Sustaining attention in affective contexts during adolescence: Age-related differences and association with risk for depression

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Abstract

Sustained attention is the ability to maintain conscious focus on a stimulus/event for an extended period of time. While deficits in sustained attention have been associated with a number of emotional disorders, it is typically studied in static and non-affective contexts that do not reflect real-world environmental dynamics. The current study therefore introduces a novel affective sustained attention to response task (aSART) that uses neutral and negatively valenced auditory stimuli as contextual distractors. A group of 465 adolescents aged 11-18 completed the aSART and self-report measures of mental health, to explore whether: (i) aSART performance would be poorer in negative versus neutral task contexts; (ii) aSART performance would improve with age across adolescence; (iii) the influence of affective context would be greater for younger adolescents relative to their older peers; (iv) adolescents at risk for depression would show overall worse performance on the aSART relative to those at lower risk (v) that would be particularly prevalent in a negatively affective context.

Results indicated that participants performed worse in negative contexts relative to neutral ones and showed the expected age-related improvements on the aSART. Although there were no differences in error levels of sustained attention as a function of depression risk, those at lower risk showed more reaction time variability in the negative condition than the neutral condition, whereas those 'at risk' showed no difference between condition. This suggests that the low levels of emotional arousal associated with moderate mental health symptomatology may mean those 'at risk' adolescents are less susceptible to the deleterious effects of negative stimuli in sustained attention tasks.

Taken together, these results suggest that the aSART is a criterion-valid measure of sustained attention in affective contexts that might be useful in identifying cognitive markers of depression risk in adolescents.

Introduction

Sustained attention is the ability to maintain conscious focus on a stimulus or an activity for a prolonged period of time even in the face of competing task-irrelevant information. Sustained attention is associated with a host of other processes including learning, academic attainment and executive functions skills such as working memory (Barklay, 1997; Sarter, Givens & Bruno, 2001; Silver & Feldman, 2005).

Sustained attention is usually measured with vigilance tasks that involve the passive monitoring of stimuli until a rare target is presented and a response is required. For example, the Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley & Yeild, 1997) involves making a button press response on high probability targets (i.e. 'Go' trials) but withholding that response to low probability targets (i.e. 'No-Go' trials). In this way the SART taxes sustained attention by encourage automatic, habitual responding (Robertson, et al., 1997; Manly, Robertson, Galloway & Hawkins, 1999). Performance tasks like the SART provide behavioural proxies of sustained attention via four main outcomes: commission errors, a failure to inhibit response to a 'No-Go' trial; omission errors, a failure to respond to a 'Go' trial; reaction time (RT), the time taken to respond correctly to a 'Go' trial; and RT variance the consistency of an individual's speed of correct responses. The two primary measures typically used to measure sustained attention in Go-No-Go tasks are an individual's accuracy in responding to the target stimuli (in the case of the SART this would be commission errors (Wright, Lipsyc, Dupuis, Thayaparajah & Schachar, 2014), and how variable an individuals speed of correct response is, namely RT variance. Indeed, increased RT variance is particularly prevalent in disorders characterised by deficits in sustained attention such as Attention Deficit Hyperactivity Disorder (e.g. Johnson, et al., 2007; Kofler, et al., 2013).

The following study presents an 'affective' version of the SART, the aSART. The affective element of the task is the addition of negative and neutrally valenced sounds that the participant

hears throughout and are not relevant to the task. Sustaining attention in the face of emotionally-salient distractions is an everyday challenge that is not captured by typical attention tasks. To our knowledge the aSART is the first sustained attention task to use affectively salient auditory stimuli as contextual distractors.

The development of sustained attention during adolescence

Performance on typical sustained attention tasks improves rapidly between the ages of around 10 and the middle teenage years, reaching adult levels at around 15 years of age (Lin, Hsiao & Chen, 1999). This improvement is usually seen in terms of better accuracy and a decrease in both RT and RT variability, which could be interpreted as a shift towards a slower, more cautious response strategy (Fortenbaugh, et al. 2015).

