Effects of a transdiagnostic cognitive behaviour therapy-based programme on the natural course of anxiety symptoms in adolescence

Alejandro de la Torre-Luque,[1] Aina Fiol-Veny,[2] Cecilia A. Essau,[3] Maria Balle,[2] and Xavier Bornas[2]

[1] Department of Psychiatry. Autonomous University of Madrid, Spain

Centre for Biomedical Research in Mental Health. CIBERSAM, Spain

[2] Research Institute of Health Sciences. University of the Balearic Islands, Spain

[3] Department of Psychology, University of Roehampton, UK

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Correspondence should be directed to:

Cecilia A. Essau, Ph.D.

Department of Psychology, Roehampton University, Whitelands College,

Holybourne Avenue, London SW15 4JD, UK

e-mail: c.essau@roehampton.ac.uk

Tel: +44 (0) 20 8392 3647

Abstract

Background: Anxiety disorders frequently have an onset during adolescence, which when left untreated could lead to a chronic course and outcome. This study aimed to examine the way in which a cognitive behaviour therapy-based programme (Super Skills for Life – adolescent version; SSL-A) could change the course of anxiety symptoms through adolescent's behavioural performance and cardiac function.

Method: Sixty-one adolescents at risk of developing an anxiety disorder (45.30% boys; M = 13.76 years, SD = 0.32) were randomly assigned to either the intervention (IG), placebo (PG), or waitlist group (WG). Adolescents in the IG participated in SSL-A over an 8-week period. Adolescents in the PG participated in an 8-session school-work programme. Adolescents in the WG did not receive any intervention. Anxiety symptoms were assessed every six months, twice before intervention, as well as at post- and six months after the intervention. Participants in the IG additionally underwent a stressful task to assess behavioural performance and cardiac adjustment.

Results: Adolescents in the IG significantly reported lower levels of social phobia and generalised anxiety symptoms at the follow-up assessment compared to the adolescents in the PG and the WG. They also showed a significant improvement in vocal quality and lower discomfort during a stressful task at post-intervention, and showed attenuated cardiac recovery indexes, in terms of sample entropy.

Limitations: The study has a small sample size.

Conclusion: SSL-A changed natural course of anxiety symptoms, as shown by a significant reduction in social phobia and generalised anxiety symptoms, and a significant improvement in behaviour and physiological (cardiac) function during a stressful situation.

Keyword: Anxiety, depression, heart rate variability, transdiagnostic intervention, CBT-based intervention

Anxiety disorder is a highly prevalent disorder among adolescents, with a lifetime prevalence ranging from 15-30% (Essau et al., 2002; Merikangas et al., 2010). Numerous studies have also shown anxiety to have an onset during adolescence, which when left untreated tend to act as a risk factor for the development of severe mental disorders in adulthood (Essau et al., 2014). An untreated adolescence-onset anxiety is also related to a chronic, unremitting course and outcome, including psychosocial impairment in various life domains (Essau et al., 2014). Previous studies have also shown subclinical anxiety disorders to be linked with alterations in physiological processes, such as reduced cardiac variability or hypothalamus-pituitary-adrenals (HPA) axis dysregulation (Assari et al., 2015; Beauchaine and Thayer, 2015; de la Torre-Luque et al., 2017; Schmitz et al., 2011). A low cardiac variability is a sign of lower flexibility in adjusting to changing environmental demands (Friedman, 2007; Thayer and Lane, 2009). On the other hand, elevated levels of stress hormones (e.g., adrenocorticotropic hormone and cortisol) have been observed under resting conditions, as well as attenuated reactivity when confronting stressors (Faravelli et al., 2012; Graeff and Junior, 2010; Klumbies et al., 2014; Petrowski et al., 2013).

Given the chronicity and the negative outcome of anxiety disorders, the last three decades have seen much effort in developing programmes for preventing or treating anxiety disorders among adolescents with these disorders. Cognitive behaviour therapy (CBT) is the intervention of choice for anxiety disorders, with up to 65% of the adolescents with these disorders responding positively to CBT (Essau et al., 2012; Essau and Ollendick, 2013; Ost and Ollendick, 2017; Seligman and Ollendick, 2011). Most of these studies have focused on changes in anxiety levels or on the presence or absence of an anxiety disorder. Examining the impact of the CBT-based intervention

programmes on specific correlates (i.e., such as physiological components and behavioural manifestations), and associated features (e.g., comorbid symptoms such as depression) of anxiety may be highly relevant in order to disentangle pathways on the development of anxiety disorder during adolescence.

Anxiety and depression are highly comorbid in adolescence (Essau, 2005; Merikangas et al., 2007, 2010). In the last decades, mounting evidence has provided some insight into the commonalities of internalising disorders (anxiety and depression), in terms of common neurophysiological underpinnings (e.g., hypothalamus-pituitary-adrenals dysregulation, sympathetic withdrawal when confronting stressful situations), psychopathological manifestations (e.g., low self-confidence, worry and rumination, fatigue, etc.) or shared genetic liability (Barlow et al., 2004; Beauchaine and Thayer, 2015; de Carvalho et al., 2014; de la Torre-Luque & Essau, 2019; de la Torre-Luque et al., 2016). Adolescents with an anxiety disorder have up to 29 times the risk of developing depression (Costello et al., 2003). Adolescents with both anxiety and depression are also more psychologically distressed than those with either one of these disorders (Essau, 2005). Finally, some common risk factors (e.g., neuroticism, poverty, genetic polymorphisms, etc.) have been identified to be involved in the development of both anxiety and depressive disorders (Blanco et al., 2014; Luciano et al., 2010). For instance, many studies have highlighted the predictive role of temperamental factors (e.g., high negative affectivity and low effortful control) in the development of internalising disorders and elevated symptom trajectories in adolescence (Davis et al., 2015; Pauw and Mervielde, 2010; Sportel et al., 2011). Temperament is involved in the natural expression of negative emotions, such as anxious emotion; as well as, in the regulation of cognitive processes (e.g., attention, memory) towards environmental stimulus processing (e.g., threating or depressogenic stimuli) (Rothbart, 2007).

Given the above findings, transdiagnostic programmes (i.e., addressing mental health conditions, in this case anxiety and depressive disorders by targeting common risk factors/mechanisms) have been developed to prevent the onset of a full-blown disorder and hinder the escalation of anxiety symptoms. Transdiagnostic interventions may well retain the benefits derived from diagnosis-specific programmes but with additional benefits, such as the prevention of a new internalising disorder from developing (Barlow et al., 2004; McEvoy et al., 2009; Norton and Barrera, 2012). These programmes can be applied both universally and as targeted interventions for individuals with at-risk profiles, such as anxiety complaints, temperamental traits which are associated with anxiety problems and escalation of anxiety symptoms (Dozois et al., 2009; Essau et al., 2014; Kirpatrick et al., 2013; Titov et al., 2016). The results from these applications are promising (especially in adolescents at risk for anxiety disorders) although modest with low-to-medium effect sizes in anxiety symptoms reduction up to the 6-month follow-ups (Bilek and Ehrenreich-May, 2012; Queen et al., 2014; Topper et al., 2017). It should however be noted that these studies often have methodological limitations (e.g., a lack of random allocation or lack of validated measures) which may put the related findings into question (see Garcia-Escalera et al., 2016). Additionally, most of these studies focused on examining how symptoms may change as a consequence of an intervention, overlooking its effects on related anxiety manifestations, such as behavioural manifestations or physiological functioning.

