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Recalling and anticipating positive events to improve the positive affect and mental health of adolescents: A cluster randomized controlled trial in secondary schools☆

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ABSTRACT

This cluster randomized controlled trial examined the effectiveness of Positive Events Training (PET), a combined group training aimed at simultaneously improving positive autobiographical memory (AM) and episodic future thinking (EFT) among adolescents (12–16 years). Delivered as a universal school-based program, PET was compared with an active (creative writing) control group (CREAT). Effects on resilience, wellbeing, positive emotions, emotional response styles towards positive emotions (savoring, dampening), anhedonia, depressive symptoms, and multiple AM and EFT indices were examined. Adolescents ($N_{PET} = 95$, $N_{CREAT} = 93$) completed self-report scales at baseline, post-training and two-month follow-up. Multilevel models revealed that PET led to significant improvements in certain AM and EFT skills. Moreover, a decrease in anhedonia was observed at post-training. However, this effect did not withstand correction for multiple testing. Absence of changes in the other outcomes should be interpreted within the context of the universal school-based approach and the potential limited scope for detectable changes. Exploratory analyses suggest the importance of further investigating PET's potential in addressing positive affect dysregulations in indicated samples, and exploring perceived likelihood of generated future events and dampening as potential underlying mechanisms. Study limitations and future directions to maximize the demonstrated potential of PET are discussed.

1. Recalling and anticipating positive events to improve the positive affect and mental health of adolescents: A cluster randomized controlled trial in secondary schools

Adolescence is a sensitive developmental window associated with an elevated emergence of stress-related mental health problems (Kessler et al., 2005; Solmi et al., 2022). Such problems represent the largest cause of burden of disease among youngsters and, if unaddressed, they can have a severe long-lasting impact on development, educational outcomes and potential to thrive in life (World Health Organization, 2021). However, adolescence is also a decisive period in development, characterized by plasticity across multiple systems, which may confer unique opportunities for strengthening mental wellbeing (Sisk & Gee, 2022). This renders adolescence the ideal life stage during which to adopt a preventative approach with a focus on protective factors, which may complement a traditional treatment approach (i.e., primarily addressing symptoms) to optimally reduce the mental ill-health related burden of disease (Jorm et al., 2017; Waigel & Lemos, 2023).

In the context of stress-related mental health problems, one prime protective factor is resilience. Resilience refers to the capacity to maintain, or to return to, positive mental health following challenging or stressful life events (Dray et al., 2017). In adolescents, stronger resilience is associated with fewer mental health problems (e.g., depression, anxiety), higher mental wellbeing, and higher quality of life (Bottolfs et al., 2020; Mesman et al., 2021; Simón-Saiz et al., 2018). In other words, building resilience may offer the potential to enhance and protect mental wellbeing in adolescents.

A range of factors may contribute to resilience in adolescence. The

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protective function of recalling specific positive memories in the face of stress has been convincingly demonstrated in recent basic research, which indicates it as an important resilience-enhancing factor. For instance, recalling specific positive memories has been found to be related to reduced depressive vulnerability in adolescents with a history of early life stress (Askelund et al., 2019), favorable post-trauma mental health outcomes (Contractor et al., 2020), and the repair of negative mood (Hall et al., 2018). In addition, a buffering effect on physiological and emotional consequences of acute stress has been found, which is reflected in changes in brain activity and connectivity (Speer & Delgado, 2017). Conversely, memory specificity appears to be impaired in adolescents with major depression (Lakshmi et al., 2023). This body of evidence corresponds with recent findings that training the recall of specific positive memories (MEmory Specificity Training, MEST) facilitates disengagement from persistent negative self-thoughts and more swiftly switching towards positive self-thoughts (Belmans et al., 2023), factors presumed crucial for resilience.

Analogously, anticipating specific future positive events also holds promise as a key component of resilience promoting interventions. For instance, basic lab research showed that positive event anticipation led to improved coping with and recovery from acute stress (Monfort et al., 2015). Furthermore, in response to chronic stress, anticipating positive events is related to more adaptive responses (Leslie-Miller et al., 2021). This basic research support for the protective impact of anticipating specific future positive events can be backed up by findings from recent intervention studies. In particular, Future Event Specificity Training (FEST) was found to be effective in community and major depression samples in increasing anticipatory and anticipated pleasure related to future events, and the perception of having control over such events (Hallford, Barry, et al., 2020; Hallford, Rusanov, et al., 2022). These aspects of future-oriented cognition may be important in effectively dealing with stressful events.

As an important aside, AM and EFT specificity are associated with several other AM and EFT characteristics that might be involved in the effectiveness of MEST and FEST programs as well. Specific EFT is associated with high levels of details and mental imagery, which are linked with stronger anticipated and anticipatory pleasure for positive events (Hallford, Barry, et al., 2020; Boland et al., 2018). In addition, increased EFT details tend to be associated with increases in the perceived likelihood of imagined future events (Kahneman & Tversky, 1981), and more perceived control over future events (Boland et al., 2018). Similarly, AM specificity is often related with higher levels of details (Barry et al., 2023), which have been found to be linked with a higher capacity for visual imagery (D'Argembeau & Van der Linden, 2006). Imagery-based processes also play a central role in remembering specific autobiographical events (Holmes et al., 2006) and, compared to verbal processing, mental imagery has been found to evoke stronger affective responses (Holmes et al., 2008).

To the authors' best knowledge, until now research has focused either on improving memory *or* future event specificity, despite the fact that each could bolster mental wellbeing in unique, complementary ways. Whereas (positive) memory specificity has been linked to less negative thinking (Askelund et al., 2019; Belmans et al., 2023), improved problem-solving (Raes et al., 2005; Williams et al., 2007), and positive self-esteem (Liao et al., 2018), positive future specificity has been linked to less impulsive behavior and improved decision-making in adolescents (Bromberg et al., 2015, 2017), and to motivating emotional states to engage in rewarding, more meaningful behaviors that maintain good mental health (Hallford, Farrell, et al., 2022; Sherdell et al., 2012). Therefore, the current study adopts a pioneering approach in testing the effects of a *combi*-training, called Positive Events Training (PET). PET incorporates the enhancement of specificity of *both* past and future positive events into one group training for adolescents.

One possible mechanism via which the recall and anticipation of specific positive events may promote resilience and wellbeing are positive emotions (Askelund et al., 2019; Hallford, Barry, et al., 2020; Hallford, Farrell, et al., 2020; Philippe et al., 2009). Indeed, one key reason why resilient people can quickly bounce back from stressful experiences is their tendency to employ positive emotions in successfully regulating emotional experiences (Tugade & Fredrickson, 2004). Even though thinking about positive past and future events can buffer against stressful life experiences, it is not always a natural way of responding to stress, and it may even be experienced as cognitively taxing and difficult (Westgate et al., 2021). So, training adolescents in recalling and anticipating positive events may make them more inclined and able to resort to this active coping strategy that could boost positive emotions. In this way, positive emotions are believed to be the "royal road" via which PET could benefit resilience and mental wellbeing.

In addition to increasing the mere experience of positive emotions, PET may indirectly cultivate adaptive emotional response styles towards such positive emotions, which is also crucial in the prevention of emotional problems. Two particularly interesting response styles in this regard are dampening and savoring. Youngsters with a tendency to dampen positive emotions (via thoughts like "This good feeling won't last" or "I am not worthy of feeling good") have higher chances to suffer mental ill-health (Bean et al., 2022; Nelis et al., 2015; Nelis et al., 2018). On the other hand, youngsters who typically deploy savoring responses (i.e., amplifying and extending positive emotions) are better off in terms of mental wellbeing (Nelis et al., 2015; Nelis et al., 2018). Sample savoring responses are "I appreciate the small pleasures that life has to offer" or "I am paying attention anytime I experience something positive". In other words, elaborating on past/future positive events and paying attention to related positive emotions during PET may reduce dampening and foster savoring response styles.

