long time for me to relax after I've been in situations that made me anxious.	.69	.82
13. Even after lots of experience in anxiety-provoking situations, I am still reluctant when I know I have to enter these kinds of situations.	.81	.80
14. After stressful situations, I find it hard to concentrate.	.60	.76
15. I feel hesitant in situations that previously made me nervous even when experience has taught me I have nothing to worry about.	.61	.81
16. After I've been in stressful situations, I find it hard to recall specific details of these situations.	.49	.70

17. After stressful situations, I feel tense and jumpy for a long time afterwards.	.77	.75
18. Situations in my present often remind me of negative experiences I've had in the past.	.73	.76

Note. Exploratory Factor Analysis (EFA) Quartimin rotated factor loadings of Fear Inhibition Questionnaire (FIQ) items on the single factor (Study 1), and standardized factor loadings from the Confirmatory Factor Analysis (CFA) (Study 2).

Table 2. Regression analysis predicting child anxiety

	Study 1			Study 2		
Dependent variable: SCARED	*b*	SE (*b*)	β	*b*	SE (*b*)	β
Step 1						
Age	1.61	.86	.18	1.76	.54	.19**
Gender	6.17	2.41	.24*	10.97	1.89	.34***
	R^2 = .09, F(2, 101) = 5.07, p < .01			R^2 = .16, F(2, 252) = 24.31, p < .001		
Step 2						
Age	.06	.67	.07	.19	.39	.02
Gender	3.27	1.85	.13	5.03	1.35	.15***
FIQ	-.54	.06	-.66***	-.64	.04	-.71***
	ΔR^2 = .35, F(1, 100) = 76.87, p < .001			ΔR^2 = .44, F(1, 241) = 274.49, p < .001		

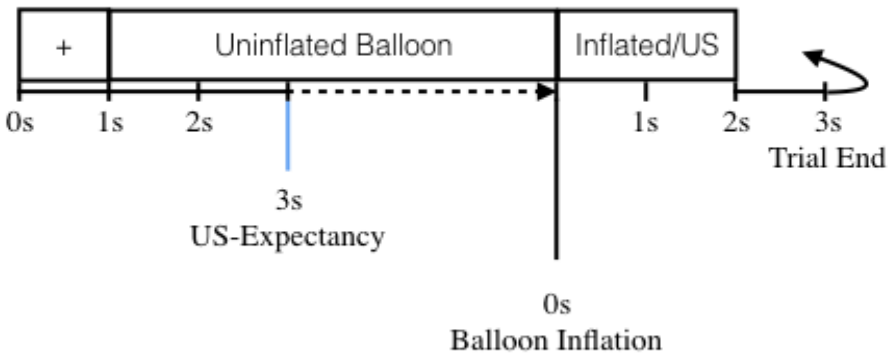
Note. Regression analyses using Fear Inhibition Questionnaire (FIQ) scores to predict Screen for Child Anxiety Related Disorders (SCARED) scores, including age and gender across study 1 and 2. *p < .05; ***p < .001

Table 3. Correlations with behavioural indices

	SCARED	FIQ	FIQ (controlling for SCARED)
US Expectancy ratings			
Acquisition			
A-C Differential	-.00	-.09	-.14*
B1-C Differential	-.01	-.08	-.14*
Generalization	.04	-.14*	-.17**
Extinction			
A-C Differential	.12	-.16*	-.06
B2-C Differential	.01	-.13*	-.14*
Stimulus Renewal	.14*	-.23***	-.19**
Reinstatement	.03	-.10	-.05