The Super Skills for Life programme (SSL; Essau and Ollendick, 2013) is a transdiagnostic programme for preventing the onset of anxiety and depressive disorders. SSL is available in two versions: One version is for children (SSL-C) and another version is for adolescents (SSL-A). The present study used the Spanish adaptation of the adolescent version of SSL (Super-AD; de la Torre-Luque et al., 2015). SSL-A is based

on the principles of cognitive-behavioural and behavioural activation principles, relying on five main cores: 1) targeting common risk factors for internalising disorders (e.g., low self-esteem); 2) coping with stressful situations (by using relaxation techniques and encouraging problem-solving skill development); 3) teaching social skills; 4) promoting healthy life style; and 5) incorporating video feedback and cognitive preparation modules to enhance self-perception (Essau et al., 2014).

Several studies have shown the effectiveness of SSL in reducing anxiety and depressive symptoms, and in enhancing self-esteem among children (Essau et al., 2014, 2019). No studies have been conducted using the adolescent version of SSL. The present study examines the effectiveness of SSL-A among adolescents who are at risk of developing an anxiety disorder.

Aims

The main aim of this study was to examine the extent to which participating in a transdiagnostic cognitive behaviour-based programme (SSL-A; Essau & Ollendick, 2013; Essau et al., 2014) version for Spanish adolescents (Super-AD; de la Torre-Luque et al., 2015) for preventing internalising disorder, could change the course of anxiety symptoms during adolescence in adolescents reporting key anxiety symptoms. Another aim was to investigate the way in which SSL-A may influence different aspects of anxiety manifestations, specifically behavioural performance and cardiac function while performing a stressful task.

Methods

Participants

The sample comprised adolescents who participated in TrANS research project (see Bornas et al., 2014). Adolescents were recruited from secondary schools in Majorca island (Spain). The criteria for inclusion in this study were: (1) The adolescents

reported key symptoms of anxiety disorders, through a self-reported version of the Mini-International Neuropsychiatric Interview for Children and Adolescents (see Instruments section below). (2) All the participants should be fluent in both Spanish and Catalan, and had a written consent form signed by themselves and their legal guardians. (3) Adolescents did not show any of these exclusion criteria: met the diagnosis of an anxiety disorder according to the M.I.N.I. Kid interview; had severe physical or intellectual disabilities, or had severe neurological, respiratory or cardiovascular diseases according to parent's and school's reports.

A total of 492 participants (64.34% of adolescents assessed, $N = 762$) reported two or more key symptoms for anxiety disorders. From these participants ($N = 492$), 96 adolescents (40.60% boys; $M = 14.47$ years, $SD = 0.56$) from 18 secondary schools were randomly selected to participate in the present study. The final sample consisted of 61 participants (45.30% boys; 13.76 years, $SD = 0.32$). All the participants came from middle socioeconomic backgrounds and were white Caucasian. They were randomly assigned to one of these three groups: intervention group (IG; $n = 21$; 46.15% boys; 13.81 years, $SD = 0.34$), placebo group (PG; $n = 13$; 42.86% boys; 13.70 years, $SD = 0.29$) or waitlist group (WG; $n = 27$; 47.62% boys; 13.76 years, SD = 0.32). See Figure 1 for the depiction of participants flow throughout the study.

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Insert Figure 1 here

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Instruments

Early Adolescence Temperament Questionnaire, Revised version (EATQ-R; Ellis & Rothbart, 2001; Catalan translation by Gonzales, see in Rothbart, 2019) was used to measure temperament in adolescence. The EATQ-R is made up of 103 items

which can be rated on a 5-point Likert scale. The items can be categorized to 13 primary factors and four principal temperament factors (negative affectivity, effortful control, affiliativeness, and surgency). However, only factors related to effortful control (EC) and negative affectivity (NA) were used in the present study. Reliability indexes within our sample were similar to those found in previous studies (see Ellis and Rothbart, 2001; Muris and Meesters, 2009): $\alpha = .82$ for EC, and $\alpha = .64$ for NA.

Mini-International Neuropsychiatric Interview for Children and Adolescents (M.I.N.I. Kid; Sheehan et al., 1998) was used to measure DSM-IV anxiety disorders (panic disorder, agoraphobia, separation anxiety disorder, generalised anxiety, social phobia, specific phobia, posttraumatic stress disorder), mood disorders (major depressive episode, suicidality risk, dysthymia), and adaptive disorders. M.I.N.I. Kid is a structured diagnostic interview for assessing 25 diagnostic modules that cover major externalizing and internalising disorders based on the DSM-IV criteria (4th edition of the Diagnostic and Statistics Manual of Mental Disorders; American Psychiatric Association; APA, 2000). For most modules, two to four screening questions are used to rule out the diagnosis when answered negatively. Positive responses to screening questions are explored by further investigation of other diagnostic criteria (i.e., the other symptoms observed in this mental disorder).

A brief screening questionnaire (see the Supplementary material), comprising the key symptoms of the internalising disorder modules of M.I.N.I. Kid (major depressive episode, panic disorder, agoraphobia, separation anxiety disorder, generalised anxiety, social phobia, specific phobia) was also used, by means of seven dichotomous items (persistent sadness, general/at-random panic, fear/unpleasantness in social situations, fear of open/enclosed spaces, fear/unpleasantness when being separated from home or attachment figures, worry about several concerns, specific fears related to concrete

stimuli, such as heights, small animals, storms, blood/injections or darkness). Exploratory factor analysis revealed a unidimensional structure with a latent factor explaining 47.12% of construct variance, with moderate reliability index (Kuder-Richardson reliability, *KR-20* = .81). The measure correlated with internalising symptoms (r = .22 for separation anxiety to r = .33 for major depression symptoms).

Revised Child Anxiety and Depression Scale (RCADS, Chorpita et al., 2000) was used to assess symptoms of anxiety disorders (separation anxiety disorder, social phobia, generalised anxiety disorder, panic disorder, and obsessive-compulsive disorder) and major depression. Obsessive-compulsive symptom factor was not used in this study because it is not considered as an anxiety disorder in the current diagnostic classification system (APA, 2013). Its 47 items could be scored on a four-point Likert scale (0=never, 1 = sometimes, 2=often, 3 = always). The internal consistency of symptom scales ranged from α = .70 (separation anxiety) and α = .88 (depression) within our sample, on average across assessments.

Procedure

This study was part of a large research project on anxiety trajectories in adolescence, and its psychological and physiological correlates (Bornas et al., 2014). Adolescents enrolled in TrANS project were assessed (T1) for anxiety symptoms (RCADS) and temperament (EATQ-R). Additionally, the M.I.N.I. Kid screening instrument was administered. Adolescents who scored ‘yes’ at least in two items was eligible for being invited to the study (see Figure 1 for further details on recruitment).

Once adolescents agreed to participate in the study, the M.I.N.I. Kid was conducted by two postgraduate psychologists who have been trained in using this interview schedule to determine the absence of internalising disorders. The interview results were reviewed and diagnoses ratified by a research team involved in this study.

