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Do emotionally intelligent adolescents flourish or flounder under pressure? Linking emotional intelligence to stress regulation mechanisms☆

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ABSTRACT

Everyday stressors are a normal part of adolescence, yet young people differ markedly in their responses. Emotional intelligence (EI), a set of emotion-related adaptive traits and skills, is thought to be an important individual difference that acts as a 'stress buffer' to safeguard adolescent well-being. EI correlates with reduced perceived life stress levels, but, to date, there is no attempt to understand how EI might underpin young people's responses to acute, situational stress. This paper explores how EI, measured as both an ability (AEI) and trait (TEI), regulates induced acute stress, using a novel, potent social stressor. Across two studies, we tested the extent to which EI moderated attention allocation to emotion (eye movements), psychological reactivity (mood), and physiological reactivity (heart rate) in older adolescents (study 1 $n = 58$; study 2 $n = 60$; age 16–18 years). Findings suggest that higher TEI (but not AEI) can 'dampen' the physiological stress response (study 1), facilitating protection against allostatic overload. However, being better at perceiving emotion (but not TEI) predicted attention towards happy stimuli when stressed (study 2). Preliminary findings suggest that, while TEI and AEI contribute differentially to stress regulation mechanisms, higher AEI may not necessarily be adaptive for young people facing social stressors.

Emotional intelligence (EI) captures individual differences in the perception, regulation, use, and understanding of emotions (Salovey & Mayer, 1990). EI can either be conceptualised as (1) a trait (TEI), representing a constellation of emotional self-perceptions assessed by self-report questionnaires (Petrides et al., 2007), or (2) as an ability (AEI), referring to objective, 'maximum performance' tests of emotional competence (Mayer et al., 2008). AEI is typically organised into four abilities with a hierarchical arrangement, whereby (1) emotion perception, and (2) using emotions to facilitate thought, provide a necessary foundation ('experiential' processes) for (3) emotion understanding and (4) emotion management, ('strategic' processes) (Mayer et al., 2008). Whether conceptualised as a trait or ability, evidence suggests that emotionally intelligent individuals tend to be happier, healthier, and more productive (Brackett et al., 2011; Petrides et al., 2016). There has subsequently been an upsurge of EI training initiatives for young people, often falling under the rubric of 'social and emotional learning' (e.g., Castillo-Gualda et al., 2017; Vila et al., 2021). However, programmes vary in their efficacy, cost-effectiveness, and in how they conceptualise/operationalise EI (Turner et al., 2019; Wood, 2020). To ensure that EI interventions are high quality, effective, and age-appropriate, we need to know more about how EI works – if, how, when, and why, high levels promote adaptive outcomes for adolescents.

Adolescence, now thought to span the ages of 10–24 years (Sawyer et al., 2018), marks a time of emotional development and challenge. In particular, late adolescence poses a period of increased vulnerability: while 16.9 % of UK adolescents have a mental health problem, difficulties are especially pronounced for those aged between 16 and 18 years (Sadler et al., 2018). While stressors are normative, and not harmful per se, the ability to navigate acute stress successfully (and avoid mental health problems) varies (Wright et al., 2013). EI could be especially helpful for older adolescents, considering that neuroscientific and behavioural evidence suggests that significant emotion regulation development takes place during this time (see for example, Casey et al., 2010; Esnaola et al., 2017; McRae et al., 2012). Indeed, research

☆ This work was carried out at the University of Worcester. Please note that since the research took place, the affiliation of the first author has changed from the University of Worcester to the University of Oxford.

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highlights EI as an important protective marker for young people, acting as a 'buffer' against the effects of acute stress (Bermejo-Martins et al., 2021; Lea et al., 2019; Sarrionandia & Mikolajczak, 2020). To rigorously investigate *how* EI contributes to stress regulation, and optimise training interventions, research needs to explore its mechanisms of action (Peña-Sarrionandia et al., 2015). Research in this area is underway. For example, the 'strategic' aspects of AEI (being able to understand and manage emotion) may lessen the effects of adverse life events on mental ill health (e.g., Cha & Nock, 2009). In addition, Szczygieł and Mikolajczak (2017) suggest high TEI (i.e., emotional self-efficacy) may promote wellbeing through effective emotion regulation. However, despite recent efforts to identify biological correlates of TEI in adults (e.g., Sarrionandia & Mikolajczak, 2020), few studies explore the physiological underpinnings of EI during adolescence, and how this might present in stressful situations.

1.1. EI as a moderator of stress reactivity

If EI is adaptive, adolescents with high EI should be less reactive in stressful situations than their low EI peers (Mikolajczak, Petrides, et al., 2009; Mikolajczak, Roy, et al., 2009). When an individual is faced with an acute stressor, the 'fight or flight' response should activate, catalysing a cascade of physiological, psychological, and behavioural responses (McEwen, 2006). It is important that these responses are sufficiently controlled, and proportionate to the threat encountered. One mechanism through which EI may promote better mental health in young people is by modulating this stress response and facilitating effective emotion regulation (Lea et al., 2019). The construct of stress reactivity – the extent to which an individual responds to an acute stressor (Schlotz, 2013) – is of particular interest. Hyperreactivity is traditionally associated with a heightened risk of adverse long term health outcomes, due to allostatic overload ("chronic wear and tear") on the body's stress systems (Chida & Steptoe, 2010). Overexposure to acute stress, or a disposition for exhibiting heightened reactivity, can be particularly problematic during adolescence (Roberts & Lopez-Duran, 2019). For example, heightened physiological and emotional reactivity appears to increase the risk of developing internalising and externalising problems (e.g., Owens et al., 2018). Buffering stress reactivity may be one key way through which EI protects adolescent mental health.

To study whether EI relates to stress reactivity, stress is typically induced in individuals within a laboratory setting, with researchers determining whether the magnitude of the stress response is associated with level of EI. In our review (Lea et al., 2019), we synthesised all available studies using this approach and concluded that, while EI could be useful in acutely stressful situations, this varied according to how EI was measured, and the type of stressful situation. For example, individuals with high global TEI secreted less cortisol during a challenging cognitive task (Mikolajczak et al., 2007), but there were null effects for AEI on perceived stress upon exposure to distressing images (Limonero et al., 2015). With respect to TEI specifically, work by Mikolajczak and colleagues found that the significant effect of TEI on lower stress reactivity was mostly attributed to the sociability factor (vs. emotionality, self-control, well-being factors) (Mikolajczak et al., 2007;Mikolajczak, Petrides, et al., 2009; Mikolajczak, Roy, et al., 2009). Conceptually, sociability is a conglomerate of several constructs, including assertiveness, agreeableness, and self-efficacy (Petrides, 2009). Therefore, these traits could potentially underpin TEI's stress-buffering effect, but further work examining AEI, TEI, and TEI's factors, is needed.

Most studies on EI and stress reactivity have opted for self-reported measures of stress (as opposed to physiological variables) in undergraduate students. Only 1 of the 45 identified studies used an adolescent sample (Ciarrochi et al., 2001), indexing reactivity via mood ratings and using emotive video clips as the stressor. Furthermore, very few assessed the respective roles of TEI *and* AEI, despite their long-established roles as distinct constructs (Davis & Humphrey, 2014).

