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Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory

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Abstract

Anxiety and depression are linked to lower academic performance. It is proposed that academic performance is reduced in young people with high levels of anxiety or depression as a function of increased test-specific worry that impinges on working memory central executive processes. Participants were typically developing children (12 to 13-years-old) from two UK schools. The study investigated the relationship between negative affect, worry, working memory, and academic performance using self-report questionnaires, school administered academic test data, and a battery of computerized working memory tasks. Higher levels of anxiety and depression were associated with lower academic performance. There was support for a mediation hypothesis, where worry and central executive processes mediated the link between negative affect and academic performance. Further studies should test these hypotheses in larger longitudinal samples. Implications for school psychology practice and interventions in schools are discussed.

Keywords

academic performance, anxiety, children, depression, working memory, worry

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Experiencing emotional states such as anxiety and depression is a universal phenomenon (Spielberger, 2006) reported internationally in children and adolescents in various countries including Australia, India, Greece, Russia, and China (Neil & Christensen, 2009; Sahoo & Khess, 2010; Savina, Coulacoglou, Sanyal, & Jhang, 2011; Tully, Zajac, & Venning, 2009). For example, Shin (2010) reports that 41% of the 80,000 Korean children completing a web-based survey experienced depressive affect. In a study from Norway, using a sample of over 1000 12-year-old schoolchildren, Stornes and Bru (2011) provided evidence of a coherent 'Emotional problems' latent trait tapping into several facets of negative affect. In addition, a finding that schoolchildren and adolescents experiencing high levels of anxiety or depression are at risk for poor academic performance (Hembree, 1988) has been replicated in many countries including South Africa (Jegede, 1996), Finland (Fröjd et al., 2008), Australia (Kouzma & Kennedy, 2004), the UK (Putwain, 2009), Germany, the USA, and others (Seipp, 1991). For example, Keogh, Bond, French, Richards, and Davis (2004) showed that anxiety was negatively correlated with coursework grades and worry was negatively correlated with written examination performance. Furthermore, emotional-cognitive interference is an important mechanism through which school pupils who experience high levels of negative affect perform poorly on tests (e.g. Putwain, Connors, & Symes, 2010).

In Eysenck's influential processing efficiency theory (PET; Eysenck & Calvo, 1992) anxiety is proposed to interfere with working memory; draining resources leading to significant decrements in test performance. Importantly, the central executive (Baddeley, 1996) facilitates the storage and processing of information that together form the core feature of what has been described as complex working memory in schoolchildren (Gathercole, Pickering, Knight, & Stegmann, 2004). Baddeley's model has been particularly influential in this area and PET synthesized existing cognitive interference findings with this model to understand more about how anxiety affects performance.

In PET, two fundamental assumptions are proposed; first anxiety will adversely affect performance in evaluative settings and second, this effect will be greater on difficult cognitive tasks. Disruptive effects of negative affect are expected on Baddeley's 'central executive component' more than on the working memory subsystems (i.e. phonological/visuospatial slave systems), which has been supported in empirical research (Eysenck, Payne, & Derakshan, 2005). While PET predicts that anxiety related deficits on tasks will usually be seen in terms of efficiency (e.g. time taken to complete a task), it is suggested that under certain circumstances effectiveness (i.e. test performance) will also be affected. However, as Eysenck, Derakshan, Santos, and Calvo (2007) point out a significant shortcoming in many studies is that worry is often assumed to be present in the more anxious individual but is rarely explicitly measured. Part of the aim of the present study is to formally test whether worry mediates the relationship between negative affect

and academic performance. International research has shown that working memory processes in children are adversely affected by anxiety. For example, in a sample of 90 10-year-old children in Singapore, Ng and Lee (2010) found that high levels of trait test anxiety negatively affected working memory efficiency. In a Romanian sample of young children it was found that high trait anxiety was related to poor working memory performance particularly on central executive tasks (Visu-Petra, Cheie, Benga, & Packiam Alloway, 2010). The majority of the research literature in this area has tended to focus on anxiety rather than depression, a fact which is reflected in the extant meta-anlayses on anxiety and test anxiety (Ergene, 2003; Hembree, 1988; Ma, 1999). Understanding more about the mechanisms involved in the relationship between negative affect and academic testing is therefore important (McDonald, 2001).