The participants from each school were randomly assigned to one of these three groups: intervention, placebo and waitlist group.

In order to examine the natural course of anxiety symptoms, the assessment of these symptoms were conducted twice before delivering the intervention, with an interval of six months (T1 and T2, respectively). Also, anxiety symptoms were assessed upon completion of the intervention (i.e., postreatment; T3) which took place six months after T2. Finally, a follow-up assessment (T4) was conducted six months later than T3.

Intervention Group (IG)

The participants in the IG participated in the adolescent version of Super Skills for Life programme (SSL-A; Essau and Ollendick, 2013; Essau et al., 2014) (Spanish adaptation of SSL-A (de la Torre-Luque et al., 2015) between T2 and T3 assessment points. The intervention was implemented in groups of 3 - 9 adolescents, once a week over a period of eight weeks, with each session lasting for about one hour.

IG performance test

To examine the changes in behavioural performance and cardiac adjustment, participants in the IG group underwent a psychosocial stress induction task at T2 and T3. The task relied on the Trier Social Stress Test, group version (Dawans et al., 2011; de la Torre-Luque et al., 2017). The task involved adolescents talking about anything they wish in front of a video-camera and members of their intervention group. The presentation lasted for one minute. The paradigm consisted of a baseline phase (3 minutes), an anticipation phase (3 minutes, an analogue of anticipatory anxiety), presentation, and a recovery phase (3 minutes).

Behavioural performance while presenting were evaluated by a researcher who was unaware of the participant's intervention group using an adapted version of the

Social Performance Rating Scale (SPRS; Fydrich et al., 1998; Essau et al., 2014). The SPRS was used to evaluate five aspects of behavioural indicators of anxiety on a 5-point scale: (a) Gaze, which was rated from very poor (i.e., participant completely avoided looking at the camera) to very good (i.e., looked at the camera during the conversation); (b) Vocal quality, which was rated from very poor (i.e., spoke at a low volume) to very good (i.e., enthusiastic in verbal expression); (c) Length, which was rated as very poor (i.e., monosyllabic [`hmmm']) to very good (i.e., for most part, participant's utterances are two or more sentences long); (d) Discomfort, which was rated from very high (i.e., constant leg movements) to very low (i.e., relaxed body posture); and (e) Conversation flow, which was rated from very poor (i.e., participant makes few attempts to talk) to very good (i.e., talk in a coherent manner). Moreover, cardiac functioning was recorded continuously throughout the task phases.

Physiological measures

Interbeat interval time series were recorded at 1000 Hz throughout the whole stress induction task, using the Firstbeat Bodyguard 2© (Firstbeat Technologies Ltd., Jyväskylä, Finland). The interbeat interval time series were filtered by applying a low-pass band filter at 1100 ms, a high-pass band filter at 400 ms, and a central interval filter. Further details on data acquisition and processing can be found in de la Torre-Luque et al. (2017).

Four cardiac measures were considered (see Camm et al., 1996): the mean heart rate, the square root of the mean of the squares of the successive differences between adjacent NN peaks (rMSSD), the high-frequency band (.15-.40 Hz) spectral power, in log-linear scale (lnHF); and sample entropy (SampEn; Richman and Moorman, 2000). Heart rate has been extensively associated with parasympathetic activity (Beauchaine and Thayer, 2015). SampEn is a measure of chaotic irregularity or complexity of a

biological system over time (the higher the SampEn the more complex the behaviour of this system). Cardiac measures were calculated by means of Kubios HRV 2.1 (Tarvainen et al., 2014).

Placebo Group (PG)

Adolescents in the PG participated in an 8-session school work programme which focused on developing and extending basic academic skills: planning skills (to make efficient timetables to deal with school and homework), reading skills (i.e., how to read comprehensively), text highlighting (to find the key information of text and colour it), how to do a presentation), summary writing (using concept maps) and presentation skills (doing classroom presentations that grab the attention of teachers and students). This program was delivered in a group format between T2 and T3 assessment points over a period of eight weeks for one hour in each session.

Wait-list Group (WG)

The participants in the WG did not receive any intervention other than attending their regular school activities.

The University Bioethics Committee of the University of the Balearic Islands approved all procedures. Participants and their parents/tutors provided written consent.

Analytic strategy

First, baseline features of initial sample and final sample in analysis were compared (attrition analyses). Student's *t* tests and χ^2-based tests, and their related effect size estimates (Cohen's *d* and Cramer's *V* statistics), were used. Second, baseline features were compared across study groups by means of one-way analysis of variance (ANOVA) for scalar variables, and χ^2-based tests for dichotomous/categorical variables. The $\eta^2_{partial}$ statistic and Cramer's *V* was used as effect size estimates.

A multivariate analysis of variance (MANOVA) was conducted using the four RCADS anxiety subscales as outcomes (separation anxiety disorder, social phobia, generalised anxiety disorder, panic disorder). Time (T1, T2, T3, T4) was the within-subject factor and the group (IG, PG, WG) was the between-group factor. The $\eta^2_{partial}$ statistic was used as an effect size estimate. Bonferroni post hoc tests were used to study pairwise between-group differences within each stage (to investigate between-group differences at any concrete measurement occasion, after correcting for multiple comparison testing) and between-stage differences across groups (to investigate changes in symptoms in any group across measurement occasion). The Greenhouse-Geisser correction was applied to deal with between-group variance homogeneity violation.

Another MANOVA was performed to study the pre-posttest changes in the IG task performance ratings using the SPRS items as outcomes. In order to study cardiac activity during the performance test, two indexes were made: a reactivity index (creating by subtracting the cardiac activity in the presentation phase and cardiac activity at baseline) and a recovery index (creating by subtracting the cardiac activity in the recovery phase and cardiac activity in the presentation phase). A series of *t* tests for paired measures (and Cohen's *d* for effect size estimation) were used to study pre-posttest effects for the indexes in each cardiac measure, correcting the *p* level according to Bonferroni multiple-comparison assumption (as we considered two comparisons per measure, reactivity and recovery indexes, the *p* value should be lower than .05/2 for differences being significant).

Further details on analytic strategy (tests for assumptions to apply ANOVA-based and *t* tests) are included in the Supplementary material. IBM SPSS v. 24 was used for all the analyses.

Results

Attrition analyses revealed no significant differences in the sociodemographic features and the study variables between the participants whose data were used in the analysis and those who dropped out of the study (see the Supplementary material for further details). Table 1 shows the sociodemographic characteristics of all the participants at baseline. No between-group differences were found in terms of sociodemographic, temperament (effortful control and negative affectivity) and RCADS anxiety symptoms. However, the three groups differed in the type of secondary school they attended (no participants from rural secondary schools in the IG) and number of key symptoms reported by means of the M.I.N.I. Kid screening instrument (the highest number in the IG, and the lowest in the WG).

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The MANOVA for anxiety disorder symptom scales showed a multivariate effect of Time, F (4, 173) = 2.92, p = .023, $\eta^2_{partial}$ = .06; and a multivariate Time x Group, F (6, 174) = 2.74, p = .015, $\eta^2_{partial}$ = .09. Regarding the univariate effects, our result showed a main effect of Time for the social phobia symptom scale, F (3, 174) = 3.24, p = .023, $\eta^2_{partial}$ = .05. Also, a Time x Group interaction effect was found for the social phobia symptom scale, F (3, 174) = 2.36, p = .033, $\eta^2_{partial}$ = .07; and for the generalised anxiety symptom scale, F (3, 174) = 2.25, p = .041, $\eta^2_{partial}$ = .07. However, there was no significant between-group effect for all the outcomes.