Importantly, limited evidence examines whether EI was helpful to adolescents in the case of social stressors, which are especially potent during adolescence (Gunnar et al., 2009), most of which use the Trier Social Stress Test (TSST; Kirschbaum et al., 1993). The TSST, which consists of a public speaking task and an arithmetic test, is generally considered the 'gold standard' social stress induction protocol (Kirschbaum et al., 1993). However, the procedure is geared towards collecting neuroendocrine responses, notably cortisol (Brouwer & Högervorst, 2014), and is challenging to implement in school settings, requiring a panel of judges dressed in white lab-coats, and a business-like testing room. To address the need to use age-appropriate social stressors for young people (Buck, 2016), we opted for the Sing-a-Song Stress Test, a paradigm that elicits stress comparable to the TSST (Brouwer & Högervorst, 2014), yet offers multiple practical advantages.

1.2. EI as a moderator of early attentional processes under stress

Early attentional deployment, the process of selectively concentrating on some stimulus in the environment, is critical for flexible and adaptive responding to stress (Yamaguchi & Onada, 2012). Theoretically, superior processing of emotional information *should* constitute a core feature of EI (Veseley-Maillefer et al., 2018). The emotional stimuli that we should pay attention to at any given moment depends on the threat present (Mogg & Bradley, 1998). When threat levels (derived from internal state, or external stimuli) are low, focussing on threatening stimuli is maladaptive (Yiend, 2010). However, when threat levels are *high* (i.e., when the individual is experiencing acute stress), selectively focussing on threat *is* adaptive, as it allows the individual respond appropriately to the source of the threat (Bar-Haim et al., 2007; Yiend, 2010). Behavioural studies (e.g., using the Stroop task) generally indicate EI is associated with attentional preferences for emotional stimuli over neutral stimuli (for review, see Gutiérrez-Cobo et al., 2016), but studies have begun to employ eye-tracking technology, a more rigorous paradigm for measuring attention (Waechter et al., 2014). Data from one such study suggests that during passive viewing, TEI directs attention towards positive emotional stimuli (happy faces, positive social scenes; Lea et al., 2018). However, to truly test EI as a facilitator of healthy attentional processing, research needs to examine how EI relates to attentional processes 'in action' (i.e., when experiencing situational stress).

If EI drives adaptive emotion processing, higher levels should correspond with attentional bias *for* threat under stressful conditions, but *away* from threat under neutral/control conditions (Davis, 2018). Very few studies to date have explicitly tested that hypothesis, and none with adolescents. Using a dot-probe paradigm, Mikolajczak, Roy, et al. (2009) found that high TEI (self-control factor only) adults showed a bias for emotional words under stressful conditions, and a bias for neutral words under neutral conditions, with the opposite found for low TEI individuals. When Davis (2018) built on that study, findings were less clear-cut. While high emotion management ability and TEI well-being predicted bias *away* from negative emotion (angry and sad faces, respectively), TEI (sociability and emotionality factors) predicted bias *towards* negative emotion (angry and sad faces, respectively). Furthermore, most effects were not sensitive to experimental condition. Ultimately, the findings painted a confusing picture, indicating different patterns of bias for TEI and AEI that may not correspond with 'adaptive' attentional processing (Davis, 2018).

All the above studies used adult samples and did not consider the role of emotion perception (e.g., Davis, 2018; Mikolajczak, Petrides, et al., 2009; Mikolajczak, Roy, et al., 2009). Implicit emotion perception ability ('experiential' AEI) is thought to be a foundational for explicit cognitive-emotional skills ('strategic' EI) (Mayer & Salovey, 1997). While the former is typically assessed using non-verbal measures, the latter often relies on verbal ability, and can confound with IQ (Olderbak et al., 2018). Both branches could influence attentional processes. Given the small number of studies and mixed findings, there is a pressing need to explore the roles of both TEI and AEI, using (1) an adolescent sample, and (2) robust eye-tracking methodology.

1.3. The present studies

The research tests the utility of EI as a 'stress buffer' in young people. Across two studies, we test whether EI moderates the stress response *directly* (e.g., by influencing affective or physiological responses to stress), and/or *indirectly*, by moderating early attentional selection, known to be integral to stress regulation (Yamaguchi & Onada, 2012). Few studies measure both TEI and AEI when examining stress reactivity (Lea et al., 2019). We recognise that they represent complementary approaches to the study of EI: emotional skill (i.e., AEI) indicates what an individual *could* do given optimal circumstances, but may not always translate to everyday behaviour, which is captured by TEI (Davis & Humphrey, 2014). Another issue is that, when investigating stress reactivity, only one third of studies account for variables that theoretically and empirically overlap with EI. We thus examined the incremental effects of EI by controlling for its well-documented confounds of personality (e.g., Petrides et al., 2007) and cognitive ability (Elfenbein & MacCann, 2017). We additionally accounted for mental health, since, compared with healthy individuals, those with high levels of anxiety and depression tend to show dysregulated stress responding (e.g., Burke et al., 2005). By taking a process-oriented, experimental approach, we investigate not only 'if', but 'how' EI contributes to stress regulation, and whether this differs between 'type' of EI, when confounding variables are accounted for (Peña-Sarrionandia et al., 2015).

Across our two studies, we test two hypotheses, informed by empirical evidence[1]:

- H1a: Adolescents with higher levels of TEI and AEI will show reduced physiological and psychological stress reactivity in response to a situational, social stressor, as indicated through changes in HR and self-reported mood (studies 1 and 2).
- H1b (exploratory): Higher TEI sociability scores will relate to reduced psychological and physiological stress reactivity (studies 1 and 2).
- H2: When viewing socially salient emotion stimuli (facial emotion expressions), adolescents with higher levels of TEI and AEI will display attentional bias towards threat (angry/sad/fearful faces) under stressful conditions, and away from threat under control conditions (study 2).

2. Study 1

Study 1 aimed to use a socially salient, situational stressor to test whether TEI and/or AEI moderate either psychological (change in mood) or physiological reactivity (change in HR).

2.1. Method

2.1.1. Participants

An opportunity sample of 74 adolescents was recruited from one state-run sixth form college in the West Midlands, UK. Individual student involvement was contingent upon the return of the opt-in consent form (co-signed by the student and their parent/guardian). While there were no exclusion criteria, the participant information sheet advised participants that they may not wish to take part if they get upset or anxious easily. Combined, the college's Ofsted[2] rating of 'good' (2nd best on a 4-point scale), and free school meal (FSM) data (9 % FSM-eligible), revealed that the sample was socioeconomically representative of the UK population (12.4 % FSM-eligible). Of the 74 participants who provided informed consent, 58 completed the entire study (48 females, aged 16–18 years); 16 completed the online questionnaire, but did not proceed with the experimental session. Those that completed and those that did not complete the study did not statistically vary in terms of sex (X^2 $(1, N = 74) = 1.03, p = .45$) or age composition ($X^2$ $(2, N = 74) = 0.60, p = .74$).

2.1.2. Design and procedure

As a field experiment (i.e., conducted in a school setting), methods were selected that were portable, non-invasive, brief, and reliable. We used a mixed-groups design, comprised of two parts: an online questionnaire battery, and an in-person experiment session. There were two independent variables: experimental condition (stressful vs. control) and EI (TEI; AEI: emotion management), and two dependent variables: subjective stress reactivity (i.e., change in self-reported mood), and physiological stress reactivity (i.e., change in HR). As alluded to earlier, the 'strategic' AEI branch is of particular interest due to its consistent link with mental health (e.g., Cha & Nock, 2009), and stress-related variables (e.g., cardiac reactivity; Schneider et al., 2013). Sex, Big Five personality traits, cognitive ability, and mental health, were included as covariates. Both studies complied with the British Psychological Society's recommendations (British Psychological Society, 2021), and ethical approval was granted by the University Ethics Committee. Participants did not receive compensation in either study. Following provision of consent, participants completed online questionnaires in a random order (TEI, AEI, Big Five personality traits, cognitive ability, mental health), hosted on Qualtrics.com; the battery took approximately 20 min). The subsequent experimental session took place in unused classrooms within 1–2 weeks of completing the questionnaire battery. First, the HR monitor was fitted, and participants completed a two-minute breathing exercise to establish resting physiology. Participants then underwent the stress or control task. Testing time was approximately 20 min.