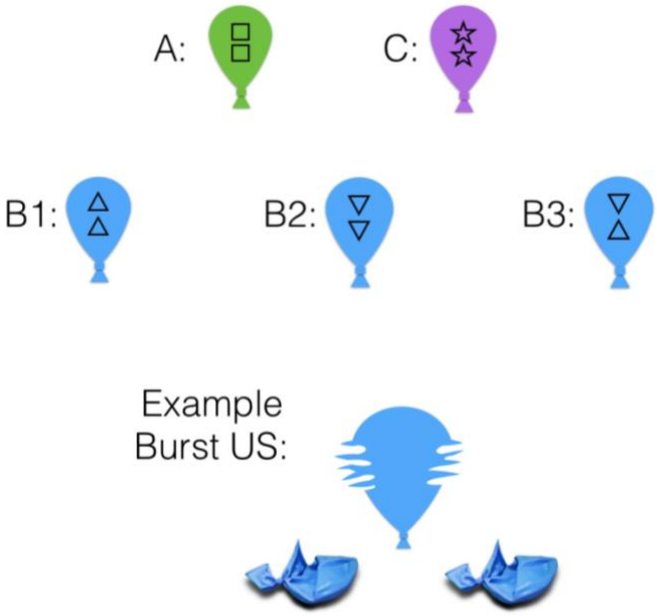
Note. Correlations (*r*) between The Screen for Child Anxiety Related Disorders (SCARED) and The Fear Inhibition Questionnaire (FIQ) scores and each of the experimental indices of threat anticipation ratings. Partial correlations between the FIQ and the experimental indices, whilst controlling for SCARED scores, are also given.*$p < .05$ **$p < .01$ ***$p < .001$.

Figure 1. Trial flow



Note. Example trial flow for trial including ratings of anticipation of the unconditional stimulus (US). Dashed lines represented undefined time-gaps wherein the trial moves to the next stage immediately following participants' rating.

Figure 2. Example stimuli



Note. Each uninflated conditional stimulus (CS) and an example of a burst unconditional stimulus (US) for the B series of stimuli.

References

Barry, T. J., Hermans, D., Lenaert, B., Debeer, E., & Griffith, J. W. (2013). The eACS: Attentional control in the presence of emotion. *Personality and Individual Differences, 55*(7), 777-782. doi:10.1016/j.paid.2013.06.014

Birmaher, B., Brent, D. A., Chiappetta, L., Bridge, J., Monga, S., & Baugher, M. (1999). Psychometric properties of the Screen for Child Anxiety Related Emotional Disorders (SCARED): a replication study. *J Am Acad Child Adolesc Psychiatry, 38*(10), 1230-1236. doi:10.1097/00004583-199910000-00011

Boddez, Y., Baeyens, F., Luyten, L., Vansteenwegen, D., Hermans, D., & Beckers, T. (2013). Rating data are underrated: validity of US expectancy in human fear conditioning. *J Behav Ther Exp Psychiatry, 44*(2), 201-206. doi:10.1016/j.jbtep.2012.08.003

Bouton, M. E. (2004). Context and behavioral processes in extinction. *Learn Mem, 11*(5), 485-494. doi:10.1101/lm.78804

Britton, J. C., Grillon, C., Lissek, S., Norcross, M. A., Szuhany, K. L., Chen, G., . . . Pine, D. S. (2013). Response to learned threat: An FMRI study in adolescent and adult anxiety. *Am J Psychiatry, 170*(10), 1195-1204. doi:10.1176/appi.ajp.2013.12050651

Duits, P., Cath, D. C., Lissek, S., Hox, J. J., Hamm, A. O., Engelhard, I. M., . . . Baas, J. M. (2015). Updated meta-analysis of classical fear conditioning in the anxiety disorders. *Depress Anxiety, 32*(4), 239-253. doi:10.1002/da.22353

Haddad, A. D., Lissek, S., Pine, D. S., & Lau, J. Y. (2011). How do social fears in adolescence develop? Fear conditioning shapes attention orienting to social threat cues. *Cogn Emot, 25*(6), 1139-1147. doi:10.1080/02699931.2010.524193

Jovanovic, T., Kazama, A., Bachevalier, J., & Davis, M. (2012). Impaired safety signal learning may be a biomarker of PTSD. *Neuropharmacology, 62*(2), 695-704. doi:10.1016/j.neuropharm.2011.02.023

Kessler, R. C., Avenevoli, S., Costello, E. J., Georgiades, K., Green, J. G., Gruber, M. J., . . . Merikangas, K. R. (2012). Prevalence, persistence, and sociodemographic correlates of DSM-IV disorders in the National Comorbidity Survey Replication Adolescent Supplement. *Arch Gen Psychiatry, 69*(4), 372-380. doi:10.1001/archgenpsychiatry.2011.160

Lau, J. Y., Britton, J. C., Nelson, E. E., Angold, A., Ernst, M., Goldwin, M. A., . . . Pine, D. S. (2011). Distinct neural signatures of threat learning in adolescents and adults. *Proc Natl Acad Sci U S A, 108*, 4500-4505.