In addition to less developed sustained attention skills, younger adolescents also tend to have increased frequency and intensity of emotions (see Bailen, Green & Thompson, 2019, for a review) and show greater emotional reactivity to negative stimuli than older adolescents (Silvers, McRae, Gabrieli, Gross, Remy & Ochsner, 2012), suggesting that sustaining attention in affective 'hot' contexts may be particularly difficult for adolescents (e.g., Homer, Plass, Rose, MacNamara, Pawar, & Ober, 2019). The motivation behind the aSART was therefore to provide a laboratory measure of any decrement in the ability to sustain attention in affective contexts, relative to neutral contexts. Given this, an aim of the present study was to use the aSART to investigate the age-related changes in sustained attention in both neutral and affective contexts, across the developmentally sensitive period of adolescence.

Sustained attention in depression and those at risk of depression

As problems with concentration are a hallmark feature of depression (American Psychiatric Association, 2013), it is unsurprising that deficits in sustained attention have been shown extensively in depressed adults (Cornblatt, Lenzenweger, & Erlenmeyer-Kimling, 1989; Koetsier, et al., 2002;

Bora, et al., 2006). The precise mechanistic relationship between sustained attention and depression is unknown, but one possibility is the excessive rumination associated with depression places a demand on cognitive resources thus limiting the ability to effectively sustain concentration on extrinsic neutral stimuli (e.g., Hartledge, Alloy, Vasquez & Dykman, 1993; van Vugt & van der Velde, 2018). Although the link between depression and sustained attention is well established in adults, it is less well defined in depressed youth populations. There is a suggestion that depressed adolescents make more commission and omission errors than non-depressed adolescents (Sommerfeldt, et al., 2016; Chantiluke, et al., 2012; Cataldo, et al., 2005), but evidence for differences in RT and RT variance are equivocal (Cataldo, et al., 2005; Han, et al., 2012; Colich, Foland-Ross, Eggleston, Singh & Gotlib, 2016).

There are very few studies examining sustained attention in affective contexts in depressed adolescents. One study showed no significant differences between a group of depressed adolescents and a group of healthy controls on a short Go/No-Go task, when priming response with happy or sad faces prior to trial onset (Colich, et al., 2016). Relatedly, and also using shorter Go/No-Go task designs, there have been mixed results when the targets themselves have been emotionally salient. Kyte, Goodyer and Sahakian (2005) found that depressed adolescents made fewer commission errors when the targets were sad compared to happy words. Ladouceur and colleagues (2006) showed that although there were no differences between a depressed group and low-risk controls in error rate, depressed youth responded significantly faster to sad than happy faces. Finally, Han et al. (2012) found that higher symptom severity in depressed adolescents correlated with faster RTs to happy faces compared to neutral ones. Taken together these studies show an inconsistent pattern on data that are likely a consequence of small sample sizes used in the studies and differences in methodology.

Although, to our knowledge, there are no studies of sustained attention in those at risk of depression, in any age group, it has been shown that youth at risk of depression exhibit attentional

avoidance of negative socio-affective stimuli (Gibb, Benas, et al, 2009; Harrison & Gibb, 2015; Gibb, Pollak, Hajcak & Owens, 2016; Platt, Waters, Schulte-Koerne, Engelmann, & Salemink, 2017) that develops before the onset of depression (Joorman, Talbot & Gotlib, 2007; Kujawa, et al., 2011). This suggests that such performance in these cognitive-affective domains may be a marker of depression risk. For these reasons, the present study aimed to examine if the relationship between depression risk, characterised by scoring above an 'at risk' cut off on a standard measure of depressive symptoms, was associated with differences in sustained attention in affective contexts in adolescence.

We administered the aSART, along with a robustly validated self-report assessment of depressive symptoms and depression risk – the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) – to a sample of adolescents (*N*=485) aged 11 to 18 years. Based on our previous work (Ford, et al., 2021), we expected that around 20-30% of the sample would fall in the 'at risk' range on the CES-D.

Hypotheses

For all of the following, commission errors and RT variance are the key outcomes. However, data for omission errors and RTs are presented in the supplementary materials. Our hypotheses were as follows:

Hypothesis one. We predict that performance would be poorer on the aSART as indexed by a greater number of commission errors and increased RT variance, in the negative versus neutral task context, across the sample as a whole.