2.1.3. Social stressor task

The Sing-a-Song Stress Test (SSST; Brouwer & Högervorst, 2014) is a novel and effective social stressor. In the SSST, participants perform four consecutive non-verbal tasks displayed on a screen (e.g., "Think of as many animals as possible starting with the letter 'p'"), interchanged by a counter counting down from 30 s to zero. The next screen informs participants that they must sing a song of their choice after a 60-second countdown, and to use that time to mentally prepare. Participants then sing for 60 s in front of an experimenter, under the pretence that they are being recorded, thus introducing social-evaluative threat. While most adolescents are seldom asked to sing in everyday life, singing to an audience elicits considerable psychological stress (Hofman et al., 2006), and the magnitude of physiological stress achieved using the SSST is comparable to the TSST (Brouwer & Högervorst, 2014). The SSST is shorter and less resource-intensive than the TSST, and body movements are kept constant (i.e., the participant remains sitting down throughout), allowing physiological changes to be attributed to mental stress. The control group instead read a neutral magazine article and completed a readability questionnaire, for which participants were assured there were no right/wrong answers; the task has previously shown no discernible increase in stress (Davis, 2018).

2.1.4. Stress responses

Most stressful experiences are accompanied by psychological and

[1] The studies were not pre-registered, but all hypotheses were generated prior to the commencement of data collection. H1b is exploratory; the prediction regarding the sociability factor is tentative since most research focusses on global TEI score, rather than factor scores. Evidence is more supportive of H1a and H2.

[2] Ofsted is the UK government office responsible for inspecting and regulating schools and colleges.

physiological responses, yet, experimentally, subjective and objective measures of stress only correlate approximately 25 % of the time (Campbell & Ehlert, 2012). Thus, psychological (mood) *and* physiological (HR) stress reactivity were measured. Mood was tested before and after the stressor, using the 10-item negative affect scale of Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). HR was monitored continuously using a wrist-worn Fitbit Charge 2 (Fitbit, US). Subjective mood was captured at two time-points: at the start of the experiment after the relaxation task (i.e., T1: baseline), and retrospectively immediately after the stressful task or control task (i.e., T2: reactivity). Physiological equivalent values were captured as the average HR during the relaxation task (i.e., baseline), and during the singing activity (i.e., reactivity).

Table 1
Measurement tools and example items for the measures used in the online questionnaire battery.

Construct	Tool	Subscales	Example item
Trait emotional intelligence	TEIQue-ASF (30 items)	Emotionality	I pay a lot of attention to my feelings
		Self-control	Sometimes, I get involved in things I later wish I could get out of (R)
		Sociability	I can make other people feel better if I want to
		Wellbeing	Sometimes, I think my whole life is going to be miserable (R)
Emotion management ability	STEM-B (18 items)	None	Clayton has been overseas for a long time and returns to visit his family. So much has changed that Clayton feels left out. What action would be the most effective for Clayton? (a) Nothing – it will sort itself out soon enough. (b) Tell his family he feels left out. (c) Spend time listening and getting involved again. (d) Reflect that relationships can change with time.
Emotion perception ability	ERT (36 items)	None	N/A (audiovisual stimuli: see Supplementary material)
Big Five personality traits	Mini IPIP (20 items)	Openness	Am not interested in abstract ideas (R)
		Conscientiousness	Like order
		Extraversion	I am the life of the party
		Agreeableness	I sympathise with others' feelings
		Neuroticism	Am relaxed most of the time (R)
Crystallised intelligence	Vocabulary test (18 items)	None	Choose the word that is closest in meaning to 'energetically': Inspiringly Skilfully Delightfully Vigorously
Mental health	HADS (14 items)	Anxiety	Worrying thoughts go through my mind
		Depression	I feel cheerful (R)

Note. TEIQue = Trait Emotional Intelligence Questionnaire - Adolescent Short Form (Petrides, 2009); STEM-B = Situational Test of Emotion Management – Brief; ERT = Emotion Recognition Test (using stimuli from Livingstone & Russo, 2018); Mini IPIP = mini International Personality Item Pool (Donnellan et al., 2006); HADS = Hospital Anxiety Depression Scale (Zigmond & Snaith, 1983). R indicates a reverse scored item.

2.2. Measures

For all measures, Table 1 displays example items and Table 2 indicates the reliability statistics.

2.2.1. Trait emotional intelligence

TEI was assessed using the Trait Emotional Intelligence Questionnaire - Adolescent Short Form (TEIQue-ASF; Petrides, 2009), an age-appropriate, brief measure from the TEIQue family of measures. In the TEIQue-ASF, individuals indicate their agreement with 30 statements using a 7-point Likert scale. From this, global scores, and four factor scores; emotionality, self-control, sociability, and well-being, are derived.

2.2.2. Emotion management ability

The strategic branch of AEI was assessed using the multiple-choice Situational Test of Emotion Management - Brief (STEM-B; Allen et al., 2015). Participants select the optimum emotional management strategy for 18 emotional scenarios; items are scored according to expert opinion.

2.2.3. Covariates

Personality was measured using the mini International Personality Item Pool (mini IPIP; Donnellan et al., 2006). Participants rate to what extent 20 statements (four for each trait: openness, conscientiousness extraversion, agreeableness, neuroticism) accurately describe themselves, using a 5-point scale. *Crystallised intelligence* (Gc) was estimated using an 18-item vocabulary test from the Kit of Factor-Referenced Cognitive Tests (Ekstrom et al., 1976). Participants read a list of words and choose alternatives that are closest in meaning. Finally, *mental health* was assessed using the Hospital Anxiety Depression Scale (HADS; Zigmond & Snaith, 1983); participants read 14 statements and indicate the extent to which they have been feeling that way over the last week.

2.3. Analytical approach

Following a manipulation check for the stress induction procedure, separate hierarchical regressions were performed, with either NA or HR at T2 as criterion.[3] The first two successive steps entered were baseline state (e.g., NA at T1), and the dummy vectors for task condition. The third step entered sex, Big Five personality traits, cognitive ability, trait anxiety, and trait depression. EI scores were entered for the fourth step. For the fifth and final step, the product vectors representing EI × task condition were entered, to test for condition-dependent effects. Exploratory analyses were also conducted with TEI factor scores.[4]

3. Results

Correlations and whole-sample descriptive statistics for EI and all other predictor variables are shown in Table 2.

3.1. Preliminary analyses

The only missing data were HR responses for three participants (due to very small wrist size), data for whom was subsequently used on a pairwise basis. The stressor was highly effective, evidenced by substantial increases in both physiological and perceived stress in the stress

[3] The analytic strategy was based upon that by Matthews et al. (2006). EI was operationalised as a continuous variable throughout, since avoiding artificial dichotomisation of psychological variables provides more meaningful data interpretation (DeCoster et al., 2011).

[4] Correcting for multiple comparisons was inappropriate in the present studie (s) since the analyses with factor scores were exploratory, and adjustments increased the risk of Type II errors (Nakagawa, 2004; Streiner & Norman, 2011).

Table 2
Correlations and whole-sample descriptive statistics for EI, personality, mental health, and cognitive ability (Study 1).