Given that much less is known about depression and academic performance, the role of depression is of particular interest in the present undertaking. Certainly, clinical depression is often associated with both an inability to concentrate (American Psychiatric Association, 2000) and intrusive ruminative thoughts (Nolen-Hoeksema, 2000) which are likely to reduce available cognitive resources. Furthermore, research on adults has shown that individuals with clinical anxiety and depression show similar levels of worry (Starcevic, 1995) and both disorders are characterized by deficits in working memory (Christopher & MacDonald, 2005). A previous study in Finland has emphasized the importance of measuring both anxious and depressive traits in schools when assessing the impact of emotional factors on cognitive and academic performance (Aronen, Vuontela, Steenari, Salmi, & Carlson, 2005).

One theoretical account of the interference of cognitive processes in depressed mood is the resource allocation model that assumes a depressed mood will reduce the ability of an individual to allocate attentional resources to a cognitive task, especially when tasks are complex (RAM; Ellis & Moore, 1999; Ellis, Ottaway, Varner, Becker, & Moore, 1997). In support of this theory, irrelevant thoughts in negative moods negatively correlate with recall on memory tasks (Seibert & Ellis, 1991).

Given that psychologists are practicing in many schools throughout the world (Jimerson, Stewart, Skokut, Cardenas, & Malone, 2009), they are arguably in a unique position to offer interventions, such as cognitive-behavioural therapy (CBT) that may improve pupils well-being (Yeo & Choi, 2011). Reducing anxiety and depression may increase test performance but psychologists need to know how this is happening in order to target the right mechanisms in intervention programmes.

The aim of the current study was to test two potential mechanisms so that effective interventions can be developed and improved. We first tested the relationship between anxiety and depression and academic test performance in schoolchildren. In Study 1 worry about tests was proposed to mediate the relationship between

negative affect and academic test performance. Study 2 tested the mediating influence of central executive versus (primarily) visuospatial or phonological loop processes of working memory. Anxiety and depression are hypothesized to increase worry about taking tests, disrupting working memory, in turn reducing academic performance.

Study 1

Method

Participants

Eighty participants (32 boys, 48 girls) were recruited from a single secondary school in the UK. The children were 12- to 13-years-old (mean = 12.1, SD = 0.3). Parental consent for the questionnaire study was obtained via information letters/consent slips sent to all pupils in a Year group. In addition, participants were presented with an information sheet and asked to sign a form indicating their informed consent before participating.

Procedure

We worked with tutor group teachers to ask participants to complete a self-report questionnaire pack in the registration period at the beginning of the school day. The questionnaire was comprised of psychometrically validated instruments tapping anxiety, depression and worry about taking tests.

Self report measures

Anxiety. We used the Spielberger Trait Anxiety Form (Spielberger, Edwards, Lushene, Montouri, & Platzek, 1973) to measure anxiety. Good psychometric properties including convergent, divergent validity and internal consistency have been demonstrated for this measure (Muris, Merckelbach, Ollendick, King, & Bogie, 2002) and Cronbach's alpha (α) of 0.91 found in the current sample.

Depression. We used the Major Depressive Disorder (MDD) subscale of the Revised Child Anxiety And Depression Scale (RCADS; Chorpita, Yim, Moffitt, Umemoto, & Francis, 2000). This scale has shown good psychometric properties in both non referred (Chorpita et al., 2000) and clinical populations (Chorpita, Moffitt, & Gray, 2005). Here, one item, 'I think about death' was removed as it was decided to be too sensitive for the target population. Internal consistency was good in the current sample ($\alpha = 0.88$).

Worry about tests. The Worry subscale of the Children's Test Anxiety Scale (Wren & Benson, 2004) was used to measure worry about tests. The questionnaire

asks children to respond to statements that are preceded with the phrase: 'While I am taking tests...'. Example items include: 'I think about what will happen if I fail'; 'I think most of my answers are wrong'. This test's internal consistency has been validated using confirmatory factor analysis in 'development' and 'validation' samples (Wren & Benson, 2004). Internal consistency for the measure in this sample was good ($\alpha = 0.91$).