Hypothesis two. That overall performance of the aSART (irrespective of the valence of the task context) would improve with age across adolescence.

Hypothesis three. That the influence of affective context, i.e. a relative decrement in aSART performance in affective versus neutral contexts, would be greater for younger adolescents relative to their older peers.

Hypothesis four. Adolescents deemed to be at risk for depression according to CES-D cut-offs, would show overall worse performance on the aSART relative to those deemed to be lower risk.

Hypothesis five. There would be a greater effect of affective context, i.e. a relative decrement in aSART performance in affective versus neutral contexts on aSART performance in those adolescents deemed at risk of depression, compared with their lower risk peers.

Method

Participants

Four hundred and eighty-five participants (320 females) aged 11-18 years (M= 14.40, SD= 1.80) were recruited from 15 schools and colleges in Greater London and Cambridge, U.K. Schools and colleges were chosen from those that responded to recruitment emails as part of a larger project investigating the mechanisms of mindfulness training in adolescence (MYRIAD; Dalgleish, et al., 2021). All students aged 11-18 years from these schools were given an information sheet with details about the study and an opt-in consent form. All students had the opportunity to take part in the study unless: (i) they had a self-reported diagnosis of a learning difficulty or a neurodevelopmental or neurological disorder; (ii) they had a self-reported mood disorder. After signed consent forms were returned, participants were selected on a first-come first-served basis until we reached our target sample size. The study was approved by the University of Cambridge and UCL Research Ethics Committees. Participants aged under 16 needed parental consent and those aged 16-18 provided their own consent. Assent was obtained from all participants. Participants were compensated with £15 in shopping vouchers for taking part in the research, which took place in small groups at the participants' school or college. Further details about the demographic, non-verbal IQ and mental health composition of the sample are provided in the Results section.

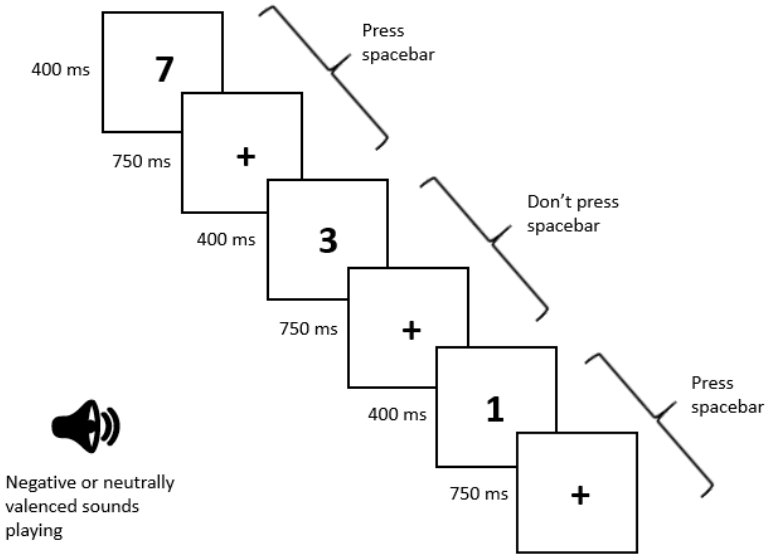
Measures

Affective Sustained Attention to Response Test (aSART)

The aSART was programmed in E-Prime version 2.0 (Schneider, Eschman & Zuccolotto, 2002). The original version of the SART (Robertson, et al., 1991) was designed as a simple, controlled, reliable and valid measure of lapses in sustained attention. The aSART adapts the original SART through the introduction of different auditory background stimuli – affective versus neutral – to evaluate whether attentional lapses vary as a function of affective context. Apart from the addition of background stimuli, the aSART is identical to the original SART. Both are computer-administered tasks that involve the withholding of key presses to rare (one in nine) targets presented visually on the screen. Specifically, targets are drawn from the numbers 1-9 and are presented one digit at a time. The participant is simply asked to respond to the appearance of each digit by pressing the space bar ('Go' trials). The exception to this is when the number '3' appears, to which the participant is told to inhibit the bar-press response ('No-Go' trials). For the aSART, the response window is 1150 ms (each digit is on screen for 400ms, followed by a mask (a fixation cross) for 750 ms; see Figure 1). Five-hundred and forty trials are presented, 60 of which are 'No-Go' trials, over a period of 12 mins.