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. TEI: total	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2. TEI: EM	0.78***	–	–	–	–	–	–	–	–	–	–	–	–	–
3. TEI: SC	0.81***	0.46***	–	–	–	–	–	–	–	–	–	–	–	–
4. TEI: SO	0.72***	0.51***	0.48***	–	–	–	–	–	–	–	–	–	–	–
5. TEI: WB	0.89***	0.57***	0.70***	0.53***	–	–	–	–	–	–	–	–	–	–
6. AEI: EM	0.33**	0.43***	0.28*	0.07	0.23*	–	–	–	–	–	–	–	–	–
7. O	−0.12	−0.19	−0.03	0.06	−0.15	−0.13	–	–	–	–	–	–	–	–
8. C	0.52***	0.49***	0.36**	0.35**	0.42***	0.09	−0.16	–	–	–	–	–	–	–
9. E	0.43***	0.29*	0.23	0.43***	0.39**	0.08	−0.16	0.21	–	–	–	–	–	–
10. A	0.31**	0.53***	0.10	0.25*	0.11	0.31**	−0.09	0.32**	0.04	–	–	–	–	–
11. N	−0.71***	−0.37**	−0.73***	−0.51***	−0.67***	−0.17	−0.00	−0.19	−0.29*	0.01	–	–	–	–
12. ANX	−0.68***	−0.42***	−0.60***	−0.59***	−0.57***	−0.24*	0.06	−0.28*	−0.31**	−0.10	0.77***	–	–	–
13. DEP	−0.69***	−0.48***	−0.57***	−0.44***	−0.71***	−0.22	0.24*	−0.33**	−0.34**	−0.18	0.55***	0.58***	–	–
14. GC	0.11	0.04	0.23	0.02	0.07	0.18	0.21	0.04	−0.25*	0.06	−0.20	−0.18	−0.03	–
M	4.42	4.74	3.90	4.92	4.33	10.14	14.56	12.73	12.14	16.55	13.72	10.03	4.56	10.88
(*SD*)	(0.90)	(0.91)	(1.07)	(0.86)	(1.53)	(2.29)	(2.83)	(3.34)	(3.48)	(2.83)	(3.84)	(4.77)	(3.96)	(16.71)
Range	2.27–6.67	2.63–6.75	1.67–6.33	2.17–7.00	1.00–7.00	3.33–14.42	7.00–20.00	5.00–20.00	4.00–19.00	8.00–20.00	4.00–20.00	0.00–20.00	0.00–18.00	5.00–18.00
Skew	−0.27	−0.08	0.088	−1.03	−0.40	−0.70	−0.36	0.21	−0.27	−0.88	−0.45	−0.03	1.41	0.35
Kurtosis	−0.02	−0.44	−0.45	1.71	−0.76	0.30	0.60	−0.34	−0.43	0.42	−0.44	−0.60	2.08	−0.46
α	0.91	0.70	0.70	0.61	0.91	0.67	0.74	0.70	0.77	0.80	0.82	0.84	0.81	0.64

Notes. TEI = Trait emotional intelligence; EM = Emotionality; SC = Self-control; SO = Sociability; WB = Wellbeing; AEI = Ability emotional intelligence; AEI: EM = Emotional management; O = Openness; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism; ANX = Trait anxiety; DEP = Trait depression; GC = Crystallised intelligence; *M* = mean, SD = standard deviation, α = Cronbach's alpha coefficient.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

group, compared to the control group (see Fig. 1 and Supplementary material 1).

3.2. TEI and stress reactivity

Hierarchical regressions were conducted to determine if TEI improved the prediction of NA or HR change, after controlling for confounding variables. As expected, baseline stress variables (step 1), and experimental condition (step 2) predicted all outcomes. For the prediction of NA, the addition of the covariates (e.g., personality) did not significantly improve the model at step 3 ($\Delta R^2 = 0.063$, $p = .202$). The addition of global TEI ($\Delta R^2 = 0.004$, $p = .396$), and TEI × condition ($\Delta R^2 = 0.001$, $p = .900$), also failed to significantly increase R^2. Findings were similar for HR reactivity. Entering the covariates, ($\Delta R^2 = 0.119$, $p = .103$), TEI ($\Delta R^2 = 0.001$, $p = .993$), and TEI × condition ($\Delta R^2 = 0.016$, $p = .154$) did not explain any additional variance. In the final model step, only baseline HR ($\beta = 0.56$, $p < .001$), experimental condition ($\beta = -0.36$, $p = .003$), openness ($\beta = 0.855$, $p = .036$), and sex ($\beta = -0.28$, $p = .012$) remained significant predictors of HR reactivity.

Exploratory analyses were conducted with TEI factor scores. None of the four factors significantly predicted either NA change. However, sociability and self-control predicted HR reactivity. The sequential addition of the factors had no effect on R^2 ($\Delta R^2 = 0.061$, $p = .080$), whereas including the factors' conditional effects resulted in a significant model, with sociability × condition retaining significance ($\beta = 0.965$, $p = .004$) (see Table 3). Post-hoc analyses revealed that the effect of sociability was restricted to the stress group, where higher scores predicted less HR reactivity. While self-control remained a significant predictor in the final model, the coefficient was small ($\beta = 0.844$, $p = .028$), and did not explain any additional variance when included in step 4.

3.3. AEI and stress reactivity

Hierarchical regressions were run to determine if AEI (emotion management ability) incrementally predicted NA or HR reactivity. Both tests were non-significant (i.e., sig(ΔFs) > 0.05), suggesting that AEI failed to predict stress reactivity (see Supplementary material 4).

3.4. Study 1 summary

We sought to investigate whether EI (measured as both a trait and an ability) influenced psychological and physiological reactivity when exposed to a potent social stressor (H1a). While AEI had no effect, the sociability TEI factor predicted HR increase in the stress condition, compared to the control condition (supporting H1b). In short, H1 was partially supported - in a socially stressful situation, individuals that perceived themselves as socially competent became less stressed, compared to individuals that did not perceive themselves as socially competent.

Our exploratory analyses findings echo those by Mikolajczak and colleagues, who found, across several studies, that higher TEI scores associated with lower stress reactivity in adults (Mikolajczak et al., 2007; Mikolajczak, Petrides, et al., 2009; Mikolajczak, Roy, et al., 2009). Furthermore, trait sociability had the strongest effect out of all four factors (emotionality, sociability, well-being, self-control) in all cases. The TEI scale of sociability thus may be helpful in cases of social stress, for adults and adolescents alike. However, before attempting to determine the significance of these exploratory findings, they need to be replicated using the same methods but a different set of participants (see study 2).

In conclusion, findings regarding EI and stress reactivity were mixed. While aspects of TEI appeared to have a physiologically protective function for adolescents in socially threatening situations, AEI did not, suggesting that perceived emotional skills may be more pertinent than actual emotional skills. A post-hoc power analysis using G*Power indicated that the study was underpowered (0.35), suggesting that a larger

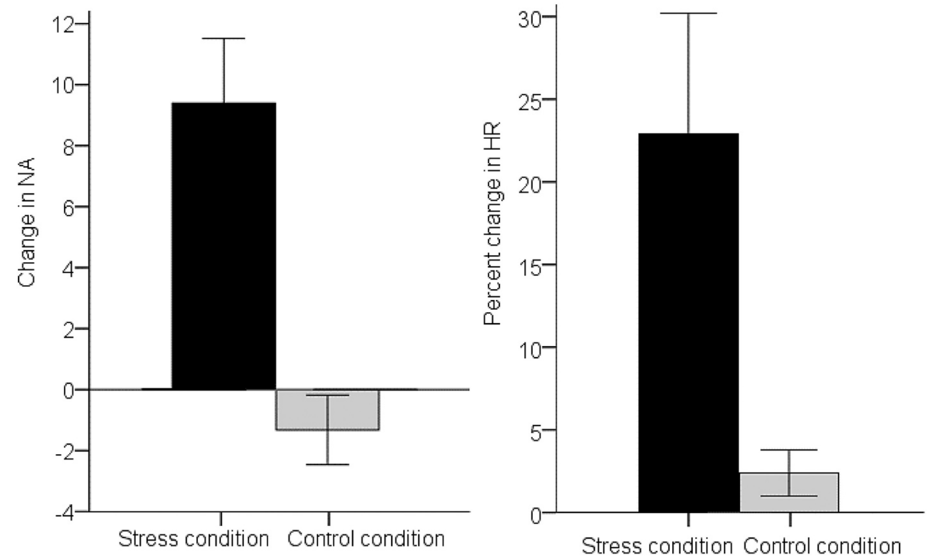

Fig. 1. Bar graphs showing changes in negative affect and heart rate during the stress induction procedure.
Notes. Figure illustrates the mean change in NA (absolute values) and HR (% change) between T1 (baseline) and T2 (task) for each experimental condition. Error bars represent 2 ± standard errors. NA = negative affect; HR = heart rate.