Lau, J. Y., Lissek, S., Nelson, E. E., Lee, Y., Roberson-Nay, R., Poeth, K., . . . Pine, D. S. (2008). Fear conditioning in adolescents with anxiety disorders: results from a novel experimental paradigm. *J Am Acad Child Adolesc Psychiatry, 47*(1), 94-102. doi:10.1097/chi.0b01e31815a5f01

LeDoux, J. E., & Pine, D. S. (2016). Using Neuroscience to Help Understand Fear and Anxiety: A Two-System Framework. *Am J Psychiatry, 173*(11), 1083-1093. doi:10.1176/appi.ajp.2016.16030353

Lissek, S., Bradford, D. E., Alvarez, R. P., Burton, P., Espensen-Sturges, T., Reynolds, R. C., & Grillon, C. (2014). Neural substrates of classically conditioned fear-generalization in humans: a parametric fMRI study. *Soc Cogn Affect Neurosci, 9*(8), 1134-1142. doi:10.1093/scan/nst096

Lissek, S., Kaczkurkin, A. N., Rabin, S., Geraci, M., Pine, D. S., & Grillon, C. (2014). Generalized anxiety disorder is associated with overgeneralization of classically conditioned fear. *Biological Psychiatry, 75*(11), 909–915. https://doi.org/10.1016/j.biopsych.2013.07.025

Lissek, S., Powers, A. S., McClure, E. B., Phelps, E. A., Woldehawariat, G., Grillon, C., & Pine, D. S. (2005). Classical fear conditioning in the anxiety disorders: a meta-analysis. *Behav Res Ther, 43*(11), 1391-1424. doi:10.1016/j.brat.2004.10.007

Lommen, M. J., Engelhard, I. M., Sijbrandij, M., van den Hout, M. A., & Hermans, D. (2013). Pre-trauma individual differences in extinction learning predict posttraumatic stress. *Behav Res Ther, 51*(2), 63-67. doi:10.1016/j.brat.2012.11.004

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods, 4*(1), 84–99. https://doi.org/10.1037/1082-989X.4.1.84

McLaughlin, N. C., Strong, D., Abrantes, A., Garnaat, S., Cerny, A., O'Connell, C., . . . Greenberg, B. D. (2015). Extinction retention and fear renewal in a lifetime obsessive-compulsive disorder sample. *Behav Brain Res, 280*, 72-77. doi:10.1016/j.bbr.2014.11.011

Milad, M. R., Furtak, S. C., Greenberg, J. L., Keshaviah, A., Im, J. J., Falkenstein, M. J., . . . Wilhelm, S. (2013). Deficits in conditioned fear extinction in obsessive-compulsive disorder and neurobiological changes in the fear circuit. *JAMA Psychiatry, 70*(6), 608-618. doi:10.1001/jamapsychiatry.2013.914

Milad, M. R., Pitman, R. K., Ellis, C. B., Gold, A. L., Shin, L. M., Lasko, N. B., . . . Rauch, S. L. (2009). Neurobiological basis of failure to recall extinction memory in posttraumatic stress disorder. *Biol Psychiatry, 66*(12), 1075-1082. doi:10.1016/j.biopsych.2009.06.026

Milad, M. R., & Quirk, G. J. (2012). Fear extinction as a model for translational neuroscience: ten years of progress. *Annu Rev Psychol, 63*, 129-151. doi:10.1146/annurev.psych.121208.131631

Milad, M. R., Wright, C. I., Orr, S. P., Pitman, R. K., Quirk, G. J., & Rauch, S. L. (2007). Recall of fear extinction in humans activates the ventromedial prefrontal cortex and hippocampus in concert. *Biol Psychiatry, 62*(5), 446-454. doi:10.1016/j.biopsych.2006.10.011

Struyf, D., Zaman, J., Hermans, D., & Vervliet, B. (2017). Gradients of fear: How perception influences fear generalization. *Behav Res Ther, 93*, 116-122. doi:10.1016/j.brat.2017.04.001

Waters, A. M., & Pine, D. S. (2016). Evaluating differences in Pavlovian fear acquisition and extinction as predictors of outcome from cognitive behavioural therapy for anxious children. *J Child Psychol Psychiatry, 57*(7), 869-876. doi:10.1111/jcpp.12522

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