Finally, PET may also beneficially impact anhedonia, one of the two core features of depression and which is defined as the lack of interest or pleasure in activities once experienced as pleasurable (American Psychiatric Association, 2022). One key dimension of anhedonia, particularly interesting in the realm of PET, involves difficulties with anticipating pleasure from future events (Phillips & Ahn, 2022). Without perceiving reward or pleasure, young people can become unmotivated, withdrawn, and hopeless (Watson et al., 2020). Indeed, anhedonia can greatly reduce quality of life and day-to-day functioning (Vinckier et al., 2017). It is also linked with common mental illness (Hallford & Sharma, 2019), including depression in adolescents (Lakshmi et al., 2023) and suicidality independently of other common mental illness symptoms (Ducasse et al., 2018). The ability to imagine positive future events, which is targeted in PET, is linked with both the anticipation and present-moment experience of pleasure (Hallford, Barry, et al., 2020) and so carries the potential to reduce anhedonia.

Based on the above, we first hypothesized that PET would strengthen resilience (Hypothesis 1, H1) and improve mental wellbeing (H2; *primary outcomes*). Second, positive emotions were hypothesized to be the "royal road" via which PET would operate (*secondary outcomes*). In particular, PET was expected to directly increase present-moment experiences of positive emotions (H3), to install more adaptive positive emotion regulation strategies (decrease dampening, H4a, and improve savoring, H4b), and to reduce impairments in anhedonia (H5). Finally, we explored whether PET's expected beneficial impact on the outcomes above would generalize to psychological distress, depressive symptoms in particular (*exploratory secondary outcomes*), and positive memory and future thinking specificity and related indices were expected to improve due to PET (*manipulation checks*).

2. Method

2.1. Research design

This cluster randomized controlled trial (c-RCT) employed a 2 x 3 factorial design (condition: PET vs. CREAtive writing Training (CREAT) as active control; time points: baseline, post-training, two-month follow-up). An independent statistician conducted the random allocation of the pairs of classes of the same secondary school via a computerized random number generator and communicated the results to author FR (principal investigator). After baseline assessment, FR informed author and trainer EL.

2.2. Participant characteristics

In total, 188 adolescents participated in the study, of which 95 participants were in the PET group ($M_{age} = 13.2$, $SD_{age} = 1.00$; 73.6% females, 25.3% males, 2.1% other) and 93 participants in the CREAT group ($M_{age} = 13.3$, $SD_{age} = 1.08$; 76.3% females, 22.6% males, 1.1% other). The majority of adolescents of both groups were of Belgian ethnicity (PET: 70.53%, CREAT: 59.14%). The remaining part indicated at least one additional ethnicity (e.g., Dutch, Italian, Moroccan; PET: 17.89%, CREAT: 23.65%), or one or two other than Belgian ethnicities (e.g., Moroccan, Turkish, Congolese; PET: 11.58%, CREAT: 16.13%).

2.3. Sampling procedure

Upon ethical approval (Social and Societal Ethics Committee, KU Leuven), the study was preregistered on the Open Science Framework prior to recruitment commencing (https://osf.io/6acy2). During data collection, the study was additionally registered as a clinical trial on ClinicalTrials.gov (NCT05757180). Both timestamped registrations can be considered equivalent, with the initial preregistration being even more exhaustive. The Dutch-speaking participants were recruited via secondary schools in Flanders, Belgium. Each participating school selected one pair of parallel classes of the first and second grade of general education. Next, adolescents were invited for study participation (i.e., in-class information session, with distribution of informed consent forms for adolescents and parents). Full study participation was rewarded with a €25-voucher for a local online store. In case of study withdrawal, reward was contingent on the actual time investment. In total, five schools, spread across three provinces, completed all study phases between January and May 2023 (i.e., two pairs of classes of the first year, one of the second year, and two of the third year; Table S1, Supplementary Material).

2.4. Sample size

Initial sample size planning was based on paired *t*-tests (G*Power 3.1.9.4) taking into account the dependence of data of the same individual across time points, and yielded an estimated required sample size of 130 adolescents. The following parameters were used: $\alpha_{Bonferroni\ corrected} = .05/6 = .008$ (rather conservative method to control for likelihood of a Type I error), $\beta = .80$, and estimated small-to-medium effect sizes ($d = 0.35$). In anticipation of drop-out, we employed a deliberate oversampling strategy of 15% (based on prior work of our lab in a school setting), resulting in an intended sample of 150 participants. A secondary more precise post-hoc analysis was run for repeated measures ANOVAs. This approach took into account the presence of time as a within- and group as between-subjects factor. For similar parameter settings (Cohen's $f = 0.175$) and estimated correlations of .50/.25 among repeated measures, this approach yielded a required sample of 82/122 which fell below the a priori determined sample size.[1]

2.5. Data collection and measures [2]

At each time point, participants completed a series of self-report scales via Qualtrics.com. All scales were uniformly rated based on experiences over the past two weeks to allow change detection within the study timeframe. If necessary, original scale instructions were adjusted accordingly. In the current sample, internal consistencies across time points for the manipulation checks and related indices ranged from acceptable to good ($\alpha = .70$-$.90$; Table S3, Supplementary Material). The vast majority of primary and secondary outcome measures demonstrated good to excellent internal consistencies across time points ($\alpha = .75$-$.95$).

2.5.1. Manipulation checks

Positive memory specificity was measured via the Autobiographical Memory (AM) Test (AMT; Raes, Williams, & Hermans, 2009), with the original instructions slightly adapted. That is, participants were prompted to retrieve positive specific memories in response to cue words (four positive and four neutral ones, presented alternately). In a similar way, positive future event specificity was assessed via the Episodic Future Thinking Test (EFT-T; Hallford, Takano, et al., 2019). Blinded for condition, author EL coded specificity (specific vs. non-specific) using existing coding templates (Raes, Williams, & Hermans, 2009; Hallford, Yeow, et al., 2020). Independently, author LB rated 15% of the retrieved memories and generated future events for each time point. Inter-rater reliability reflected excellent agreement (Cohen's $\kappa_{AMT} = .86$-$.90$, $\kappa_{EFT\text{-}T} = .75$-$.87$).

Simulated future events and retrieved memories were accompanied by single-item rating scales ranging from 1 (*not at all*) to 9 (*very much*). In line with the study of Hallford, Yeow, et al. (2020), participants rated the index of detail (IoD), mental imagery (MI), anticipated (AdP) and anticipatory pleasure (AyP), and perceived control (PC) and perceived likelihood of occurrence (PLO) associated with the generated future events on the EFT-T. In an analogous way, participants rated the index of detail (IoD) and mental imagery (MI) used, and levels of remembered (RP) and felt pleasure (FP) related to the retrieved memories on the AMT. Erroneous ratings by irrelevant answers (e.g., "I cannot think of anything") were considered as missing values. More information about the cue word sets and single-item rating scales is provided as Supplementary Material.

2.5.2. Primary outcomes

Resilience was assessed via the short version of the Connor-Davidson Resilience Scale (CD-RISC; Campbell-Sills & Stein, 2007; Connor & Davidson, 2003; translated into Dutch by Danhof-Pont & Schrier, 2006, 2010). Statements of this 10-item scale (e.g., "I am able to adapt to change") are rated on a 5-point scale ranging from 1 (*not at all*) to 5 (*very often*), with higher scores reflecting higher levels of resilience.

Mental wellbeing was measured via the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS; Ikink et al., 2012; Stewart-Brown et al., 2009). This self-report scale comprises seven statements (e.g., "I have been feeling relaxed") rated on a 5-point scale ranging from 1 (*never*) to 5 (*always*). Higher scores indicate higher self-reported wellbeing.

[1] The potential reduction of power due to reliance on a cluster randomized controlled trial was evaluated in a post-hoc way and is discussed as a study limitation.