Figure 1

Example of aSART trial sequence



While completing the task, participants listen to a continuous background stream of either neutral- or negative-valence sounds through headphones, in a within-subjects design. The 540 trials are divided into six blocks of 90 trials each. In three of the blocks, participants hear a stream of negative sounds (e.g., an alarm clock going off, a baby crying) and in the other three blocks they hear a stream of affectively neutral sounds (e.g., crowd murmur, farmyard animals). Each source sound file lasts around 6 seconds and, the files were concatenated using a custom script written in MATLAB 2014a (Mathworks, 2014). The International Affective Digitized Sounds (IADS) corpus, a set of normative emotional sound stimuli and were pre-rated in terms of valence and arousal by college adults (Bradley & Lang, 2007), contains audio files (.wavs) recorded at several different sample rates, ranging from 8 to 44.1 kHz. In order to standardize playback without reducing the quality of the high sample rate files, the audio files were resampled to 44.1 kHz in MATLAB using the default parameters. The respective sets of sounds gave us six auditory streams (three negative, three neutral), each lasting around 2 mins. These were played to participants over headphones in a random order. A list of all sounds used, along with the adult and adolescent valence ratings form an unreported pilot study can be found in the supplementary materials (Table S1).

Outcomes measures were as follows: RT was the time taken in ms for participants to correctly respond to target trials. Commission errors are made when the participant fails to inhibit response to a '3' and omission errors are made when a participant does not respond to a target trial within 1150 ms. RT variance is calculated by dividing the standard deviation of an individual participant's mean RT for correct responses by the mean RT for correct responses.

As noted, the key outcome variables for the present study were commission errors and RT variance. In addition, we computed indices to measure the effect of affective context by subtracting scores on the key aSART outcome variables in the neutral condition from scores in the negative condition, such that larger scores represent a bigger influence of affective context.

Center for Epidemiologic Studies Depression Scale (CES-D)

The CES-D (Radloff, 1977, 1991) is a 20-item self-report measure in which participants rate how often over the past week they have experienced symptoms associated with depression (e.g. *I felt that everything I did was an effort*). Responses range from 0 to 3 (0 = Rarely or none of the time; 1 = Some or little of the time; 2 = Moderately or much of the time; 3 = Most or almost all of the time. Four items are reverse scored (e.g. *I felt hopeful about the future*). Responses are summed and scores ranged from 0 to 60, with higher scores indicating greater depressive symptoms.For the purposes of the present study, scores of 19 or higher identifying a risk for clinical depression. Although different cut-offs have been used in previous studies involving the CES-D (e.g. Garber, et al., 2009; Roberts, Lewinsohn & Seeley, 1991), the relatively conservative cut-off score of 19 was chosen based on the largest recent dataset from a comparable sample – a large (*N*=5262) school-based epidemiological study (Briere, Pascal, Dupere & Janosz, 2013).

Cattell Culture Fair Intelligence Test (CCFIT)

The CCFIT (Cattell, 1963) is a measure of non-verbal intelligence that minimises sociocultural and environmental influences. A paper and pencil version of Scale 2 Form A of the test was used. This comprised four timed subtests that consisted of questions involving the relationships between pictures of abstract geometric shapes (e.g., completing a sequence of pictures of shapes or choosing a shape that is different from others). Correct responses were summed, and age-appropriate standard scores were calculated based on a set of existing norms. The internal reliability of the CCFIT is α=.77 (Nenty & Dinero, 1981).

Procedure

Participants were tested in small groups, supervised by at least two researchers, as part of a larger battery of tasks during the baseline session for a study on mechanisms of mindfulness (Dalgleish, et al., 2020). Before commencing the aSART, participants were asked to put on a set of over-ear headphones, given a set of instructions (see supplementary material for full instructions) and completed a series of practice trials. The aSART took around 12 mins to complete.