Academic performance

The National Curriculum Standard Assessment Tests are indicators of academic competence that are taken in all schools in England. At the end of key stage 2 (from 7 to 11-years-old) pupils take standardized tests in mathematics, English and science, with higher scores indicating better performance. The present study used raw scores for mathematics, English and science which range from 0–100 for mathematics and English and 0–80 for science.

Data analysis

Basic statistical analyses were run in STATA 11.1. In the mediation analysis, the academic test measures were z-transformed and summed to create an academic performance composite score. To test the mediation hypotheses in this study, indirect effects were calculated in MPLUS 5.1. Indirect effects and statistical mediation are synonymous. The procedure used in this study is the recommended best practice for testing mediation effects (Dearing & Hamilton, 2006). Other approaches such as the causal steps approach have been shown to have very low power to detect mediation effects (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002).

Results

The results showed that higher levels of both anxiety and depression were significantly related to lower academic performance ($r = -0.43$, in both cases). More worry about tests was also related to lower academic performance ($r = -0.42$). See Table 1 for Means, Standard Deviations and correlations.

There were significant indirect effects between anxiety–worry and academic performance ($\beta = -0.26$, SE $= 0.12$, $p < 0.05$) and between depression–worry and academic performance ($\beta = -0.22$, SE $= 0.10$, $p < 0.05$) for mathematics and science combined (see Figure 1). The indirect effects reached trend significance levels when English was included in the composite score (anxiety $= \beta = -0.24$, SE $= 0.1$, $p = 0.07$; depression $= \beta = -0.19$, SE $= 0.10$, $p = 0.06$). The results of Study 1 suggest that negative affect is related to lowered academic performance in both anxiety and depression. The indirect effects show that anxiety and

Table 1. Means, Standard Deviations and correlations between study variables in Study 1

	Mean	*SD*	1.	2.	3.
1. Academic performance composite[†]	−0.00	1.91			
2. Anxiety	31.23	7.97	−0.43**		
3. Depression	6.21	5.32	−0.43**	0.80***	
4. Worry	27.91	8.14	−0.42**	0.76***	0.62***

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.0001$.
[†]Summed standardized scores of mathematics and science.

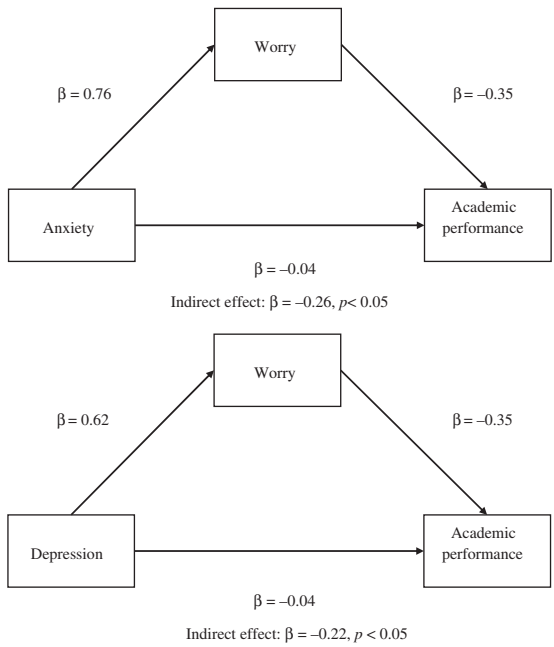

Figure 1. Worry as a mediator between negative affect variables and academic performance in Study 1. This model includes mathematics and science combined. The arrowed lines represent the three regression coefficients while the labelled boxes refer to observed variables.

depression are both associated with higher levels of worry and that in turn worry is related to lowered academic performance. This effect reached statistical significance when assessing a composite academic achievement scores that included mathematics and science (and not English test scores), which may be reflective of mathematics and science tests having additional complexity. The mediational role of working memory in the relationship between negative affect and academic performance was tested in Study 2.

Study 2

The purpose of Study 2 was to test the presence of indirect effects of negative affect on academic performance through either central executive or phonological/visuo-spatial working memory processes. It was hypothesized that anxiety and depression would affect the more demanding central executive processes which would in turn adversely affect academic performance, whereas the same would not be true for non central executive processes. In addition, mediation models were tested that included worry in this mediational chain.