[2] Table S2 in the Supplementary Material provides an overview of all included measures for the primary, secondary and manipulation check related outcomes. Additional information about the psychometric properties of the included measures is provided in the Supplementary Material as well.

2.5.3. Secondary outcomes

Positive affect was assessed via the Positive Affect subscale of the Positive and Negative Affect Schedule Scales (PANAS; Engelen et al., 2006; Watson et al., 1988). The extent to which 10 positive feelings (e.g., "enthusiastic") were experienced are rated on a 5-point scale ranging from 1 (*rarely*) to 5 (*very often*), with higher scores reflecting higher positive affect.

Positive emotion regulation strategies were primarily measured via the child version of the Responses to Positive Affect scale (RPA-C; Feldman et al., 2008; Raes et al., 2009; Bijttebier et al., 2012), consisting of items reflecting dampening thoughts (7 items) and savoring (or positive rumination; 9 items). Respective sample items are "When you felt happy, how often did you think about the things that could go wrong?" and "… how often did you notice that you felt full of energy?". Items are rated on a 4-point scale ranging from 1 (*not at all*) to 4 (*very often*), with higher scores reflecting a higher tendency towards dampening and savoring respectively. Two additional measures were used to assess dampening and savoring more broadly. The Leuven Exeter Dampening Scale (LEDS, Bogaert et al., 2023, *manuscript in preparation*, see Supplementary Material) consists of 13 items rated on a 5-point scale ranging from 1 (*not at all*) to 5 (*very often*). The 10 savoring items of the abridged Ways of Savoring Checklist for Adolescents (not yet validated in Dutch) taps into diverse savoring strategies (WOSC; Chadwick, 2012). Items (e.g., "I looked for other people to share it with") are rated on a 7-point scale ranging from 1 (*totally disagree*) to 7 (*totally agree*). Higher scores reflect higher levels of engagement in the respective emotion regulation strategy.

Anhedonia was assessed via the Leuven Anhedonia Self-report Scale (LASS, second version; Bastin et al., 2018), which consists of 12 items (e.g., "There are few things I looked forward to") to be rated on a 5-point scale ranging from 1 (*completely untrue for me*) to 5 (*completely true for me*). Higher scores reflect higher levels of anhedonia related symptoms.

Psychological distress was measured via the Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995). All 21 items were rated on a 4-point scale going from 0 (*never*) to 3 (*almost always*). This scale consists of three subscales reflecting depressive symptoms, symptoms of anxiety and stress symptoms (7 items per subscale), with higher scores reflecting higher levels of the respective symptomatology.

2.5.4. Adherence, generalizability to real-life, and acceptability

At post-training and follow-up, adherence to the training (i.e., active attitude during the sessions, completion of homework between sessions and use of extra material during follow-up) was assessed using a 10-point rating scale from 0 (*not at all*) to 10 (*extremely applicable*). In addition, open questions asked about generalizability to real-life and acceptability of the training (e.g., "Have you experienced any impact of the training you followed? If so, in which way?", "What did you experience as (not) helpful?").

2.6. Group trainings

PET is a group-based training uniting elements from MEST (Raes, Williams, & Hermans, 2009) and FEST (Hallford, Yeow, et al., 2020). It comprises four in-class sessions (50 min/week, for four consecutive weeks), delivered in a standardized manner (manual and worksheets: https://osf.io/yj3zr/). The first two sessions focus on sharpening positive memory specificity, and the last two sessions on enhancing positive future event specificity. The in-class training was supplemented with worksheets to encourage practice at home, which closely resembled the exercises used during the training. Finally, at the end of the PET, extra material was offered for continuation of practicing (without obligation).

The active control CREAT, delivered in a standardized way (https://osf.io/yj3zr/), followed the same format and length as PET. Participants trained their creative writing skills via exercises using funny and thought-provoking writing prompts. Similar to PET, participants received information about the beneficial impact of creative writing for mental wellbeing due to the cultivation of creativity and imagination skills. A comparable program had been successfully implemented in a controlled trial before (Belmans et al., 2023). A session-by-session overview for both trainings can be found in Table S4 (Supplementary Material).

2.7. Data analytic strategy

Analyses were completed in accordance with the CONSORT standards, using intention-to-treat (ITT) analysis. For each outcome, a multilevel model[3] (MLM) was run via the lme4 R package (version 0.6.7; Bates et al., 2015), with (a) time point coded by dummy variables (T2 and T3), (b) condition, and (c) their cross-level interactions as predictors. Time points (Level 1) were nested within persons (Level 2), which were nested within schools (Level 3). Uncorrected *p*-values were compared with $\alpha = .05$. If relevant, the Benjamini-Hochberg's (BH) corrected significance level threshold is reported (Benjamini & Hochberg, 1995; q_{BH}). In addition, 95% confidence intervals (CIs) were generated via wild bootstrapping (lmeresampler R package, Loy & Korobova, 2021), as this approach does not require distributional assumptions on the error terms or homoscedasticity (Modugno & Giannerini, 2015). Details about model composition and applied BH-correction can be found in the Supplementary Material.

3. Results

3.1. Preliminary analyses

Fig. 1 presents the participant flow. Only a small number of participants discontinued the assigned training ($n_{PET} = 1$, $n_{CREAT} = 5$; no formal reason for study withdrawal, cf. informed consent) and the vast majority attended all sessions. No (emerging) adverse events or safety issues were observed. A subset of participants missed one of the sessions ($n_{PET} = 23$ (24.21%), $n_{CREAT} = 12$ (12.90%)) due to unforeseen circumstances (e.g., illness). As the training consisted of two similarly structured parts covering past and future events, the impact of missing a session should be relatively limited. A few participants did not attend two or more sessions ($n_{PET} = 3$, $n_{CREAT} = 1$). It cannot not be guaranteed that they received all crucial instructions and had sufficient opportunities to practice under supervision of the trainer. However, given the small number and following the ITT principle, they were included in the analyses. Except for missing values due to formal study withdrawal, missing values mainly resulted from absence from school on the day of testing. Model-specific Cook's distances did not show influential observations (performance R package, version 0.10.2; Lüdecke et al., 2021).

The training groups did not differ on age ($t(183) = 0.68$, $p = .50$), self-identified gender ($\chi^2(2) = 2.18$, $p = .34$) or ethnicity ($\chi^2(21) = 24.01$, $p = .29$). Table 1[4] (*primary and secondary outcomes*) and Table S6 (Supplementary Material, *manipulation checks*) present descriptive statistics. For the majority of the study variables, standardized mean differences (SMDs) showed no baseline imbalance (SMD <0.10; Schober & Vetter, 2019). Some baseline imbalance was found for dampening,

[3] Mixed ANOVAs and multilevel models (MLMs) were preregistered. However, following this registration, it was understood that only the MLMs would accurately take into account the repeated measure nature of the study and the nested data structure of the cluster design. The results of the mixed ANOVAs (time as within-, condition as between-subjects factor) were not reported as they did not accurately take into account the nested data structure. For the sake of transparency, none of the models revealed significant time × condition interaction effects.

[4] Table S5 provides the same information as Table 1 but with sum scores. Comparison with available normative data is provided in the Supplementary Material.