Post hoc tests revealed the absence of T1-T2 significant differences between the study groups across symptom scales (p between .10 and .99), nor between T1 and T3 (p between .16 and .99), between T2 and T3 (p between .16 and .99), or between T3 and T4 (p between .28 and .99). On the other hand, between-group differences at T4

between the IG and PG (higher scores in the PG), t (1) = 2.89, p = .016, for the social phobia symptom scale; and marginally significant between IG and WG at T4, t (1) = 1.89, p = .067. For generalised anxiety symptoms, between-group differences in T4 were found between the IG and PG, t (1) = 2.50, p = .046; and between the IG and WG, t (1) = 2.79, p = .021. In both social phobia and generalised anxiety scales, the IG showed lower levels of symptoms. The IG showed significant differences in social phobia symptoms between T1 and T4, t (1) = 2.80, p = .041; and between T2 and T4, t (1) = 2.87, p = .034. Scores in T4 were lower than those shown in T1 and T2. Finally, the IG showed lower levels of generalised anxiety symptoms from T1 to T4, t (1) = 3.18, p = .014. No other post hoc effects were significant.

Figure 2 shows the course of social phobia and generalised anxiety symptoms across the study assessment points (figures for the remaining symptom scales are shown in the Supplementary material, Figure S1). Specifically, the IG showed lower symptoms of social phobia and generalised anxiety disorders at T4, in comparison to the PG and WG groups. Additionally, the IG showed significant differences in social phobia symptoms when comparing T1 and T2 at T4 (lower symptoms at T4). Significant differences were also found between T1 and T4 (lower symptoms at T4) in generalised anxiety symptoms.

Insert Figure 2 here

IG performance test and cardiac functioning

Table 2 shows the pre-posttest ratings for the behavioural performance of IG participants using the SPRS. Results showed a significant improvement in vocal quality, F (1, 18) = 5.70, $p < .05$, $\eta^2_{partial}$ = .24, and discomfort F (1, 18) = 15.84, $p < .01$, $\eta^2_{partial}$

= .47 at the posttest in comparison to pretest. Gaze and conversation flow were marginally better rated at the posttest (p = .057). No pre-posttest differences were found on speech length (p = .41).

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Figure 3 shows the pre-posttest reactivity and recovery indexes across the cardiac measures. As expected, positive reactivity indexes were seen in terms of heart rate and negative indexes in terms of RMSSD, lnHF and SampEn. The opposite patterns were observed for the recovery indexes across measures (negative indexes for heart rate and positive indexes for RMSSD, lnHF and SampEn). The t tests revealed significant differences in the SampEn recovery index, t (18) = 2.64, p = .017, d = 0.86. The SampEn recovery index was significantly lower in the posttest (T3) in comparison to pretest (T2).

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Discussion

This study aimed to provide some evidence in the way in which a transdiagnostic CBT-based intervention (SSL-A) may change the natural course of anxiety symptoms in adolescents reporting key symptoms of anxiety disorders. Moreover, the present study examined how SSL-A may promote behavioural and physiological (cardiac) adjustment changes when confronting stressful tasks. To achieve these aims, adolescents were randomly assigned to either one of the three groups: the IG participated in the Spanish version of the SSL-A (de la Torre-Luque et al., 2015) once a

week over a period of eight weeks; the PG attended an 8-session programme to improve schoolwork skills; and the WG received no intervention other than being in their regular class.

The SSL intervention was found to change the natural course of anxiety symptoms in our sample of adolescents who were at risk in developing an anxiety disorder. In other words, the intervention provided the adolescents with skills to tackle risk factors leading to symptom escalation towards the development of an anxiety disorder. Numerous studies have provided some support in the way in which a CBT was beneficial in preventing the development of an anxiety disorder in children and adolescents with early signs of anxiety problems (Essau et al., 2014; Johnson et al., 2016; Queen et al., 2014; Stockings et al., 2016; Werner-Seidler et al., 2017). However, most of these studies have shown short-term impact of the intervention on anxiety/depressive symptoms (i.e., reduction in anxiety/depressive symptoms 3 – 6 months after the the intervention). We found that participating in SSL promoted anxiety symptom changes that became evident at T4 (6-month follow-up), as proven by the significant differences in symptoms of social phobia and generalised anxiety disorder between the study groups. Additionally, significant differences were observed across assessment points only in the IG. Analyses between the three groups showed significant differences in social phobia symptoms between the intervention group and placebo, however, marginal differences were found between the waitlist and placebo. The small sample size could have explained for this finding. Furthermore, the intervention did not lead to any changes in the other anxiety symptoms.

These findings (i.e., differential patterns of changes in the symptoms of the subtypes of anxiety disorders may be related to developmental issues. Adolescence constitutes a sensitive period for the development of anxiety disorders (see Paus et al.,

2008). However, not all anxiety syndromes (understood as a collection of symptoms) are manifested within adolescence, or not with the same severity. Early adolescence constitutes a critical period for the development of specific anxiety disorder symptoms, more concretely social phobia and generalised anxiety (see Beesdo-Baum and Knappe, 2012; Copeland et al., 2014; Seligman and Gahr, 2013; Weems, 2008). Thus, our findings seem to suggest that SSL-A was able to modify the course of anxiety symptoms in interaction with the developmental vulnerability to express concrete manifestations of anxiety.

To provide additional evidence on SSL-A-driven effects, we incorporated an experimental task to study behavioural performance and physiological (cardiac) adjustment. The task relied on stress induction protocols which constitute a suitable setting to study intervention-driven improvements in the context of adolescent anxiety disorders (Dawans et al., 2011; Dieleman et al., 2016; Kirschbaum et al., 2010). Additionally, the task is highly relevant due to the psychosocial nature of stressor which involved giving a speech in front of an audience of a group of same age peers.

Some studies have shown that adolescents at-risk for anxiety disorders may be related to impairment in physiological adjustment to task demands within stress induction paradigms (de la Torre-Luque et al., 2017; Iverach et al., 2017; Kramer et al., 2012; Schmitz et al., 2013) as well as worsening of behavioural performance during interaction/social tasks, which was interpreted as a sign of skill deficit (Inderbitzen-Nolan et al., 2007; Miers et al., 2010). In line with these previous studies, participating in a transdiagnostic CBT-based intervention had led to the improvement in vocal quality when giving the speech in the stressful task as well as showing a lower discomfort when speaking. Moreover, cardiac adjustment changed at the post-intervention in terms of recovery after giving the speech which is the most stressful stage within the stress

induction task. More concretely, we found attenuated sample entropy recovery index at the post-intervention, in comparison with the adjustment at pre-intervention. Entropy-based measures show the complexity/irregularity of a physiological system behaviour over time (Bravi et al., 2011; de la Torre-Luque et al., 2016). Sample entropy is proven to be sensitive (and not other time-domain and frequency-domain measures) to characterise stress-induced states in adolescents at risk and improvements after anxiety-reduction interventions (Bornas et al., 2012; de la Torre-Luque et al., 2017).