Method

Participants

Thirty one pupils (15 boys, 16 girls) were recruited from a single secondary school in the UK. The sample was drawn from Year 8 children who were either 12 or 13-years-old (mean = 12.4, SD = 0.5).

Self report measures

The self-report measures used in the present study were identical to those used in Study 1.

Working memory tasks

The automated working memory assessment (AWMA). The forwards and backwards digit recall tests and spatial span test were used from the AWMA (Alloway, 2007) to measure central executive and phonological/visuospatial working memory. The forwards digit span measured phonological processes while the remaining tests tapped into the central executive.

The Cambridge neuropsychological test automated battery (CANTAB). The CANTAB (2004) uses non-verbal tasks to measure a range of executive functions. The forwards and backwards versions of the spatial span task were used to measure non-central executive and central executive visuospatial working memory, respectively. The CANTAB has been validated for use with children (Luciana, 2003).

Academic performance

The SATs data obtained from the school in this study were conversion scores based on the sub-levels of the Key Stage 2 results. In addition to the SATs scores, two tests of the WRAT 4 (Wilkinson & Robertson, 2006) were used. The WRAT is a well established measure of educational attainment validated for a wide range of

ages that includes the four subtests of word reading, sentence comprehension, spelling and mathematics comprehension. In this study, the spelling (WRAT spelling) and mathematics computation (WRAT mathematics) subtests were administered in groups of equal numbers. The spelling test is administered by reading aloud words of increasing difficulty to participants who are then asked to spell each word. In the mathematics test, participants are given 15 minutes to complete as many problems as they can.

Procedure

Parental consent was obtained via information letters/consent slips that were sent to a random selection of parents/guardians of young people in Year 8. Participants were first tested in two approximately equal groups. The study was briefly explained to the pupils who were then asked to complete a consent form. Young people were tested on the working memory battery individually; counterbalanced so that half the participants tested in the morning and half in the afternoon. Participants were shown a debriefing statement at the end of the testing and encouraged to ask questions about the study.

The standardized scores for the indicators were summed to create a composite score variable for academic performance (WRAT mathematics, WRAT spelling, SATs mathematics, SATs English and SATs science). In addition, the standardized working memory variables were summed into groups according to whether they tapped central executive processes or not; thus creating two composite score variables of central executive (backward digit span, spatial span and CANTAB backward spatial span) and visuospatial/phonological only (forwards digit span and CANTAB forward spatial span).

Table 2. Means, Standard Deviations and correlations between study variables in Study 2

	Mean	*SD*	1.	2.	3.	4.	5.
1. Academic performance composite	0.00	4.21					
2. CE working memory composite[†]	−0.00	2.43	0.66**				
3. PL/VSSP working memory composite	−0.00	1.63	0.50**	0.15			
4. Anxiety	34.10	6.83	−0.15	−0.40*	−0.03		
5. Depression	6.55	3.08	−0.13	−0.37*	−0.14	0.71***	
6. Worry	29.46	9.08	−0.17	−0.43*	0.05	0.50**	0.47**

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.0001$.

CE = central executive; PL/VSSP = phonological loop/visuospatial sketchpad.

[†]Summed standardized scores for backwards digit span, backwards spatial span and the AWMA spatial span test.

Results

The results showed that while all aspects of working memory were associated with better academic test performance, the effect was larger for central executive processes ($r = 0.66$, $p < 0.01$) when compared with phonological loop/visuospatial tests ($r = 0.50$, $p < 0.01$). Higher negative affect was related to decreased central executive working memory performance for both anxiety ($r = -0.40$, $p < 0.05$) and depression ($r = 0.37$, $p < 0.05$) and anxiety and depression were both similarly related to more worry about taking tests ($r = 0.50$, $p < 0.01$ and $r = 0.47$, $p < 0.01$, respectively).

There was a significant indirect effect of anxiety on academic performance via central executive working memory ($\beta = -0.28$, SE = 0.14, $p < 0.05$) and a similar trend for depression ($\beta = -0.26$, SE = 0.14, $p = 0.06$). In contrast, there was no evidence that the phonological/visuospatial variable acted as a mediator for anxiety ($\beta = -0.02$, SE = 0.10, $p = 0.87$) or depression ($\beta = -0.07$, SE = 0.07, $p = 0.36$).