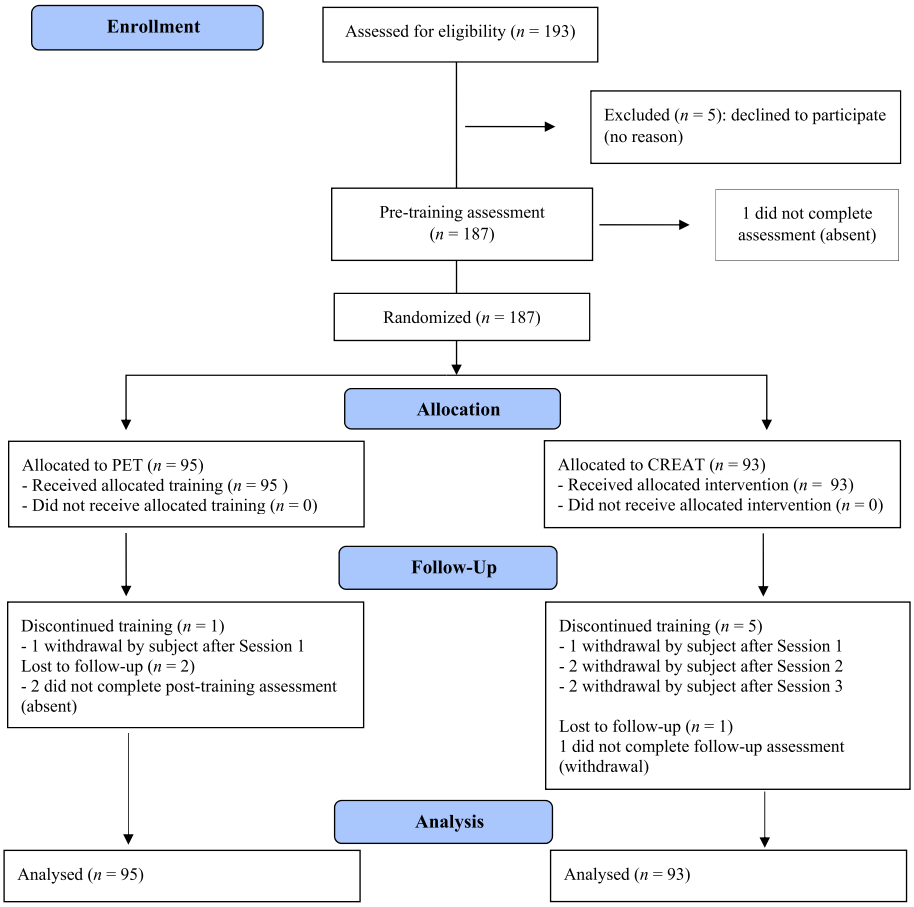

Fig. 1. CONSORT flowchart of participants.

depressive symptoms, symptoms of anxiety, and reported levels of mental imagery on the AMT (SMD = 0.10-0.17) and for symptoms of stress (SMD = 0.24). For all those variables, higher mean scores were observed for the CREAT group. Table S7 presents baseline correlations for all study variables (Supplementary Material).

3.2. Data analyses

3.2.1. Manipulation checks and main analyses [5]

Detailed findings for the manipulation checks are presented in Table S8 (Supplementary Material). In sum, at post-training (T2) and at follow-up (T3), MLMs found significant fixed effect estimates for the time × condition interactions in favor of PET for EFT specificity ($ps < .05$, $< q_{BH\ T2} = .02$, $< q_{BH\ T3} = .007$; small-to-medium effects sizes, $\eta^2_{partial\ T2} = .05$, $\eta^2_{partial\ T3} = .04$) and AMT specificity ($ps < .016$, $< q_{BH\ T2} = .01$, $< q_{BH\ T3} = .02$; small(-to-medium) effects sizes, $\eta^2_{partial\ T2} = .03$, $\eta^2_{partial\ T3} = .02$). For EFT perceived control (PC) and likelihood of occurrence (PLO), significant time × condition interactions were observed at post-training ($ps < .05$, $< q_{BH\ T2} = .02$; small effect size, $\eta^2_{partial\ T2} = .02$) in favor of PET. For AMT mental imagery (MI), a significant time × condition interaction was found at follow-up ($p < .05$, $< q_{BH\ T3} = .02$; small effect size, $\eta^2_{partial\ T3} = .02$) in favor of PET. Finally, a marginally significant time × condition interaction for AMT felt pleasure (FP) was found at follow-up ($p = .03$, $> q_{BH\ T3} = .02$; small effect size, $\eta^2_{partial\ T3} = .01$) in favor of PET.

As to the primary and secondary outcomes, Table 2 summarizes the estimates of the fixed effects of the MLMs. In sum, for none of the outcomes significant time × condition interactions were found at post-training or follow-up ($ps > .05$), indicating the absence of significant differences between conditions in terms of changes across time. Noteworthily, the time × condition interaction at post-training for anhedonia in favor of PET ($p = .04$; small effect size, $\eta^2_{partial\ T2} = .02$), became non-significant after correction for multiple testing ($> q_{BH\ T2} = .006$). At follow-up, the time × condition interaction for anhedonia was associated with a small effect size ($\eta^2_{partial\ T3} = .02$) but did not reach statistical significance ($p = .08$).

3.2.2. Exploratory analyses

Moderation Analyses. Post-hoc analyses explored whether the absence of significant differences between conditions across time could be explained by moderating variables. It could be that especially adolescents who suffer from symptoms reflecting mental health impairments benefit (more) from PET. To test this possibility, depressive symptoms (measured via the corresponding DASS-21 subscale; Lovibond & Lovibond, 1995) and anhedonia were used as proxies for mental health impairments. That is, baseline levels of both proxies were separately included as additional predictors in the MLMs for each dependent variable (DV), and we were interested in testing three-way interactions in those extended models (time x condition x baseline symptomatology). Importantly, only for baseline depressive symptoms[6] as a moderator, detected significant three-way interaction effects were confirmed via the

[5] Adjusting the sample composition based on participants' answers to instructional manipulation checks (e.g., "Please mark the first answer option") did not affect our conclusions in any notable way (details, Supplementary Material).

[6] Descriptive statistics and information on data distribution can be found in Table S5 (Supplementary Material).

Table 1
Descriptive statistics for the means of primary and secondary outcomes by condition.

	PET (intervention)						CREAT (control)					
	T1		T2		T3		T1		T2		T3	
	M (SD)	Range	*M (SD)*	Range	*M (SD)*	Range	*M (SD)*	Range	*M (SD)*	Range	*M (SD)*	Range
1. CD_RISC (resilience)	3.32 (0.60)	1.80–4.50	3.31 (0.59)	1.80–4.60	3.40 (0.62)	1.60–5.00	3.29 (0.61)	1.90–4.80	3.25 (0.62)	1.90–4.80	3.26 (0.58)	1.80–5.00
2. SWEMWBS (wellbeing)	3.51 (0.70)	1.14–5.00	3.60 (0.59)	1.71–5.00	3.68 (0.61)	1.71–5.00	3.49 (0.71)	1.57–5.00	3.53 (0.65)	2.14–5.00	3.63 (0.63)	2.14–5.00
3. PANAS (positive affect)	3.29 (0.64)	1.20–4.40	3.36 (0.66)	1.30–4.70	3.49 (0.65)	1.30–4.80	3.34 (0.68)	2.00–5.00	3.35 (0.70)	1.40–5.00	3.46 (0.71)	1.30–5.00
4. RPA-D * (dampening)	2.20 (0.59)	1.00–3.43	2.04 (0.62)	1.00–3.29	2.03 (0.65)	1.00–3.43	2.26 (0.59)	1.00–3.71	2.11 (0.72)	1.00–3.57	2.10 (0.77)	1.00–4.00
5. LEDS * (dampening)	1.85 (0.72)	1.00–4.15	1.65 (0.70)	1.00–4.38	1.61 (0.67)	1.00–4.54	1.96 (0.81)	1.00–4.62	1.90 (0.81)	1.00–4.38	1.74 (0.78)	1.00–4.62
6. RPA-S (savoring)	2.39 (0.61)	1.11–3.67	2.42 (0.64)	1.22–4.00	2.59 (0.68)	1.33–3.89	2.40 (0.59)	1.22–4.00	2.43 (0.60)	1.11–3.67	2.53 (0.61)	1.11–4.00
7. WOSC (savoring)	4.22 (0.96)	1.50–6.10	4.21 (1.07)	1.00–6.40	4.20 (1.06)	1.70–6.50	4.19 (0.99)	1.20–6.40	4.12 (1.00)	1.30–6.70	4.26 (1.05)	1.30–7.00
8. LASS (anhedonia)	2.26 (0.97)	1.00–4.92	2.07 (0.86)	1.00–4.83	1.98 (0.89)	1.00–4.42	2.27 (0.88)	1.00–4.58	2.33 (0.91)	1.00–4.42	2.23 (0.97)	1.00–4.58
9. DASS-d * (depressive symptoms)	0.70 (0.65)	0–2.86	0.59 (0.59)	0–3.00	0.57 (0.61)	0–2.43	0.80 (0.72)	0–3.00	0.81 (0.68)	0–2.43	0.78 (0.74)	0–2.71
10. DASS-a * (symptoms of anxiety)	0.87 (0.71)	0–2.86	0.74 (0.59)	0–2.71	0.76 (0.66)	0–2.71	1.00 (0.80)	0–3.00	0.98 (0.79)	0–2.86	0.93 (0.78)	0–2.86
11. DASS-s ** (stress symptoms)	0.96 (0.67)	0–2.71	0.85 (0.58)	0–2.57	0.82 (0.62)	0–2.71	1.13 (0.69)	0–3.00	1.14 (0.70)	0–2.57	1.05 (0.71)	0–3.00