Our results point to an attenuated pattern regarding the interplay between sympathetic and parasympathetic influences on cardiac function after being exposed to the stressor (also in the adjustment to the stressor exposure, but marginally probably due to the low sample size). The lower the SampEn recovery index, the lower the increase of cardiac complexity/irregularity (or variability) after confronting a stressor. A higher cardiac complexity may be a sign of our system responding to multiple stimuli across multiple time scales (i.e., more variable/complex functioning), that involves physiological regulation of internal organs, mobilisation of attentional resources, circadian rhythms, etc. (Costa et al., 2008; Ivanov et al., 1999). A loss of complexity is a sign of satisfactory adjustment when confronting stressful situations (de la Torre-Luque et al., 2017; Visnovcova et al., 2014; Williamon et al., 2013). We suggest that the attenuated complexity at post-intervention could be a sign of heart being more focused on responding to the stressful task (attractor) demands. In this regard, the intervention may lead to substituting inefficient emotion regulation strategies that affect cardiac adjustment to stressors with other more efficient strategies. One of these inefficient strategies could be worry or ruminating at their own performance in the exposition stage of the paradigm. Some evidence highlights the damaging effects of worry following stressors, such as prolonged cardiac recovery (Brosschot et al., 2014;

Brosschot, 2010). We speculate that the SSL-A could provide adolescents with skills that efficiently help them handle the stressful task (e.g., problem-solving skills, social interaction skills) better that rumination, for instance.

The influence of the repeated exposure to the stress paradigm we used in the present study on our results are not likely to have had happened for three reasons: First, the experimental task was introduced at both T2 and T3, ensuring that stress induction was unexpected (i.e., adolescents were not informed about the task they had to perform; see Dawans et al., 2011), and the task demands were uncontrollable, challenging, and threatening (see Lazarus and Folkman, 1984). Second, time interval between T2 and T3 and task exposure was six months apart. Finally, repeated exposure to a stress induction protocol leads to changes in time-domain and frequency-domain cardiac measures, as they are sensitive to stressor habituation reactions (Boesch et al., 2014; Jonsson et al., 2010). We did not find such pre-post changes.

Our study has some strengths and limitations. A major strength of the present study was that its design allows the investigation of the natural course of anxiety symptoms by including two assessments points before delivering the intervention and another two assessments after delivering the intervention. In this sense, natural developmental patterns (i.e., trends of expression) of anxiety symptoms were considered before intervention delivery. Moreover, some relevant factors involved in the development of internalising disorders (e.g., sex, temperament factors) were also controlled (i.e., study groups showed similar levels of negative affectivity and effortful control at baseline). It used multi-modal measures of intervention outcomes, namely, behavioural performance and cardiac measures collected before and after the intervention in the IG, allowing us to directly testing the impact of SSL-A during a stressful situation. Finally, our design comprises two control groups: a quasi-control one

(PG) and the WG. Limitations include a small sample size that did not allow us to conduct separate analyses by gender and age groups. This was related to the length of the whole study (18 months). Moreover, the higher drop-out rate in the PG may be related to the content of this intervention, as it was related to school and academic skills (e.g., some participants who dropped out mentioned that the programme was very boring). Future research should have a bigger sample size. Additionally, psychosocial stress induction task was conducted only in the IG due to our interest in providing additional evidence on SSL-A effects. Future studies should extend examining the impact of the psychosocial stressful stress induction task on cardiac adjustment in all the comparison groups. On the other hand, groups were not equivalently in terms of screening tool score (i.e., M.I.N.I. Kid screening tool) and urbanicity. However, we decided not to use these variables as covariates, due to the risk of type I error inflation caused by multiple testing (i.e., interaction effects covariates and independent variable) and our limited sample size (see Van Breukelen and Van Dijk, 2007). Finally, other measures to characterise stressful reactions (e.g., cortisol releasing, subjective reports of stress) should be included to assess the extent to which the SSL-A may change stressful situation coping.

In spite of these shortcomings, our findings provide interesting information in that the SSL-A has successfully reduced the number of anxiety symptoms (social phobia and generalised anxiety symptoms), and showed changes in performance when facing a stressful situation in terms of behaviour and physiological (cardiac) function, pointing to changes in emotion regulation. Finally, symptom reductions were evident up to six months after the implementation of SSL-A. The present finding has two important implications: first, the SSL-A is an effective programme to tackle the escalation of anxiety symptoms. The programme can be easily and cost-effectively implemented in

school settings. Second, governments should make greater effort to incorporate preventive strategies as a way to contribute to a healthy development in terms of enhancing mental health during a critical developmental stage (the adolescence).

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Table 1

Sociodemographic and clinical characteristics of the adolescents at baseline.

	IG	PG	WG
N	21	13	27
Sex (% boys)	47.62	38.46	44.44
Age	13.81 (0.34)	13.70 (0.29)	13.76 (0.3
Secondary school (% rural)	0	28.57	11.11
Family structure (% living with both natural parents)	19.05	23.08	18.52
EATQ-R			
EC	4.41 (0.54)	4.14 (0.42)	4.47 (0.42
NA	3.00 (0.71)	3.07 (0.42)	2.80 (0.43
MINI Kid Screening instrument	4.38 (1.99)	3.92 (1.75)	2.44 (1.88
RCADS			
MDD			
T1	7.76 (6.92)	9.08 (4.31)	5.92 (3.50
T2	8.18 (6.43)	9.29 (4.70)	7.40 (3.73
PA			
T1	5.48 (6.19)	5.77 (4.11)	3.96 (2.97
T2	5.59 (5.03)	4.78 (3.83)	3.76 (2.54
SA			
T1	1.05 (1.43)	1.08 (1.75)	1.42 (1.64
T2	1.36 (2.22)	1.00 (1.47)	2.12 (2.09
GAD			
T1	5.62 (4.24)	6.61 (3.25)	5.96 (3.14
T2	5.23 (4.08)	7.29 (3.99)	5.56 (3.50
SPh			
T1	8.90 (7.06)	11.69 (4.97)	9.67 (3.42
T2	9.00 (7.10)	11.36 (5.58)	8.20 (4.18

Note. Mean and standard deviations (between brackets) are displayed for scalar variables, and percentage of cases for dichotomous factors.

Contrast tests consisted of χ^2-based tests (i.e., sex, secondary school and family composition) and one-way analysis of variance (the remaining variables, which were scalar). Effect size estimates were Cramer's *V* (i.e., sex, secondary school and family composition) and $\eta^2_{partial}$ (the remaining variables).

EATQ-R = Early Adolescence Temperament Questionnaire, Revised version. EC = Effortful control scale. NA = Negative affectivity scale. RCADS = Revised Child Anxiety and Depression Scale. MDD = Major depression disorder symptom scale. PA = Panic disorder symptom scale. SA = Separation anxiety symptom scale. GAD = Generalized anxiety disorder symptom scale. SPh = Social phobia symptom scale.

T1 = Baseline assessment point. T2 = Pretest assessment point.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Table 2

Pre-posttest performance on behavioral test in the intervention group.