There was also further evidence to support the hypothesis for an indirect effect between negative affect and academic performance via worry and central executive working memory in the case of anxiety ($\beta = -0.15$, SE = 0.08, $p = 0.05$) and depression ($\beta = -0.14$, SE = 0.07, $p = 0.06$).

Discussion

Taken together, the results of these two studies indicate that both anxiety and depression are associated with increased worry about test-taking that interferes with complex working memory, leading to lowered test performance. The results are consistent with previous research that has found a negative relationship between elevated negative affect in young people and academic performance (Keogh, Bond, & Flaxman, 2006) and the size of the relationship was similar to that found in previous studies (Hembree, 1988). The negative association between anxiety and working memory has also been found in previous research (Aronen et al., 2005; Hadwin, Brogan, & Stevenson, 2005; Owens, Stevenson, Norgate, & Hadwin, 2008). Study 1 extended previous findings to show the mediating role of worry in the relationship between anxiety and academic achievement. The results of this study further suggested that this effect may be particularly relevant for specific school subjects that draw more explicitly on working memory (Ashcraft & Krause, 2007). Study 1 found similar evidence for indirect effects in the case of depression, lending support to interference theories in depressed mood (Ellis & Moore, 1999).

Study 2 also showed that the link between negative affect and performance is partly driven by the strong association between central executive working memory and academic performance (Alloway, Gathercole, & Elliott, 2010; Gathercole et al., 2004). The specific association between central executive working memory processes and negative affect found in Study 2 is also consistent with previous work (Eysenck et al., 2005).

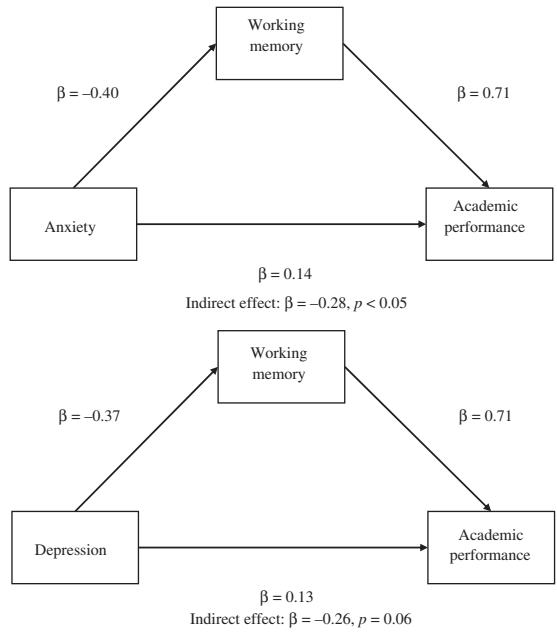

Figure 2. An illustration of the significant indirect effect calculated in Study 2 between negative affect, academic performance via working memory. The arrowed lines represent regression coefficients while the labelled boxes refer to observed variables.

Furthermore, recent evidence suggesting that worry restricts working memory capacity supports the plausibility of worry as a causal agent in reducing test performance (Hayes, Hirsch, & Mathews, 2008). Future studies measuring distracting thoughts and worry in more detail, as well as rumination associated with depression, will help school psychologists to understand the role of cognitive-affective factors in underachievement more clearly.

Limitations

Several limitations to the present studies should be noted. First, although the second study detected indirect effects from both anxiety and depression through working memory and worry, some were at trend for significance (see Figures 2 & 3). This may be due to the reduced statistical power arising from the relatively small sample in Study 2. However, this issue needs to be clarified in a replication study using a larger sample. Second, both studies presented in this article used a cross-sectional design to test the plausibility of the models. This design necessarily limits the conclusions that can be drawn regarding causality. Further longitudinal studies will help with this issue as will experimental methods. Lastly, there is a potential limitation in researching anxiety and depression simultaneously in that