Note. Mild and moderate baseline imbalance ($N_{PET} = 95$, $N_{CREAT} = 93$), determined based on the conventional cut-off for standardized mean differences of 0.10 (Schober & Vetter, 2019), are indicated by * (between 0.10 and 20) and ** (≥0.20) respectively. Table S5 (Supplementary Material) provides similar descriptive statistics for the sum scores.

bootstrapped 95% CIs, which rules out potential confounding effects related to assumption violations. Therefore, only results for this moderator were reported. From the included outcomes, significant three-way interaction effects were detected only for positive emotions and anhedonia as DVs.

In particular, for positive emotions at follow-up (DV), a significant three-way-interaction was found via the extended MLM, which withstood correction for multiple testing (Est. $_{T3:Condition:BaselineDepressiveSymptoms} = 0.57$, SE $= 0.17$, $t(262.75) = 3.36$, $p < .001$, $< q_{BH\ T3} = .006$, 95% CI $_{bootstrapped}$ [0.22; 0.94]). For the sake of interpretation, follow-up (T3) simple slope analyses were run based on grand mean (*GM*) centered baseline depressive symptom levels (i.e., *GM*, $GM \pm 1\ SD$; $GM = 10.33$, $SD = 9.42$, range = 0–42; via the interactions R package, version 1.1.5, Long, 2019). Full results are reported in the Supplementary Materials. In short, for adolescents with moderate baseline depressive symptom levels, according to the cut-offs of Lovibond and Lovibond (1995), the T3-slope estimate for PET was significant ($p < .05$), and the 95% CIs for both groups did not overlap (95% CI $_{PET}$ [0.29; 0.76], 95% CI $_{CREAT}$ [−0.16; 0.26]). This suggests that, for adolescents with elevated depressive symptoms, PET might be preferable to CREAT in terms of its ability to boost positive emotions. For mild levels of baseline symptoms, both trainings might be equally effective (*ps* < .05; 95% CI $_{CREAT}$ [0.06; 0.38], 95% CI $_{PET}$ [0.15; 0.46]). For normal levels, the T3-slope estimate was only significant ($p < .05$) for CREAT. However, the overlap of the 95% CIs for both conditions precludes a sound interpretation in terms of superiority of one training above the other (95% CI $_{CREAT}$ [0.15; 0.62], 95% CI $_{PET}$ [−0.13; 0.31]).

For anhedonia at post-training and follow-up (DV), significant three-way-interactions were detected via the extended MLMs (*ps* < .05; confirmed via the 95% CIs $_{bootstrapped}$). However, they did not withstand correction for multiple testing (Supplementary Material[7]). Nevertheless, it is worth mentioning that, notwithstanding the non-significance after correction for multiple testing, the follow-up (T2 and T3) simple slope analyses pointed towards PET's potential superiority for adolescents with mild or moderate baseline depressive symptom levels. For CREAT, no significant symptom improvements were found.

Mediation Analyses. Exploratory simple mediation analyses were run using structural equation modeling (lavaan R package, Rosseel, 2012). In this way, we explored whether putative change processes (i.e., EFT and AMT specificity, EFT perceived control and perceived likelihood of occurrence, on which significant changes were observed) could act as mediators for the suggested trend towards lower anhedonia at post-training for PET ($p = .04 > q_{BH\ T2} = .006$; small effect size, $\eta^2_{partial\ T2} = .02$). We also explored the role of dampening (measured via the LEDS, *manuscript in preparation*) as a potential change process, given the trend towards a small, albeit not significant, time × condition interaction effect ($\eta^2_{partial\ T2} = .01$; $p = .12$) at post-training via the MLM analysis. Details are reported in the Supplementary Materials. In short, results for the indirect (a*b) path suggested that the trend towards lower anhedonia levels at post-training in the PET group might be partially accounted for by effects on increasing the perceived likelihood of future events (Est. $_{a*b} = -0.05$, SE $= 0.02$, $p = .03$, 95% CI [−0.05; −0.005] and reducing dampening (Est. $_{a*b} = -0.12$, SE $= 0.05$, $p = .04$, 95% CI [−0.14; −0.007]). None of the other tested indirect effects approached significance (*ps* > .16). Importantly, these post-hoc findings should be interpreted with caution (e.g., multilevel data structure could not be taken into account, no BH-correction). Nonetheless, they might be informative for future research on potential underlying mechanisms of PET.

[7] We decided to mention these findings and fully report on them in the Supplementary Materials, because the applied correction for multiple testing might be relatively conservative in the light of a recent recommendation (see *Discussion*).

Table 2
Main and interaction fixed effects of multilevel model estimating primary and secondary outcomes.