	Assessment point		*F*	$\eta^2_{partial}$
	T2	T3		
Gaze	3.00 (0.67)	3.42 (0.77)	4.14	.19
Vocal quality	3.21 (0.63)	3.63 (0.76)	5.70*	.24
Speech length	3.37 (0.96)	3.63 (1.06)	0.70	.04
Discomfort	2.37 (0.50)	3.05 (0.78)	15.84**	.47
Conversation flow	3.21 (0.92)	3.63 (0.83)	4.14	.19

Note. Mean and standard deviations (between brackets) of the Social Performance Rating Scale items are displayed. Scale of response for these items has 5 points (from 1 = 'very poor' to 5 = 'very good`). The discomfort item scale of response ranges from 1 = 'very high' to 5 = 'very low'.

Contrast tests consisted of multivariate analysis of variance Snedecor's *F* statistic (scalar variables), after applying Greenhouse-Geisser's correction for sphericity violation. Effect size estimates are based on $\eta^2_{partial}$.

T2 = Pretest assessment point. T3 = Posttreatment assessment point.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Figure 1. Participants' flow chart.

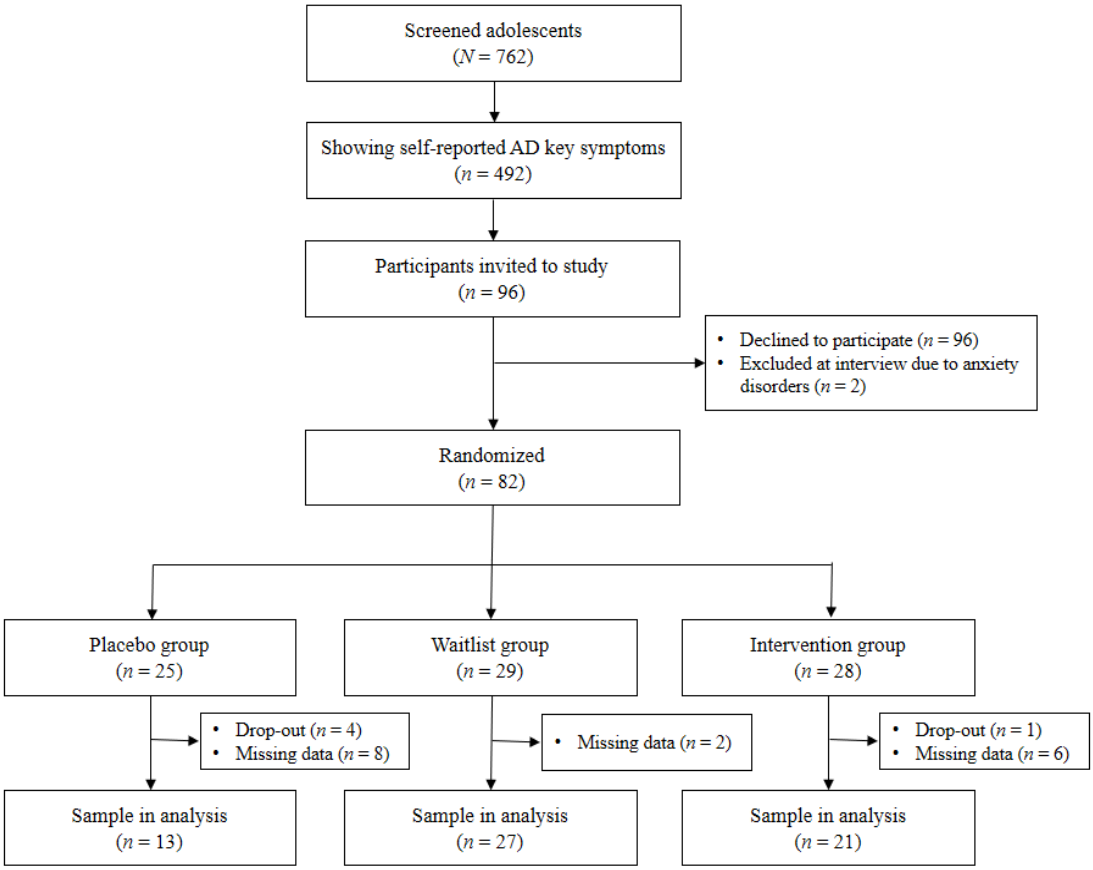
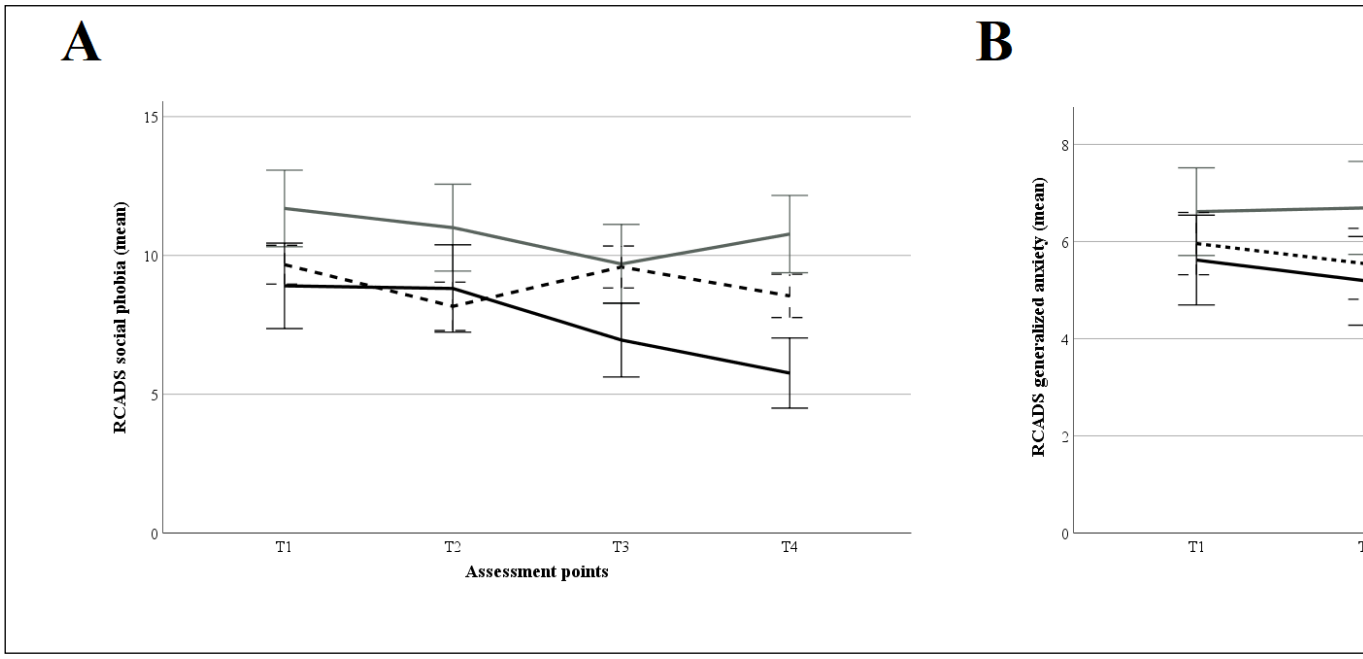


Figure 2. Group-specific course of social phobia and generalized anxiety symptoms across assessment points.



Note. Figure in the A box depicts the course of social phobia symptoms. Figure in the B box depicts the course of generalized anxiety symptoms.