Results

Participants

Data from 39 participants were excluded from the analysis, either because they did not complete the aSART task (n=8), the CES-D (n=12) or the CCFIT (n=3), or they scored <70, suggestive of cognitive difficulties, on the CCFIT (n=2). In addition, It was decided that those with omission errors more than three standard deviations from the mean (mean=29.42, SD =25.35) would be treated as outliers and excluded from the analysis (n=14). This decision was taken as omitting responses to 'Go' trials artificially inflates performance on the 'No-Go' trials, meaning fewer commission errors. This gave an analysis sample of 446 participants (293 females, 153 males); mean = 14.42 years, SD = 1.82 years, age range 11.20 – 18.50 years).

aSART performance

Data for the analysis sample on all metrics of aSART for both the affective and neutral conditions are presented in Table 1. Here we report analyses on the two core aSART outcomes of commission errors and RT variance. Analyses on omission errors and RT are presented in the supplementary materials

Hypothesis one. To test if that aSART performance would be poorer in negative relative to neutral contexts, we analysed within-participant differences between affective conditions using repeated-measures general linear models. In support of our hypothesis, results showed that participants made significantly more commission errors, $F(1, 445) = 5.63$, $p < .05$, $d = .23$, and showed significantly greater RT variance in the negative versus neutral condition ($F(1, 445) = 7.50$, $p < .01$, $d = .26$). Table 1 shows the means, SD and range for aSART variables.

Table 1

Means, standard deviations and range of scores of the main task variables

	Mean (SD)	Range
aSART		
Commission errors negative condition	16.67 (6.49)	0 - 30
Commission errors neutral condition	16.24 (6.38)	0 - 30
RT variance negative condition(ms)	.33 (.13)	.11 - .92
RT variance neutral condition (ms)	.32 (.12)	.12 - .80
IQ (standard scores)	113.23 (17.05)	76 - 158
CES-D Total	17.33 (10.49)	0 - 56

Note. aSART = Affective Sustained Attention to Response Task; IQ = Cattell Culture Fair Intelligence Test; CES-D = Center for Epidemiological Studies-Depression Scale; RT= Reaction time

The developmental trajectory of aSART performance

Zero-order correlations across the analysis sample (Table 2) revealed significant associations between age, IQ and gender, as well as with the measures of depression. These variables were included as covariates in all subsequent analyses.

Table 2

Correlations between independent variables

	Gender	IQ	CES-D Total
Age	-.18*	.01	.19*
Gender		.08	-.23*
IQ			.01

*P<.01

Hypothesis two. In support of our second hypothesis, that performance on the aSART would improve with age across adolescence, linear regressions (adjusting for gender and CES-D scores) examining if age in months predicted aSART performance, showed that older participants made fewer commission errors (negative: $R^2_{adjusted}$ =.068, F (3, 440) =11.70, p<.001, β = -.22, p<.001; neutral: $R^2_{adjusted}$ =.093, F (3, 440) =16.04, p<.001, β= -.25, p<.001) and showed lower RT variance (negative: $R^2_{adjusted}$ =.0.81, F (3, 440) =14.00, p<.001, β=-.28, p<.001; neutral: $R^2_{adjusted}$ =.11, F (3, 440) =18.81, p<.001, β= -.33) than did younger participants.

Hypothesis three. Failing to support our third hypothesis, that the influence of negative affective context would be greater for younger adolescents relative to their older peers, the difference in aSART performance between negative and neutral conditions appeared consistent across adolescence (see Figure 2), when adjusting for gender and depression and using our computed commission errors Index ($R^2_{adjusted}$ =-.002, F (3, 440) =.69, p=.56, β=.05, p=.31; RT variance Index= $R^2_{adjusted}$ =.01, F (3, 440) =2.08, p=.10, β=.02, p=.66).