	Resilience (H1)			Wellbeing (H2)			Positive Emotions (H3)		
	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$
Intercept	2.56 (0.93) [0.96; 4.15]	2.75 (.04)* 5.00		3.08 (1.19) [0.90; 4.90]	2.59 (.04)* 6.29		4.07 (1.08) [2.49; 5.75]	3.78 (.01)* 5.43	
Age	−0.15 (0.07) [−0.28;−0.03]	−2.12 (.08) 5.66		−0.20 (0.09) [−0.34; 0.03]	−2.23 (.06) 6.89		−0.28 (0.08) [−0.41;−0.15]	−3.44 (.01)* 5.99	
Gender	−0.74 (0.15) [−0.99;−0.45]	−4.82 (<.001)** 153.10		−0.70 (0.16) [−1.00;−0.44]	−4.51 (<.001)** 159.59		−0.51 (0.15) [−0.73;−0.20]	−3.44 (<.001)** 161.63	
T2	−0.02 (0.08) [−0.19; 0.16]	−0.30 (.76) 348.90		0.10 (0.08) [−0.05; 0.27]	1.19 (.23) 160.89		0.06 (0.08) [−0.06; 0.19]	0.75 (.46) 19.11	
T3	−0.0007 (0.08) [−0.17; 0.15]	−0.002 (.99) 349.00		0.25 (0.09) [0.05; 0.41]	2.89 (.008)* 23.54	.49	0.22 (0.08) [0.03; 0.41]	2.63 (.009)* 262.18	.39
Condition	0.008 (0.14) [−0.27; 0.24]	0.06 (.96) 271.20		0.003 (0.14) [−0.31; 0.25]	0.02 (.98) 260.14		−0.11 (0.13) [−0.33; 0.14]	−0.87 (.39) 252.03	
T2:Condition	0.02 (0.11) [−0.19; 0.18]	0.18 (.86) 348.00	<.001	0.03 (0.11) [−0.18; 0.23]	0.22 (.83) 160.42	<.001	0.04 (0.10) [−0.12; 0.20]	0.36 (.72) 179.20	<.001
T3:Condition	0.15 (0.11) [−0.09; 0.42]	1.34 (.18) 347.80	.005	−0.02 (0.12) [−0.28; 0.25]	−0.16 (.88) 276.97	<.001	0.07 (0.11) [−0.16; 0.25]	0.65 (.52) 263.62	.002
	Dampening (RPA−C; H4a)			Dampening (LEDS; H4a)			Savoring (RPA−C; H4b)		
	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$
Intercept	−1.66 (1.47) [−3.34; 0.01]	−1.13 (.40) 1.54		−0.52 (1.19) [−1.92; 1.33]	−0.44 (.71) 183.40		2.01 (1.16) [0.08; 3.53]	1.73 (.11) 10.72	
Age	0.13 (0.11) [0.0004; 0.26]	1.19 (.38) 1.60		0.07 (0.09) [−0.05; 0.17]	0.78 (.52) 1.91		−0.12 (0.09) [−0.24; 0.04]	−1.36 (.20) 11.20	
Gender	0.30 (0.16) [0.01; 0.56]	1.87 (.06) 136.59		−0.0003 (0.17) [−0.30; 0.34]	−0.002 (.99) 128.70		−0.68 (0.15) [−1.01;−0.44]	−4.56 (<.001)** 175.50	
T2	−0.23 (0.18) [−0.60; 0.04]	−1.25 (.21) 179.71		0.09 (0.18) [−0.39; 0.35]	0.49 (.63) 342.60		0.22 (0.16) [−0.12; 0.47]	1.37 (.17) 178.20	
T3	−0.25 (0.23) [−0.70; 0.23]	−1.10 (.28) 168.45		−0.26 (0.19) [−0.80; 0.13]	−1.38 (.17) 101.00		0.26 (0.20) [−0.18; 0.59]	1.29 (.20) 235.43	
Condition	−0.07 (0.14) [−0.29; 0.23]	−0.47 (.64) 241.36		−0.14 (0.15) [−0.48; 0.05]	−0.99 (.32) 257.90		−0.02 (0.14) [−0.20; 0.23]	−0.16 (.88) 28.67	
T2:Condition	−0.001 (0.12) [−0.17; 0.19]	−0.12 (.99) 136.86	<.001	−0.18 (0.12) [−0.35; 0.12]	−1.55 (.12) 193.70	.01	−0.08 (0.10) [−0.25; 0.14]	−0.83 (.41) 177.92	.004
T3:Condition	−0.004 (0.14) [−0.29; 0.26]	−0.3 (.98) 241.60	<.001	−0.03 (0.12) [−0.26; 0.27]	−0.22 (.83) 100.20	<.001	0.03 (0.13) [−0.21; 0.29]	0.22 (.83) 75.20	<.001

	Savoring (WOSC; H4b)			Anhedonia (H5)			Depressive Symptoms		
	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$
Intercept	−0.24 (1.31) [−1.99; 1.97]	−0.19 (.85) 22.39		−2.75 (1.07) [−4.32;−1.06]	−2.57 (.051) 4.91		−0.22 (0.99) [−2.14; 1.68]	−0.22 (.84) 2.89	
Age	1.1 (0.10) [−0.14; 0.14]	0.14 (.89) 23.07		0.21 (0.08) [0.08; 0.36]	2.68 (.04)* 5.13		0.03 (0.07) [−0.09; 0.17]	0.45 (.67) 3.00	
Gender	0.008 (0.16) [−0.28; 0.38]	0.05 (.96) 181.93		0.02 (0.16) [−0.28; 0.29]	0.11 (.91) 151.89		0.11 (0.16) [−0.20; 0.42]	0.64 (.52) 127.58	
T2	−0.09 (0.20) [−0.46; 0.21]	−0.45 (.66) 186.16		0.24 (0.16) [−0.03; 0.57]	1.48 (.14) 175.30		0.15 (0.18) [−0.24; 0.51]	0.82 (.41) 177.98	
T3	0.19 (0.22) [−0.20; 0.55]	0.85 (.40) 268.70		0.17 (0.19) [−0.16; 0.58]	0.87 (.39) 172.56		0.19 (0.21) [−0.38; 0.75]	0.91 (.36) 140.35	
Condition	0.07 (0.16) [−0.23; 0.27]	0.40 (.69) 26.01		−0.01 (0.14) [−0.30; 0.28]	−0.09 (.93) 203.04		−0.16 (0.14) [−0.48; 0.08]	−1.11 (.27) 249.09	
T2:Condition	1.2 (0.13) [−0.21; 0.27]	0.27 (.79) 145.83	<.001	−0.22 (0.10) [−0.44;−0.04]	−2.10 (.04)(*) 174.89	.02	−0.15 (0.12) [−0.37; 0.08]	−1.25 (.21) 110.55	.01
T3:Condition	−0.11 (0.14) [−0.36; 0.17]	−0.82 (.42) 269.36	.002	−0.22 (0.13) [−0.47; 0.03]	−1.78 (.08) 90.89	.03	−0.19 (0.13) [−0.50; 0.15]	−1.48 (.14) 259.22	.008

	Symptoms of Anxiety			Stress Symptoms		
	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$	Est. (SE) 95% CI $_{bootstrapping}$	*t (p)* *df*	$\eta^2_{partial}$
Intercept	−0.65 (1.31) [−1.99; 1.31]	−0.50 (.63) 6.64		0.34 (0.95) [−1.54; 1.80]	0.36 (.74) 3.39	
Age	0.05 (0.10) [−0.10; 0.15]	0.55 (.60) 6.91		−0.006 (0.07) [−0.12; 0.14]	−0.08 (.94) 3.52	
Gender	0.39 (0.17) [0.17; 0.70]	2.35 (.02)* 165.17		0.23 (0.16) [−0.13; 0.55]	1.43 (.16) 124.44	
T2	0.008 (0.17) [−0.34; 0.32]	0.05 (.96) 171.80		0.09 (0.18) [−0.16; 0.41]	0.52 (.60) 181.99	
T3	−0.07 (0.20) [−0.44; 0.26]	−0.36 (.72) 261.64		−0.02 (0.20) [−0.41; 0.34]	−0.09 (.93) 80.15	
Condition	−0.17 (0.14) [−0.45; 0.17]	−1.23 (.22) 242.53		−0.24 (0.15) [−0.56; 0.08]	−1.65 (.10) 244.72	
T2:Condition	−0.07 (0.11) [−0.27; 0.15]	−0.65 (.52) 171.38	.002	−0.11 (0.11) [−0.29; 0.05]	−1.02 (.31) 138.85	.007
T3:Condition	−0.03 (0.12) [−0.27; 0.21]	−0.23 (.83) 262.26	<.001	−0.08 (0.12) [−0.33; 0.18]	−0.73 (.47) 270.04	.002

Note. $N_{PET} = 95$; $N_{CREAT} = 93$; *$p < .05$; **$p < .001$; Est. = Estimate, SE = Standard Error; $\eta^2_{partial} = .01$ (small effect size), $\eta^2_{partial} = .06$ (medium effect size), $\eta^2_{partial} \geq .14$ (large effect size); p = uncorrected p-values; (*) no longer significant when comparing with $q_{BH\ corrected} = 0.006$ following Benjamini-Hochberg's procedure (1995).

3.2.3. Adherence, generalizability to real-life, and acceptability

The vast majority of adolescents of both groups reported being "considerably" to "very adherent" to the training and the homework (±90% indicated ≥5 on the 10-point scale). About half of them continued practicing after the end of the training, and actively continued using the acquired skills in daily life (≥5 on the 10-point scale).

Concerning generalizability to real-life, a substantial minority of the adolescents of both groups experienced some impact at post-training (40–50%) and follow-up (30–40%). For the two groups, descriptions of experienced changes considerably overlapped (e.g., feeling generally better, started to talk/write about feelings, thinking in a more positive way), but also a few unique experienced changes were mentioned (e.g., PET: better at imagining the future; CREAT: became more creative). Concerning descriptions of experienced changes in general wellbeing, about 20–30% for both groups noticed some improvement, but the reported improvements for both groups were almost indistinguishable (e.g., feeling better, thinking in a more positive way, calmer/less stressed).