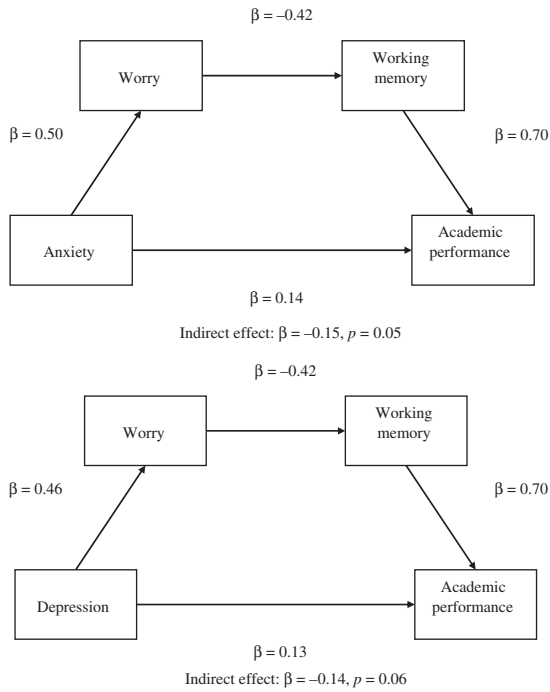

Figure 3. An illustration of the indirect effect calculated in Study 2 testing the addition of worry. The arrowed lines represent linear regression coefficients. The boxes represent observed variables.

they are typically highly correlated (Chorpita et al., 2005) and were in the present study. In order to address the relationship between negative affect and performance more clearly, future studies should focus on groups of relatively 'pure' clinically anxious and clinically depressed children and young people. Alternatively, the tripartite model of anxiety and depression could be used (Clark & Watson, 1991) which would essentially discriminate anxious and depressed individuals on the basis of presence of arousal in the former and anhedonia in the latter.

Implications for practice

Although psychologists practice in many schools around the world, the phenomenon is far from ubiquitous (Cook, Jimerson, & Bergeny, 2010). However, psychologists in schools are keen to receive more training on all aspects of internalizing disorders and believe that a role in school-based interventions is appropriate (Miller & Jome, 2010). The results of the present study suggest that

programmes targeting a reduction in symptoms of anxiety and depression should improve academic performance for young people in schools and there is already some evidence to support this (Keogh et al., 2006). Interventions should focus on the cognitive component of worry because it may be disruptive to essential working memory processes that are needed to successfully complete tests.

The results also suggest a complex dual-valenced relationship between negative affect and academic performance in Study 2; where the direction of association was dependent on the level of working memory. After factoring in working memory, the relationship between negative affect and academic performance became positive, although not significant (see Figure 2). From this line of reasoning, individuals with sufficient working memory capacity may actually benefit from some, perhaps mild, elevations in negative affect; whereas for those with poor working memory, the presence of negative affect could be catastrophic.

While further research is needed in a larger sampled study to test such facilitative/debilitative hypotheses, the implication is that interventions should initially be designed for pupils with both low working memory and high levels of anxiety, depression and worry. Lending support to the importance of working memory, it has recently been suggested in the UK that pupils with social, emotional and behavioural difficulties may benefit from working memory training (Roughan & Hadwin, 2011). Given that both negative affect (anxiety and depression) and working memory skills affect children in all geographical locations, these two facets are universal key components to learning and can be very easily measured in most settings.

Professionals working in a school psychology context could use a simple screen comprised of a small battery of working memory tests and a measure of self/teacher reported levels of negative affect to identify 'at-risk' pupils (low working memory and high negative affect) for intervention. The strengths and difficulties questionnaire (http://www.sdqinfo.org) is one such well-validated measure that has the advantage of being translated into many languages. Thus many psychologists around the world should be able to make use of these assessments. In an ideal world interventions would be subjected to evaluation in order to add to the evidence base for other practitioners. However, carrying out research whilst practising as a school psychologist can be challenging, although real world research is certainly feasible (see Atkinson, 2009 for example). In the current example, at-risk pupils could be randomly assigned to experimental versus control arms of an appropriate intervention and the improvement or otherwise on a range of outcome measures from general well-being to test-specific worry and educational performance could be assessed.

In summary, the studies in the current article suggest that worry and working memory are two potential mediating factors involved in the negative relationship between negative affect and academic performance. Longitudinal studies in this area are needed to tease out the causal status of the variables in the relationship. Evaluations of interventions by school psychologists will provide invaluable empirical evidence to assess the efficacy of such programmes.

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