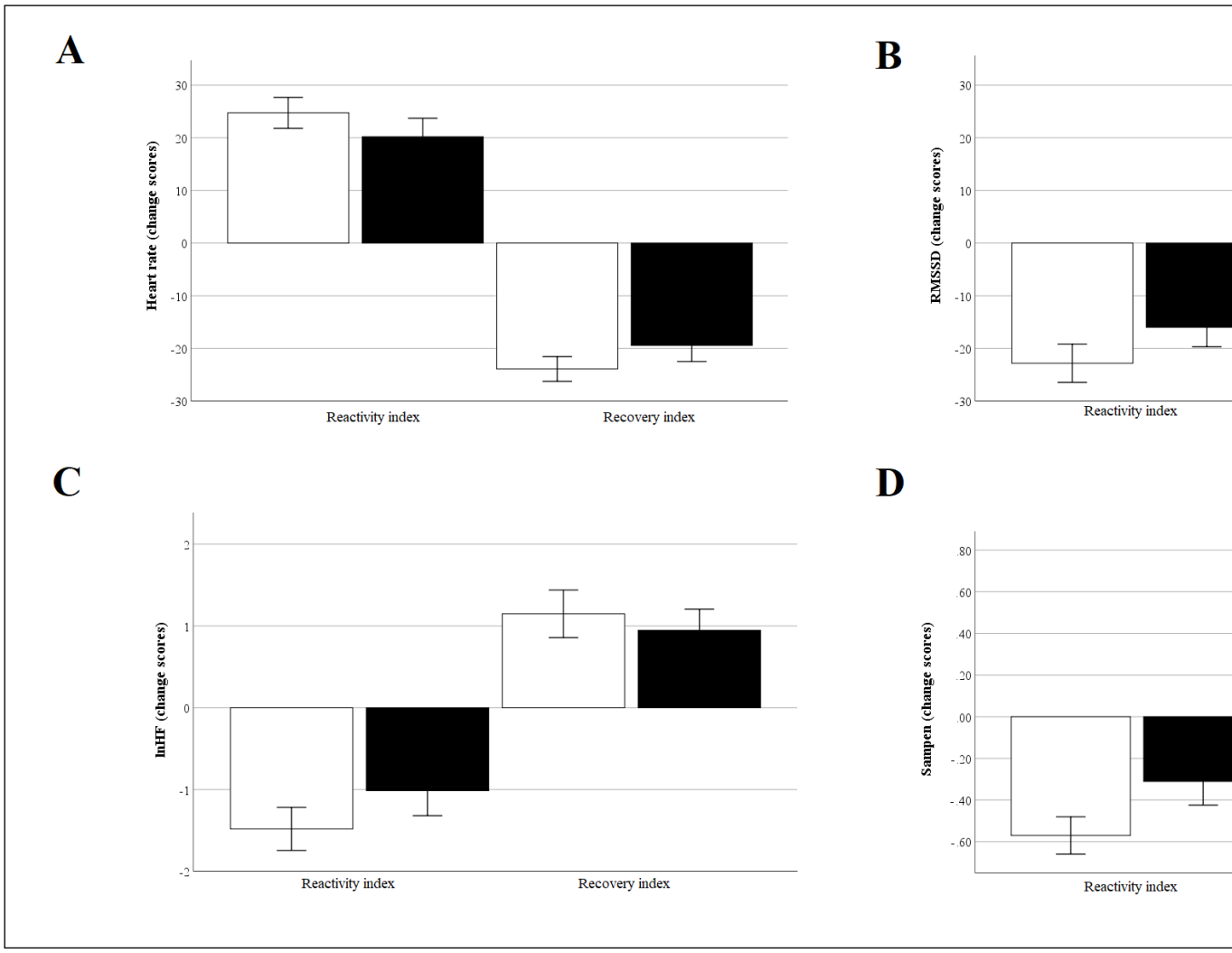
Assessment points were six months before participating in each intervention programmes (T1; baseline), shortly before participating in each intervention programmes (T2; pretest), shortly after participating in each intervention programmes (T3; posttest, six months after T2) and at 6-month follow-up (T4).

Error bars depict the standard error of the mean.

Dark dashed line = waitlist group. Grey solid line = placebo group. Dark solid line = intervention group.

RCADS = Revised Child Anxiety Depression Scale.

Figure 3. Pre-posttest cardiac functioning of adolescents in the intervention group.



Note. Figure in the A box shows the cardiac indexes considering the heart rate (HR) measure. Figure in the B box shows the cardiac indexes considering the root mean square of the successive differences (RMSSD) measure. Figure in the C box shows the cardiac indexes considering the high-frequency band power in log-linear scale (lnHF) measure. Figure in the D box shows the cardiac indexes considering the sample entropy (SampEn) measure.

The reactivity index was calculated for every measure by subtracting the exposure stress phase and the baseline levels. The recovery index was calculated for every measure by subtracting the recovery phase and the exposure stress phase levels.

Error bars depict the standard error of the mean.

White bars = pretest scores (T2 in the study design). Black bars = posttest scores (T3 in the study design).

* $p < .05$.

Supplementary material

M.I.N.I. Kid screening questionnaire (note that the questionnaire was administered in Spanish)

1. Have you felt sad or depressed, down or empty, or grouchy or annoyed, most of the day, nearly every day for the past two weeks?
2. Have you ever been too scared or nervous for no reason, or have you ever been too scared or nervous in a situation where most children would not feel that way?
3. Do you feel anxious, scared, or uncomfortable in places or situations where you might feel very afraid, like being in a crowd, standing in a line, when you are completely alone, or crossing a bridge, or traveling by bus, train, or car?
4. In the last month, have you been very afraid of being away from someone?; Or have you been very afraid of losing someone you are attached to (such as losing your parents or something bad happening to them)?
5. In the past month, did you feel afraid or ashamed when others were watching you? Were you afraid of being teased or mocked (for instance, talking in front of the class, or eating or writing in front of others)?
6. In the past month, have you been very afraid of things like: snakes, snakes, insects? Dogs or other animals? Heights? Storms? Darkness? Or blood or injections?
7. In the last six months, have you been worried or have you been nervous about several things (like school, your health, or something bad could happen)? Have you been more worried than other children your age?

Data analysis

We decided to use ANOVA tests due to its robustness (mainly in comparison with non-parametric methods) even when assumption violations (especially those coming from normality in data distribution violation) are found (Blanca et al., 2017; Lantz, 2013). Normality was assessed by means of Kolmogorov-Smirnov test (and the Shapiro-Wilk test for the behavioural performance and cardiac measures, due to the small sample size) and sphericity (i.e., variance homogeneity in repeated-measure designs) by means of the Greenhouse-Geisser's ε. Table S2 displays the results from testing normality and sphericity. As mentioned in the main manuscript, the Greenhouse-Geisser correction was applied when sphericity was violated. No correction was needed when normality was violated (Blanca et al., 2017).

Regarding the *t* tests for paired samples, normality was assessed by means of Shapiro-Wilk test. Violations in normality involves using non-parametric tests (i.e., Wilcoxon test). See the Table S2C to find the results from the normality tests for cardiac measures.