Table 3
Summary statistics for regressions of stress reactivity onto pretask state, condition, personality, cognitive ability, mental health, and TEI subfactor predictors.

	Step 1: Pretask state		Step 2: Condition			Step 3: FFM, cognitive ability, mental health			Step 4: Emotionality, self-control, sociability, well-being			Step 5: TEI × condition interaction			Significant EI and covariate predictors (at Step 5)
Criterion	R^2	F(1,56)	R^2	ΔR^2	ΔF(1,55)	R^2	ΔR^2	ΔF (9,46)	R^2	ΔR^2	ΔF (1,45)	R^2	ΔR^2	ΔF (1,44)	
NA	0.33	28.09***	0.72	0.38	73.38***	0.78	0.06	1.43	0.78	0.00	0.16	0.80	0.02	1.00	None
HR	0.40	35.08***	0.56	0.16	19.20***	0.68	0.12	1.77	0.74	0.06	0.08	0.81	0.07	0.02*	SEL (β = 0.84*) SOC (β = −1.11**) SOC × Condition (β = 0.97**) A (β = −0.2.02*)

Note. NA = negative affect; HR = heart rate; FFM = Five Factor Model personality traits; TEI = trait emotional intelligence; SEL = TEI (self-control factor); SOC = TEI (sociability factor); A = agreeableness.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

sample size was needed to verify findings. Thus, we sought to replicate our findings in study 2.

4. Study 2

Study 2 was conducted to verify the stress reactivity findings of Study 1 (using separate analyses and also a pooled analysis) (H1), but also to examine the influence of EI on attentional processing under stress (H2). However, understanding the role of the 'experiential' branch (namely emotion perception) in attentional processes also warrants consideration, yet is missing from previous work. This ability describes one's capacity to identify discrete emotions in others and oneself, requiring the individual to accurately detect and decipher, emotional signals (Mayer et al., 2008).

4.1. Method

4.1.1. Participants

70 adolescents were recruited from three state-run educational establishments in the West Midlands, UK. One of those sites was the same as in Study 1 (but a different cohort of students). The consent processes were the same as for Study 1, and socioeconomic data suggested that the sample was very similar. Of the 70 participants who provided consent, 60 completed both the online questionnaire and the experimental session (50 females, aged 16–18 years). Those that completed the study did not significantly differ in sex (X^2 (1, N = 70) = 0.91, p = .70) or age (X^2 (2, N = 70) = 1.19, p = .55) from those that did not complete the study.

4.1.2. Design and procedure

Study 2 had the same (mixed-groups) design as study 1, comprising an online questionnaire and an experimental session. There were two independent variables: experimental condition (stressful vs. control) and EI (TEI; AEI: emotion management and emotion perception), and four dependent variables: subjective stress reactivity, physiological stress reactivity, attentional bias for emotion (reaction times), and emotion of first fixation (eye movements). Sex, personality traits, cognitive ability, and mental health, were included as covariates. Ethical approval was granted by the University Ethics Committee, and complied with the British Psychological Society's guidelines (British Psychological Society, 2021). After providing informed consent, participants completed the online measures in a random order (the battery took approximately 25 min). The subsequent experimental session took place in unused classrooms. The stress induction procedure was identical to that described for Study 1. Immediately afterwards, participants started the dot-probe task. Mood was captured at baseline, and retrospectively immediately after the stressful or control task (reactivity). Physiological responses were captured at time-matched points. The experiment (stress induction plus dot-probe task) lasted approximately 45 min.

4.2. Measures

4.2.1. Emotional intelligence

As per study 1, TEI was measured using the TEIQue-ASF (Petrides, 2009), and emotion management ability was measured using the STEM (Allen et al., 2015). Emotion perception ability was assessed using a bespoke emotion recognition test (ERT) constructed using audio-visual stimuli from the Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS; Livingstone & Russo, 2018), a large, multimodal database of validated emotional stimuli. Further detail on the construction of our ERT is located in Supplementary material 2. In the ERT, participants select the emotion they think is being expressed (from: happiness, sadness, anger, fear, disgust, surprise) for 36 videos, resulting in a score of % emotions correctly identified.

4.3. Attentional bias

Attentional bias was measured immediately after stress induction, using the dot-probe paradigm developed by Davis (2018). In a standard dot-probe paradigm, two stimuli that differ in their emotional content (e.g., threatening versus neutral) are presented simultaneously, followed by the presentation of a probe. Participants then indicate the location of the probe as quickly and accurately as possible through key press. Response to the 'attended' location (i.e., the location the participant is focussing on) is usually faster. Thus, it is presumed that the difference in reaction time (RT) between congruent (when the probe appears at the same location as the emotional stimulus), and incongruent trials (probe and emotional stimuli at different locations) reflects attentional allocation (Bar-Haim et al., 2007). A shorter average RT to congruent stimuli indicates an attentional bias towards emotional stimuli. In contrast, shorter RTs to incongruent stimuli indicate avoidance of emotional stimuli. To capture continuous attentional deployment prior to the onset of the probe, manual RTs can be coupled with eye movement data to provide a multi-dimensional, robust assessment of attentional bias under stress (Davis, 2018; Mogg & Bradley, 1998). One such approach is to measure which stimuli type participants tend to fixate on first, whereby more first fixations on emotional stimuli (e.g., happy, sad, angry) than neutral indicate greater attentional allocation to that emotion type. Thus, the present study used a dot-probe paradigm where attentional bias was indexed via two independent assessments: 1) manual RTs (captured through key press responses), and 2) first fixations (captured through eye-tracking).

4.3.1. Dot-probe task

The dot-probe paradigm for the present study was constructed and presented in OpenSesame (Mathôt et al., 2012), using facial emotion stimuli from the NimStim Set of Facial Expressions (Tottenham et al., 2009). The 112 image pairs replicated those used by Davis (2018), and consisted of 32 angry-neutral pairs, 32 happy-neutral pairs, 32 sad-neutral pairs, and 16 neutral-neutral pairs (for practice trials). Each pairing used expressions from the same actor (e.g., for an angry-neutral pair, an image of an actor showing an angry expression would be presented alongside another image of the same actor with a neutral expression). Images measured 90 mm (width) × 110 mm (height) and were spaced 215 mm apart, set against a white background. Following a practice session, stimuli were presented twice across two blocks, producing 192 experimental trials in total. Trials began with the presentation of a central fixation cross (500 ms), followed by a face pair (500 ms) (Fig. 2). With the offset of the pair, a probe (triangle) immediately appeared in the location previously occupied by one of the faces (neutral or emotional face) for 1100 ms, or until a key press response was detected. The emotional face, and the probe, each appeared on the left/right hand side of the screen with equal frequency. Image pairings were presented in a random order. Participants were instructed to first focus on the fixation cross, and then to identify the location of the probe as quickly as possible by pressing either A (left) or L (right). RT was recorded for the interval between the onset of the probe and the key press response. The inter-trial interval had a randomised duration of between 750 and 1250 ms. Timings were identical to those described in Davis (2018).