Figure 2

aSART commission errors, with standard errors, in negative and neutral conditions showing an improvement in performance from 11 to 18 years

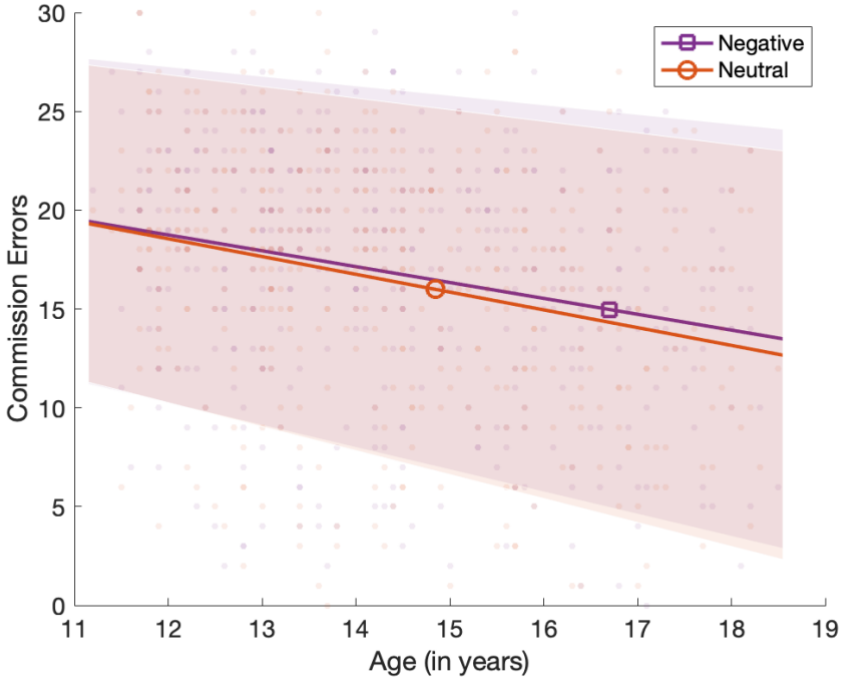
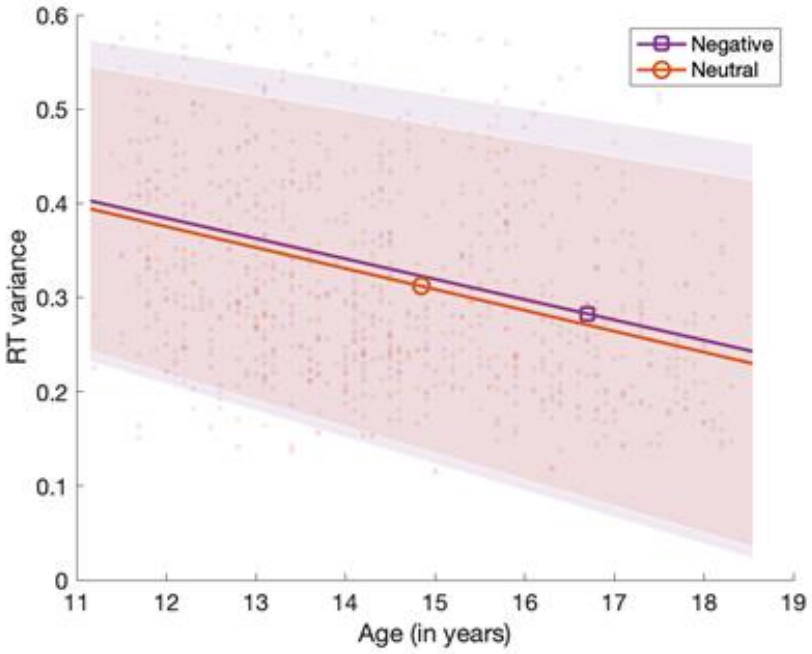


Figure 3

aSART RT variance , with standard errors, in negative and neutral conditions, showing a reduction in RT variance across ages 11 to 18 years



aSART performance and depression risk

Participants were allocated to two groups based on CES-D scores, with scores of 19 and over indicating a risk of depression and scores of less than 19 indicating lower risk (Briere, et al., 2013). One-hundred and sixty-four participants (125 Females, 39 Males; 36.8% of all participants) met the criteria for being 'at risk'. Demographic and aSART data for the two groups are presented in Table 3.