References

Blanca, M.J., Alarcon, R., Arnau, J., Bono, R., Bendayan, R., 2017. Non-normal data: Is ANOVA still a valid option? Psicothema 29, 552–557. https://doi.org/10.7334/psicothema2016.383

Lantz, B., 2013. The impact of sample non-normality on ANOVA and alternative methods. Br. J. Math. Stat. Psychol. 66, 224–244. https://doi.org/10.1111/j.2044-8317.2012.02047.x

Table S1

Attrition analysis to compare sample included in the analysis and drop-out sample.

	Sample in analysis	Drop-outs	Contrast tests	Effect size
Sex (% boys)	45.30	33.34	2.86	-0.2
Age	13.76 (0.32)	13.94 (0.58)	1.58	0.4
Secondary school (% rural)	38.23	48.72	0.81	0.1
Family structure (% living with both natural parents)	80	62.5	4.23	0.3
EATQ-R				
EC	4.33 (0.46)	4.30 (0.57)	-0.26	-0.06
NA	3.00 (0.56)	3.00 (0.58)	-0.01	0.00
MINI Kid Screening instrument	4.79 (1.34)	4.74 (1.23)	-0.17	-0.04
RCADS				
MDD	7.79 (5.89)	8.06 (6.86)	0.17	0.04
PA	5.23 (5.04)	6.81 (5.53)	1.24	0.3
SA	1.09 (1.52)	2.00 (2.69)	1.75	0.42
GAD	6.00 (3.89)	6.42 (4.04)	0.44	0.11
SPh	9.76 (6.35)	9.56 (6.47)	-0.14	-0.03

Note. Mean and standard deviations (between brackets) are displayed for scalar variables, and percentage of cases for dichotomous factors. Contrast tests consisted of Student's *t* tests (scalar variables) and χ^2-based tests (dichotomous factors). Effect size estimates were Cohen's *d* (scalar variables) and Cramer's *V* (dichotomous factors). None of contrast tests were significant ($p > .05$).

EATQ-R = Early Adolescence Temperament Questionnaire, Revised version. EC = Effortful control scale. NA = Negative affectivity scale. RCADS = Revised Child Anxiety and Depression Scale. MDD = Major depression disorder symptom scale. PA = Panic disorder symptom scale. SA = Separation anxiety symptom scale. GAD = Generalized anxiety disorder symptom scale. SPh = Social phobia symptom scale.

Table S2A

Statistics derived from testing parametricity regarding the anxiety symptom scales.

	Social phobia				Generalised anxiety				Separation anxiety				Panic			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
Z	0.10	0.13*	0.10	0.11	0.11	0.14*	0.16*	0.15*	0.28*	0.24*	0.24*	0.27*	0.20*	0.17*	0.22*	0.21*
ε	.67				.74				.90				.77			

Note. Assessment points were six months before participating in the intervention programmes (T1; baseline), shortly before participating in the intervention programmes-A (T2; pretest), shortly after participating in the intervention programmes (T3; posttest, six months after T2) and at 6-month follow-up (T4).

The *Z* statistic was derived from the Kolmogorov-Smirnov normality test (a *Z* with $p < .05$, revealed that the assumption of normal distribution of data cannot be upheld). The Greenhouse-Geisser's ε was used to measure sphericity (an $\varepsilon < .75$, revealed that the assumption of sphericity cannot be upheld).

* $p < .05$.

Table S2B

Statistics derived from testing parametricity regarding the behavioural performance variables.

	Gaze		Vocal quality		Speech length		Discomfort		Conversation flow	
	T2	T3	T2	T3	T2	T3	T2	T3	T2	T3
W	0.84*	0.83*	0.78*	0.83*	0.87*	0.85*	0.69*	0.79*	0.84*	0.85*
ε	.89		.84		.97		.94		.87	

Note. Assessment points were shortly before participating in SSL-A (T2; pretest) and shortly after participating in SSL-A (T3; posttest, six months after T2).

The *W* statistic was derived from the Shapiro-Wilk normality test (a *W* with $p < .05$, revealed that the assumption of normal distribution of data cannot be upheld). The Greenhouse-Geisser's ε was used to measure sphericity (an $\varepsilon < .75$, revealed that the assumption of sphericity cannot be upheld).

* $p < .05$.

Table S2C

Statistics derived from testing parametricity regarding the cardiac measures.

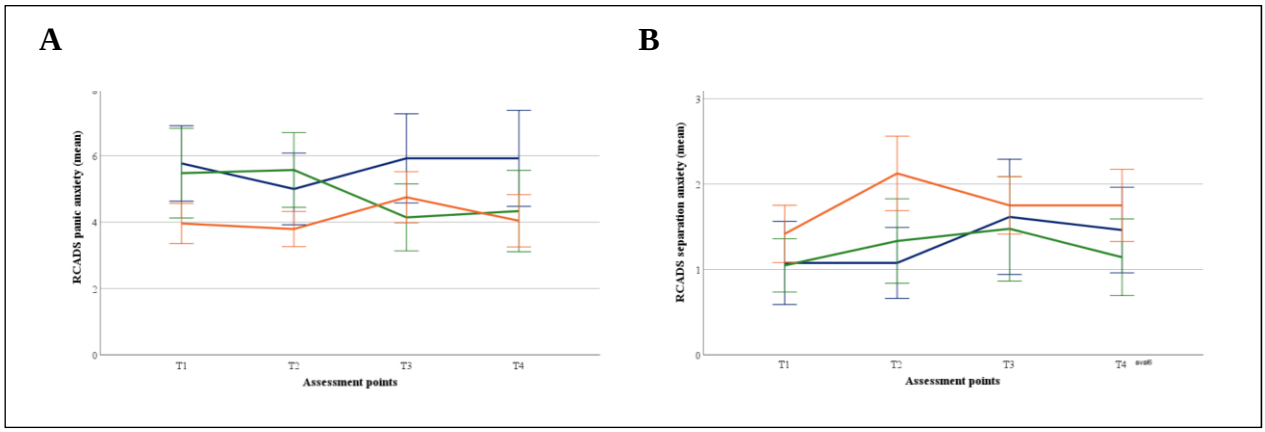
	HR		RMSSD		lnHF		SampEn	
	T2	T3	T2	T3	T2	T3	T2	T3
Reactivity index	0.98	0.95	0.98	0.98	0.96	0.96	0.97	0.96
Recovery index	0.96	0.96	0.96	0.97	0.97	0.97	0.98	0.99

Note. Assessment points were shortly before participating in SSL-A (T2; pretest) and shortly after participating in SSL-A (T3; posttest, six months after T2).

The *W* statistic was derived from the Shapiro-Wilk normality test (a *W* with $p < .05$, revealed that the assumption of normal distribution of data cannot be upheld).

* $p < .05$.

Figure S1. Group-specific course of depression, panic and separation anxiety symptoms across assessment points.



Note. Figure in the A box depicts the course of panic symptoms. Figure in the B box depicts the course of separation anxiety symptoms.

Assessment points were six months before participating in the intervention programmes (T1; baseline), shortly before participating in the intervention programmes (T2; pretest), shortly after participating in the intervention programmes (T3; posttest, six months after T2) and at 6-month follow-up (T4).

Error bars depict the standard error of the mean.

Orange line = waitlist group. Blue line = placebo group. Green line = intervention groups.

RCADS = Revised Child Anxiety Depression Scale.