4.3.2. Eye-tracking

A mobile Eye Tribe eye-tracker (Eye Tribe, Denmark) recorded participants' eye movements continuously for each trial at a temporal resolution of 30 Hz, and an on-screen average error of 0.5–1 cm. Evidence indicates that despite being classed as a 'budget' eye-tracker, the accuracy and precision of the Eye Tribe is well-suited for fixation investigations (e.g., Ooms et al., 2015). For each participant, seat and screen heights were adjusted such that the participant's eye height met the centre of the screen. The distance between participants' eyes and the screen was approximately 60 cm. The eye-tracker was calibrated for

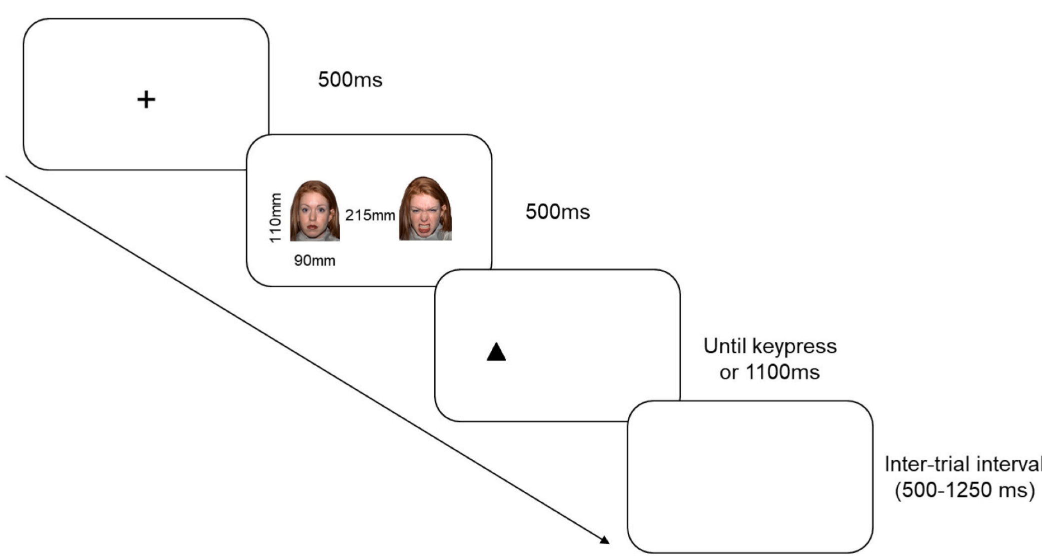

Fig. 2. Procedure and dimensions used for the dot-probe task.

each participant using a 9-point visual display at the start of the task.

4.4. Analytical approach

The analytic strategy for both the stress manipulation check and the reactivity analyses mirrored that of Study 1. As the stress procedure was identical, a pooled analysis was also performed, where stress reactivity data from participants across both studies were combined. The same covariates as Study 1 (sex, personality, cognitive ability, trait anxiety, trait depression), were also entered into the models. For the attentional bias analyses, hierarchical regressions were run to test whether EI predicted attentional bias to different emotions, with either a) manual reaction times, or b) eye movements (first fixations) as criterion. Exploratory analyses were also conducted with TEI factor scores.

4.5. Results

4.5.1. Data screening and preparation

4.5.1.1. Preparation of manual reaction time data. After screening for incorrect responses and outliers, bias scores for each emotion type (happy, angry, sad), were computed for each participant using established methodology (Bradley et al., 1998). For this, the mean RT to congruent stimuli (emotional face appears in the same position as the probe) is subtracted from the mean RT to incongruent stimuli (emotional face and the probe appear in different locations). Scores with a positive value represent a bias towards that emotion type, whereas a negative value represents a bias away from that emotion type (zero = no bias).

4.5.1.2. Preparation of eye movement data. For each trial, the inbuilt Eye Tribe eye-tracker algorithm recorded whether a fixation occurred throughout the 500 ms presentation of the face pair, and the screen coordinates for which gaze was directed at that time-point (x,y). Those first fixation coordinates were cross-referenced with the locations of the on-screen images to determine whether the first fixation was on the left image, right image, or neither. The emotion of first fixation (i.e., happy, sad, angry) and gaze direction (i.e., towards/away) was then deduced. 'Anticipatory' eye movements that occurred <100 ms after the onset of the face pair were discarded (Mogg et al., 2004). To establish attentional bias scores for each emotion type, the number of first fixations to that emotion type was divided by the total number of trials where a fixation was detected during emotion-neutral pairings of that emotion type (Davis, 2018). For example, bias for happy faces = number of first fixations to happy faces/total number of first fixations made in trials with happy-neutral face pairings. Scores of >0.50 represent a bias towards that emotion type, whereas scores of <0.50 represent a bias away from that emotion type. Bias towards emotion types did not vary between experimental conditions.

4.5.2. Preliminary analyses

The only missing data were eye-tracking responses for three participants due to a failure to calibrate their eye movements, even after ruling out technical issues. Their data was subsequently used on a pairwise basis. There were no pre-existing differences between experimental groups in terms of age, sex, and independent variable scores. Correlations and whole-sample descriptive statistics for EI and all other predictor variables are located in Supplementary material 4. As with Study 1, the stress manipulation procedure was highly successful (see Supplementary material 1).

4.5.3. TEI and stress reactivity

Separate hierarchical regressions tested whether TEI improved the prediction of NA or HR change when confounding influences were held constant. In the same manner as for Study 1, baseline stress variables (step 1), and experimental condition (step 2) predicted all outcomes.

For mood reactivity, results broadly replicated Study 1; the addition of global TEI and TEI × condition variables failed to significantly improve predictions of NA reactivity or HR reactivity (i.e., sig(ΔFs) > 0.05 for all models for the final two steps). Exploratory analyses with TEI factors were also run. Their addition did not improve model fit for NA reactivity. In contrast to Study 1 (where sociability predicted HR under stress), none of the factors nor their conditional effects predicted participants' change in HR.

4.5.4. AEI and stress reactivity

Akin to the TEI analyses, neither AEI (either emotion management ability or emotion perception ability) predicted either NA or HR reactivity (i.e., sig(ΔFs) > 0.05 for all models for the final two steps) (see Supplementary material 4).

EI and stress reactivity: pooled data from Studies 1 and 2.

Whole sample and descriptive statistics from the pooled sample (n = 118) are shown in Table 4. The full set of findings is described in Supplementary material 3. In general, those findings were a combination of those obtained from analysis of the separate samples. In the stress group (but not the control group), global TEI predicted less NA reactivity (it did not in Study 1 or 2 separately), but not HR reactivity (akin to Studies 1 and 2). With respect to TEI's factors, sociability predicted less NA reactivity *and* less HR reactivity (supporting Study 1), suggesting a stress-buffering effect. AEI did not predict either NA or HR reactivity.