Finally, based on adolescents' evaluation of the training in terms of it being "(not) helpful" or "interesting", the trainings can be considered as sufficiently acceptable. Several adolescents provided suggestions to improve the trainings, which are of considerable value in finetuning them for future implementation. We present a complete overview of these summarized findings in Table S9 (Supplementary Materials).

4. Discussion

This c-RCT in secondary schools is the first of its type to assess the impact of PET, a combined past and future autobiographical thinking training (vs. active control group), on resilience, mental wellbeing, positive emotions and related outcomes in adolescents. As for the manipulation checks, PET (vs. the active control group) clearly resulted in small(-to-medium) sized improvements in AM and EFT specificity, both at the end of the training and after the two-month follow-up. In addition, for the PET condition, significant small-sized increases in levels of perceived control (EFT PC) and likelihood of occurrence related to the generated future events (EFT PLO) were found at post-training. At follow-up, small-sized increases in levels of mental imagery (AMT MI) and felt pleasure (AMT FP) related to recalled positive memories were observed. However, the latter effect fell below the significance level after correction for multiple testing.

The observed changes correspond with prior work on PET's subcomponents and suggest the effectiveness of this combined program to cultivate at least some aspects of past and future autobiographical thinking. To the authors' knowledge this is the first intervention in adolescents to produce sustained changes in EFT specificity, a known cognitive factor in mental illness (Hallford et al., 2018). Sustained improvements in AM specificity constitute an important outcome too, given that lower specificity is known to be a risk factor in future depressive symptoms, and particularly in clinical depression (Hallford, Rusanov, et al., 2021).

However, PET's impact on the other AM and EFT related indices in the current trial was not as conclusive as expected. This contradicts existing evidence which shows that these autobiographical thinking processes can be successfully targeted and that they are all positively interrelated (e.g., undergraduate students: Hallford, Barry, et al., 2020; clinical adult sample: Hallford, Rusanov, et al., 2022). In contrast with prior work, the current study exclusively focused on the recall and anticipation of positive events in response to neutral and positive cue words. In combination with specific attributes of our adolescent community sample, this might have limited the room for improvement (ceiling effect) and may be partly accountable for the absence of significant changes in those other AM and EFT related indices.

Concerning the primary and secondary outcomes, the current study did not yield support for the hypothesized effectiveness of PET to strengthen resilience (H1), boost well-being (H2), lower/foster the endorsement in dampening/savoring response styles (H4a/H4b), or impact psychological distress in general. As to positive emotions (H3), no support was found for PET's superiority compared to CREAT either. The small-sized improvements for anhedonia (H5) in favor of PET at post-training were no longer significant after correction for multiple testing. Towards follow-up, the potential impact of PET for anhedonia seemed to flatten out. However, no indications were found either that anhedonia levels returned to their original pre-training levels.

Post-hoc exploratory MLMs suggested the moderating role of baseline depressive symptoms, as a proxy for mental health impairment, in the prediction of positive emotions (follow-up), and to a certain extent, of anhedonia (post-training and follow-up). Notably, results of the MLM analyses for anhedonia were not robust to correction for multiple testing and must be interpreted with caution. Based on the results of follow-up simple slope analyses, PET might be preferable to CREAT to boost positive emotions in adolescents suffering from moderate depressive symptom levels. For mild depressive symptom levels, both trainings might be equally effective. No sound conclusions can be drawn for normal baseline levels. In alignment with the findings for positive emotions, follow-up simple slope analyses for anhedonia as outcome suggested a potential beneficial effect of PET for adolescents with mild or moderate depressive symptoms. In sum, and given the exploratory nature of the analyses and the lack of robustness of the results for anhedonia as outcome, the observed data patterns provide some evidence that further research into PET's effectiveness in repairing positive affect dysregulations in indicated samples may be warranted.

The absence of consistent changes in resilience and wellbeing for both conditions may be related to relatively high baseline levels for those outcomes in our non-selective adolescent sample (e.g., compared to Davidson, 2018; Anthony et al., 2022; Burckhardt et al., 2015). The study was only powered for detection of small-to-medium effects, and this potential ceiling effect could have further reduced the scope for detection of (subtle) enhancements. Relatedly, in light of the seemingly good mental wellbeing in our sample, it cannot be ruled out that newly acquired resilience-enhancing coping skills laid dormant due to the absence of stressors that require the utilization of these skills (Liu et al., 2022). Such a limited skill transfer to daily life may be an explanation for the absence of increases in the deployment of in-moment savoring as a result of PET. An additional challenge here might be related to the expected transfer between savoring techniques across time orientations. That is, PET combines reminiscence of past and anticipation of future positive events, two typical savoring intervention components (Smith & Bryant, 2017). However, the administered self-report scales measured in-moment savoring techniques. Despite the association of different savoring techniques (Quoidbach et al., 2010), the absence of changes in the measured in-moment savoring techniques might be in part attributed to limited generalization of skills. Concerning dampening as an outcome measure, a methodological aspect might have complicated change detection. More specifically, relatively high intracluster correlation coefficients (ICCs) were observed for the dampening measures (ICCs >0.19 vs. ICCs of 0.03–0.10 for the other outcomes/measures; Table S10, Supplementary Material). These (unexpectedly) strong correlations between reported dampening levels within clusters (i.e., schools) may have further reduced the possibility of detection of improvements.

Taken together, the current findings call into question the relevance of implementing PET in its current form as a universal school-based approach aimed at improving resilience and mental wellbeing in adolescents. Recently formulated recommendations in the field of universal school-based social emotional teaching (Kuyken et al., 2023) should guide further steps. For instance, fine-tuning PET in close collaboration with adolescents and school professionals (Foulkes & Stapley, 2022) and allowing program flexibility (Fenwick-Smith et al., 2018) could help to reach an optimally engaging training. Reach and student engagement are indeed crucial for program success (Kuyken et al., 2023), and in the current study, still considerable variation was observed among adolescents as to the extent of active participation in the training. Another

important recommendation is to design interventions with future implementation in mind (Kuyken et al., 2023). In line with this, PET was designed bearing two potential challenges in mind that were thought could hamper its effectiveness. First, at the organizational level, session and training duration were kept to a minimum to reduce the burden of study participation for adolescents and school staff. Second, targeted skills did not rely on intrapersonal higher-order mental processes or reflective capacities for which constructive group dynamics might be important prerequisites. The latter might for instance be the case in mindfulness training (Roeser et al., 2023), and it possibly makes the training's effectiveness (even) more vulnerable to unhelpful interpersonal group dynamics. An interesting suggestion that could be helpful to create greater support for the training in future studies is teacher involvement. Teachers may more flexibly respond to adolescents' needs and preferences by relying on their understanding of, for instance, adolescents' habitual coping and help-seeking strategies (Fenwick-Smith et al., 2018).

An alternative pathway for future developments, moving away from the universal school-based approach (Cuijpers, 2022), may be exploring PET's potential as an early-intervention program for adolescents with or at risk for mental health disorders like major depression. The relevance of examination of this indicated approach is supported by the findings of the exploratory moderation analyses. Similar trends were found before in the field of universal-school based programs which showed stronger therapeutic effects for adolescents with higher baseline symptomatology (Van der Gucht et al., 2017; Wang & Fang, 2022). This approach also aligns with the solid base of evidence for the symptom-reducing capacities of the subcomponents of PET in clinical samples (Hallford, Austin, et al., 2021; Hallford, Rusanov, et al., 2022; Hitchcock et al., 2017; Neshat-Doost et al., 2013; Sandman & Craske, 2022). Importantly, besides objectively more room for symptom improvement in indicated samples, adolescents suffering from mental health issues might be more intrinsically motivated and make more efforts to immerse themselves in the training.