4.5.5. EI and attentional bias: reaction time data

Hierarchical regressions tested whether TEI (either global or factor scores) predicted attentional bias (indexed using RT data) for different emotion types. Personality traits, cognitive ability, sex, and mental health were controlled for in the 2nd step, after experimental condition (step 1). The addition of global TEI, and TEI × condition terms, did not significantly increase R^2 for the models predicting bias for sad faces, angry faces, or happy faces (i.e., sig(ΔFs) > 0.05). However, a different pattern of findings emerged for exploratory analyses with TEI factors. For sad faces, entering the TEI factors at step 4 significantly improved the model, $\Delta R^2 = 0.36$, $F(4, 44) = 2.02$, $p = .021$, adjusted $R^2 = 0.21$. Of those, self- control was the only significant predictor, whereby higher scores predicted a bias *away* from sad faces, across both conditions ($\beta = -0.56$, $p = .003$). Turning to AEI, after controlling for experimental condition (step 1) and covariates (step 2), neither emotion management ability nor emotion perception ability predicted bias for any emotion type when using reaction times (i.e., sig(ΔFs) > 0.05 for all models). In sum, while AEI and TEI did not predict bias for any emotion type, the self-control TEI factor suggested a general bias away from sad faces.

4.5.6. EI and attentional bias: eye movement data

Hierarchical regressions tested whether EI predicted attentional bias (as determined through first fixations) for different emotion types. After experimental condition (step 1), covariates were entered in the 2nd step. For models predicting bias for happy, sad, or angry faces, neither global TEI, nor TEI × condition terms significantly increased the models' R^2. Furthermore, exploratory TEI factor analyses did not reveal significant roles for any of the four factors in explaining variation in first fixations (i.e., sig(ΔFs) > 0.05 at the final two steps of all models). In sum, TEI did not predict attentional bias for any emotion type.

Emotion management ability did not predict first fixations for happy, sad, or angry faces, in either experimental condition. Likewise, emotion perception ability and its product vector did not indicate a bias for sad or angry faces. However, an interesting finding emerged regarding emotion perception ability and fixation on *happy* faces. While the addition of emotion perception ability alone did not explain additional variation, adding the interaction between emotion perception ability and condition did, $\Delta R^2 = 0.10$, $\Delta F(1, 45) = 2.22$, $p = .030$, adjusted $R^2 = 0.19$ (Table 5). To probe this further, follow-up testing compared the effects for each condition separately. In stressful conditions, while emotion

Table 4
Correlations and whole-sample descriptive statistics for EI, personality, mental health, and cognitive ability (pooled sample).

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. TEI: total	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2. TEI: EM	0.78***	–	–	–	–	–	–	–	–	–	–	–	–	–
3. TEI: SC	0.76***	0.45***	–	–	–	–	–	–	–	–	–	–	–	–
4. TEI: SO	0.64***	0.44***	0.27**	–	–	–	–	–	–	–	–	–	–	–
5. TEI: WB	0.88***	0.56***	0.61***	0.48***	–	–	–	–	–	–	–	–	–	–
6. AEI: EM	0.26**	0.36***	0.22**	0.07	0.17	–	–	–	–	–	–	–	–	–
7. O	−0.10	−0.05	−0.04	−0.05	−0.13	−0.02	–	–	–	–	–	–	–	–
8. C	0.44	−0.19	0.35***	0.24**	0.34***	0.07	−0.14	–	–	–	–	–	–	–
9. E	0.31***	0.36***	0.06	0.47***	0.25**	0.00	−0.03	0.07	–	–	–	–	–	–
10. A	0.33***	0.56***	0.16	0.24**	0.11	0.23	0.03	0.20	0.11	–	–	–	–	–
11. N	−0.65***	−0.31***	−0.68***	−0.37***	−0.62	−0.04	0.12	−0.21*	−0.17*	0.02	–	–	–	–
12. GC	0.01	−0.01	0.05	0.03	−0.01	0.13	0.24**	0.01	−0.12	0.04	−0.04	–	–	–
13. ANX	−0.57***	−0.39***	−0.50***	−0.32***	−0.52***	−0.02	0.10	−0.18*	−0.19*	−0.18*	0.60***	−0.04	–	–
14. DEP	−0.50***	−0.41***	−0.41***	−0.23**	−0.50***	−0.06	0.08	−0.18*	−0.15	−0.30***	0.37***	0.00	0.76***	–
M	4.38	4.64	3.82	4.94	4.27	10.33	14.63	12.83	12.05	16.00	13.95	60.95	13.45	8.33
(*SD*)	(0.85)	(0.94)	(1.02)	(0.80)	(1.51)	(2.24)	(2.87)	(3.26)	(3.80)	(3.34)	(3.74)	(17.78)	(5.79)	(5.35)
Range	2.27–6.67	2.13–6.75	1.67–6.33	2.17–7.00	1.00–7.00	3.33–14.42	7.00–20.00	5.00–20.00	4.00–20.00	4.00–20.00	4.00–20.00	11.11–100	0.00–27.00	0.00–23.00
Skew	−0.20	−0.19	0.14	−0.82	−0.30	−0.75	−0.35	0.17	−0.18	−1.15	−0.45	0.14	0.03	0.25
Kurtosis	−0.15	−0.20	−0.27	1.21	−0.86	0.43	0.26	−0.43	−0.80	−1.44	−0.25	−0.41	−0.19	−0.69
α	0.90	0.67	0.61	0.57	0.91	0.64	0.71	0.64	0.81	0.80	0.78	0.70	0.84	0.73

Notes. TEI = Trait emotional intelligence; EM = Emotionality; SC = Self-control; SO = Sociability; WB = Wellbeing; AEI (EM) = Ability emotional intelligence (emotional management); O = Openness; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism; GC = Crystallised intelligence; ANX = Trait anxiety; DEP = Trait depression; M = mean, SD = standard deviation, α = Cronbach's alpha coefficient.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

perception ability presented a significant, *incremental* contribution towards first fixations towards happy faces (i.e., it statistically improved the model), the final model did not quite reach statistical significance, $F(9, 19) = 2.25$, $p = .067$, adjusted $R^2 = 0.28$. Under control conditions, emotion perception ability did not explain additional variance or result in a statistically significant final model. Overall, findings hint at a potential role of emotion perception ability facilitating first fixations happy faces in stressful conditions, although neither 'types' of EI *robustly* predicted first fixations, for any emotion type.

4.6. Study 2 summary

The present study was the first to explore whether EI moderates early attentional processing of emotion under conditions of social stress with an adolescent population (H2). In addition, the study served to replicate Study 1, by testing whether EI moderated psychological or physiological stress reactivity (H1a; H1b).

Study 2 replicated the stress induction paradigm from Study 1. Interestingly, while Study 2 did not yield significant findings, in analyses conducted with the larger, pooled sample ($n = 118$), sociability predicted both psychological reactivity and physiological reactivity. Findings therefore indicate that sociability may contribute to multiple aspects of the fight or flight response in social settings, providing some support for H1a and H1b, and for findings from Mikolajczak et al. (2007), Mikolajczak, Petrides, et al. (2009) and Mikolajczak, Roy, et al. (2009).

Generally, attention data did not support H2. The reaction time data revealed significant findings for the TEI self-control factor, where higher scores predicted a bias *away* from sad faces, but this applied across stress *and* control conditions. This factor also emerged as one of importance in one study by Mikolajczak, Petrides, et al. (2009) and Mikolajczak, Roy, et al. (2009), where higher self-control scores predicted attentional bias for emotional material in stressful conditions, and attentional bias for neutral material in neutral conditions. This contrasts with Davis (2018), who found that the other three TEI factors were associated with attentional bias. With respect to AEI, our eye-tracking data tentatively suggested that adolescents with a greater ability to recognise others' emotions showed a tendency to fixate on happy faces when under stress. We attempt to interpret these findings in the discussion.

5. General discussion

5.1. Summary of findings from Studies 1 and 2

Using a novel and effective social stressor for adolescents (the SSST; Brouwer & Högervorst, 2014) across two studies, we examined the capacity of EI to act as a 'stress buffer' in older adolescents, an empirically neglected group. We also addressed several limitations of the extant literature, by assessing both EI conceptualisations (i.e., TEI; AEI) and their covariates, and measuring stress reactivity across both psychological and physiological domains. We tested whether EI moderated the stress response *directly* (e.g., by influencing stress reactivity) (H1), and/or *indirectly*, by moderating early attentional selection (Yamaguchi & Onada, 2012) (H2). When assessing stress reactivity, pooled data from both studies indicated that the TEI sociability factor moderated both psychological and physiological reactivity following exposure to an acute social stressor, suggesting an important role for perceived social competence. We also examined participants' bias for different emotions under either stressful or control conditions, using a dot-probe paradigm. The TEI self-control factor corresponded with generalised avoidance of sad faces, but emotion perception ability predicted bias towards happy faces under stressful conditions. The remainder of the discussion section aims to interpret those findings and consider their implications.

Table 5
Summary statistics for regressions of bias (first fixations) for different emotions onto condition, personality, cognitive ability, mental health, and AEI (emotion perception) predictors.

	Step 1: Condition		Step 2: FFM, cognitive ability, mental health			Step 3: AEI (EP)			Step 4: AEI × condition interaction			Significant EI and covariate predictors (at Step 4)
Criterion	R^2	F(1,585)	R^2	ΔR^2	ΔF(8,47)	R^2	ΔR^2	ΔF(1,46)	R^2	ΔR^2	ΔF(1,45)	
ANG	0.02	1.17	0.13	0.11	0.77	0.14	0.01	0.09	0.17	0.03	1.77	None
SAD	0.00	0.10	0.15	0.15	1.06	0.15	0.00	0.01	0.16	0.01	0.06	None
HAP	0.02	1.30	0.22	0.20	1.48	0.25	0.03	1.83	0.35	0.10	7.12*	AEI (EP) (β = 1.24**) AEI (EP) × Condition (β = −1.10*)

Note. ANG = bias for angry faces; SAD = bias for sad faces; HAP = bias for happy faces; FFM = Five Factor Model personality traits; AEI (EM) = emotional intelligence (emotion perception).
* $p < .05$.
** $p < .01$.

5.2. EI and social stress in adolescents

5.2.1. TEI

The TEI sociability factor – a conceptual amalgamation of several constructs, including assertiveness, agreeableness, and self-efficacy (Petrides, 2009) – predicted dampened psychological and physiological reactivity. The wider literature on adolescent individual differences and reactivity to social stressors has highlighted the roles of several constructs closely related to TEI (e.g., optimism and self-esteem; Chiang et al., 2019; personality; Evans et al., 2016). Crucially, however, because Big Five personality traits (including agreeableness) were controlled for, *assertiveness* could be the key component underpinning our findings. Evidence suggests that assertive individuals are more likely to face stressful demands with confidence and competence, and to have a high locus of control (e.g., Mikolajczak et al., 2006; Trotman et al., 2018). Perhaps, high sociability individuals perceive socially charged acute stressors as non-threatening, or within their coping capabilities, and this reduced cognitive load allows them to instead allocate resources to effectively managing their emotional response. While we did not test such mechanisms directly, these could form future testable hypotheses going forward.

Another TEI factor – self-control – was associated with early attention allocation. It is unclear why one's perceived ability to control impulses and cope under pressure may contribute towards an attentional bias away from sad faces. Biases *towards* sadness are typically seen in young people with clinical or subclinical depression (Peckham et al., 2010). Furthermore, a wealth of evidence has highlighted a link between higher TEI and lower risk of depression in adolescents (e.g., Fernández-Berrocal et al., 2006). One could therefore speculate that TEI might help safeguard adolescents against developing depression by facilitating avoidance of sadness-evoking stimuli. However, it is unclear why this finding spanned both stressful and control conditions; further exploration is warranted.

5.2.2. AEI

Adolescents with a greater ability to recognise others' emotions showed a tendency to fixate on happy faces when under stress. Given the paucity in empirical research involving EI and attention bias, it is difficult to contextualise this finding. While Lea et al. (2018) identified that higher TEI was associated with a generalised attentional bias for positive emotional stimuli in adults, we are the first to investigate the relationship between emotion perception ability in early attentional selection under stress. Such a ‘positivity bias’ (i.e., preferentially attending to positive stimuli) is often viewed as protective, and even a target for therapeutic modification (e.g., Lazarov et al., 2018). However, theoretically, adaptive processing entails threat avoidance (i.e., attentional bias away from threat) in non-stressful conditions, but threat hypervigilance (i.e., attentional bias towards threat) in acutely stressful conditions (Yiend, 2010). In contrast to this ‘adaptive’ pattern, our findings suggest that one stress regulation strategy used by high AEI adolescents was to focus visual attention on the positive emotion in the environment when stressed. While Davis and Nichols (2016) discuss a potential ‘dark’ side of EI (where high levels may not always be advantageous) emotion perception ability did not predict stress reactivity, meaning that this phenomenon did not translate into maladaptive outcomes. Further study is required to understand the importance of these findings for adolescent resilience.

5.3. Limitations and future directions

The present studies had limitations that warrant consideration. First, it should be noted that the reliability scores for the sociability and self-control factors were only 0.51 and 0.53, respectively. Drawing firm conclusions should be reserved until similar findings are observed using the full-length TEIQue (Petrides, 2009). Future work could also test whether findings translate to ecologically valid contexts. For example, virtual reality technology could be used to recreate situations that are particularly salient to the individual or difficult to replicate experimentally. Second, early attentional selection was operationalised through identifying the emotion of first fixation. However, early attentional selection is thought to involve a combination of processes (vigilance, disengagement, avoidance) (Bar-Haim et al., 2007). While we focussed only on first fixations (i.e., vigilance for threat), future researchers could use alternative paradigms to the dot-probe (such as visual search tasks), or use other indices, such as dwell time. Finally, it should be acknowledged that participants were all recruited from a W.E.I.R.D. (Western Educated Industrialized Rich and Democratic) society. Given cultural differences in EI (notably TEI; Pérez-Díaz et al., 2021), our sample may not be representative of all adolescents.

6. Conclusion

Although social stress is prevalent and often challenging for adolescents (Gunnar et al., 2009), responding appropriately is essential to avoid detrimental developmental outcomes (Chida & Steptoe, 2010; Owens et al., 2018). Our findings offer preliminary support for EI as a moderator of stress regulation during adolescence, both in terms of early attentional allocation, and modulation of stress reactivity. Importantly, findings suggested divergent roles for TEI and AEI. All findings described in our paper demonstrate EI's capacity to predict outcomes *beyond* the effects of personality, cognitive ability, and mental health, suggesting EI may offer unique contributions to stress regulation in adolescents. Critically, however, further work is needed to understand whether the stress regulation mechanisms we observed are equivalent to adaptive responding, given that the underlying assumption of the growing number of EI training programmes is that high EI levels are unequivocally beneficial for all young people.

CRediT authorship contribution statement

Rosanna Lea: Conceptualization, Methodology, Original draft preparation, Data curation, Project administration. **Sarah Davis**: Conceptualization, Methodology, Writing – review & editing, Supervision. **Bérénice Mahoney**: Conceptualization, Methodology, Writing – review & editing, Supervision. **Pamela Qualter**: Conceptualization, Methodology, Writing – review & editing, Supervision.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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