A particular advantage of PET in this regard may be its focus on a broad variety of positive emotions of different intensities (e.g., happiness, contentment, enthusiasm) related to multiple types of positive events (e.g., leisure time, listening to relaxing music, holidays). More specifically, this perspective on positivity may overcome adverse risks associated with a focus on highly novel positive future events or major unique positive past events. For instance, imagined highly novel future positive events have been found to be often experienced as less positive than expected, which was associated with suicidal ideation severity in adolescents (Nam & Cha, 2023). Moreover, a focus on remarkably positive past events might trigger a comparative dampening-like thinking style (e.g., "I used to feel better or to enjoy this more"; Nelis et al., 2015), which might easily tip over into negative ruminative thinking (e.g., "Why am I feeling so sad and low in energy now?"). This may minimize the potential risk of an overly simple pursuit of (intense) happiness (vs. training resilience-enhancing skills), given that it may result in worse wellbeing in the long term (Zerwas & Ford, 2021). Indirect preliminary support for the strength of the adopted "mild" perspective on positivity in PET is the absence of indications of worsening of symptomatology or adverse experiences.

In addition to the indicated approach, another priority for future research is gaining insight into PET's mechanisms of action. The exploratory cross-sectional mediation analyses provided some first insights to guide future studies. Improvements in memory and future thinking specificity as a result of PET appeared not to be underlying the detected marginally significant improvement for anhedonia at post-training. This finding further backs up the suggestion to evolve towards a more inclusive analysis of AM features (vs. primacy of specificity; Barry et al., 2023), which might also be applicable to EFT. Indeed, instead of EFT specificity, findings pointed towards the possible role of increased perceived likelihood of occurrence of simulated future events (EFT PLO). Imagining future positive events in a rich and detailed way may for instance increase the likelihood that one will actually engage in and benefit from those and potentially related positive events (Hallford, Rusanov, et al., 2022).

The exploratory analyses also suggested the potential role of dampening, albeit only measured via one of the two included dampening scales, as an involved working mechanism. For instance, by approving and normalizing positive emotional self-referent displays, PET may counter one's tendency to dampen. Alternatively, by increasing the accessibility of positive self-referent past events, PET may help to overcome impaired belief updating (here, integrating positive disconfirming information) and initiate the process of cracking (excessively) coherent negative beliefs about the self, often related to mood disorders (Kube, 2023). Similarly, and supported by the improvements in PLO of simulated future events due to PET, PET may contribute to targeting the belief updating impairments related to one's personal future observed in the context of depression (Kube, 2023). One potentially vital aspect in this regard concerns the recurring self-referential focus emphasized in the PET program, because depressed individuals' tendency to avoid positive information seems to particularly emerge if self-referential (Ji et al., 2017).

The current findings should be interpreted within the confines of the following study limitations. First, the self-report nature of the study carries inherent risks like recall bias and moderate ecological validity. One option to address these is the use of ecological momentary assessment tools, tailored to the adolescent target group (Csikszentmihalyi & Larson, 1987; Wen et al., 2017). Such tools also allow mapping symptom improvement and active deployment of emotion regulation strategies in daily life in a more fine-grained way. Relatedly, built-in control questions could ensure that all data stem from meticulously completed self-report scales. For instance, many of the AM characteristics did not correlate with the primary/secondary outcomes, in contrast to prior work (e.g., Hallford, Barry, et al., 2021). This might be attributable to undetected noise in the data related to order effects. Counterbalancing the sequence of scales could help to prevent this.

Second, advances need to be made concerning the validation of some of the included self-report scales in Dutch-speaking adolescents, in particular the LEDS (*manuscript of validation in adults in preparation*) and the WOSC (Chadwick, 2012). It should be noted though that good internal consistency and baseline correlational patterns (convergent validity) in the current study support the usefulness of these scales in adolescents. Relatedly, the adjusted time frames of some scales somewhat complicated comparison with data collected via the original scales. However, data distributions of all variables at baseline closely resembled available normative data.

Third, future studies should aim to span a sufficiently long time period to enable us to draw inferences about the long-term beneficial impact of PET. For instance, the total duration of resilience-enhancing school-based programs, including the follow-up intervals, is generally more extended (Pinto et al., 2021). Therefore, extending the time period, such as spacing out sessions or prolonging the intervals between them, could naturally provide more chances for actively deploying skills and subsequently enhancing resilience. Providing adolescents with opportunities to actively search for strategies to deploy their acquired skills in daily life might further facilitate this, irrespective of the context of program implementation.

Fourth, concerning study methodology, the findings of the exploratory moderation and mediation analyses should be interpreted with caution. In addition, sample size planning did not take into the presence of ICCs at the design stage. However, a post-hoc estimation of the required number of clusters based on the guidelines of Hemming et al. (2017) does not suggest power-related issues (for small-to-medium sized change detection), except for the outcomes measuring dampening due to relatively high ICCs (see above). As ICCs are difficult to reliably estimate at the design stage, follow-up studies could rely on the observed ICCs in the current study and plot power or precision curves (Hemming et al., 2017), combined with careful piloting and refinement before definite

evaluation (Hemming & Taljaard, 2023). A related aspect that may have negatively impacted the power of the study involves the number of related outcomes, and the applied correction for multiple testing. This correction might be relatively conservative in the light of a recent recommendation, that states that the use of alpha adjustments is only justifiable for inferences about an omnibus null test via multiple piecewise statistical tests (García-Pérez, 2023). Future studies including several related outcomes should carefully balance the risk of Type I and Type II errors in the design phase. In a post-hoc way, we explored a multivariate multilevel approach which allows for associations between outcome variables (MacCallum et al., 2010). However, model complexity resulted in convergence issues which prevented us from interpretation of these results.

Finally, although the training progress at the different schools was closely followed up during supervision, training protocol adherence should be formally registered in future trials. For instance, an objective evaluation form could be used to register deviations across classes and schools. Related to training implementation, the adopted clustered approach inherently carries a risk of contamination across training groups within schools. However, following the framework of Jacobsen and Wood (2020), we argue that this risk was relatively low in the current study. The training program for both groups was newly developed, not widely available and only accessible via the trainer and during the training sessions at school. Moreover, trainings were to a certain extent idiosyncratic as they departed from participants' individual input (e.g., past and anticipated future experiences in the PET program). One potential risk factor for contamination was the homework as it was developed to allow self-paced practice at home. However, the tailored instructions and feedback participants received during the in-class training was expected to increase the potential benefit to be reaped from this home practice. Finally, although the same trainer provided the different trainings, the use of a standardized session-by-session manual should be seen as another important risk-reducing factor for contamination within schools.

In conclusion, the results of this c-RCT provide initial evidence supporting the effectiveness of PET, an innovative group training designed to enhance some past and future autobiographical thinking skills in adolescents. No significant support was found for the hypothesized effectiveness of PET, as implemented in its current form as a universal school-based program, in improving resilience, wellbeing and related outcome variables. However, results of the exploratory moderation analyses suggest the relevance of further research into PET's effectiveness within indicated samples. In addition, results of the exploratory mediation analyses might be informative for future studies on potential mechanisms of action that drive the trends in change found for PET. Future studies that build upon the current work should carefully weigh and balance factors such as reach, effectiveness, methodology, engagement, and implementation designs (Kuyken et al., 2023) in order to fully harness the potential benefits of PET.

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CRediT authorship contribution statement

L. Bogaert: Writing – review & editing, Writing – original draft, Project administration, Formal analysis, Data curation, Conceptualization. **D. Hallford:** Writing – review & editing, Supervision, Conceptualization. **E. Loyen:** Project administration, Formal analysis, Data curation. **A. D'Argembeau:** Writing – review & editing, Supervision, Conceptualization. **F. Raes:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2024.104543.

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