Chi^2 analysis showed a significant difference in the gender ratios between the 'at risk' and 'lower risk' groups, with a larger proportion of females in the 'at risk' group (X^2 (1, 446) = 12.75, p <.001). There was also a significant difference in age between groups, with the 'at risk' group being older than the 'lower risk' group (t (440) =3.48, p=.001, d= .34). Finally, self-reported depression was higher in the 'at risk' group (t (444) =28.50, p=.001, d= 2.80). There were no significant IQ differences between groups (t (444) = .40, p=.69). To adjust for these group differences, age and gender were covaried in subsequent analyses. These analyses were repeated using a continuous measure of anxiety (RCADS; Chorpita, Yim, Moffitt, Umemoto & Francis, 2000). Results for the analysis of anxiety can be seen in the supplemental materials.

Table 3

Means and standard deviations for the demographic and aSART data for those characterized as at risk and at lower risk of depression

	Lower Risk (n=282; Females n=168)		At Risk (n=164; Females n=125)	
	M	SD	M	SD
Age	14.19	1.76	14.80	1.81
IQ	112.99	17.29	113.66	16.67
CES-D total	10.91	4.61	28.38	8.34
aSART				
Commission errors negative	16.55	6.85	16.87	6.49
Commission errors neutral	16.09	6.57	16.50	6.38
RT variance negative (ms)	.34	.14	.32	.13
RT variance neutral (ms)	.32	.12	.32	.12

Note. IQ = Cattell Culture Fair Intelligence Test; CES-D = Center for Epidemiological Studies-Depression Scale; aSART = affective Sustained Attention to Response Task

To evaluate our fourth and fifth hypotheses, that adolescents deemed to be at risk for depression according to CES-D cut-offs, would show overall worse performance on the aSART relative to those deemed to be lower risk and that this would be greater in affective contexts, we conducted mixed-model general linear models with aSART Condition (negative, neutral) as the within-subjects factor, Group ('at risk', 'lower risk') as the between-subjects factor, and with age and gender included as covariates.

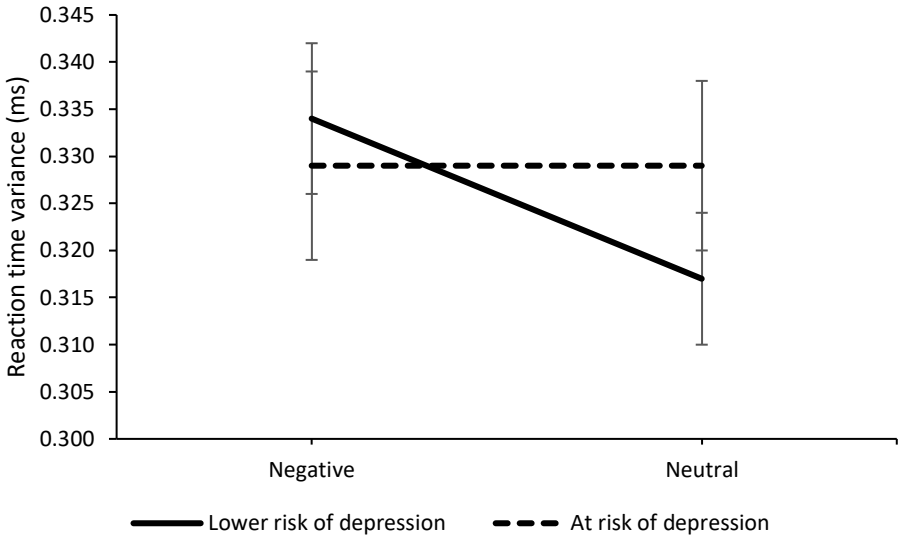
Hypothesis four. There was no significant main effect of Group (all *Fs*<2). This meant our hypothesis that aSART performance overall would be worse in the 'at risk' group than the 'lower risk' group, was not supported.

Hypothesis five. However, there was a significant Group by Condition interaction for RT variance (F (1,437) =4.18, p=.042, d=.19; see Figure 4). Those at risk of depression showed no difference in RT variance between the neutral and negative conditions, *F*< 1, while those deemed at lower risk of depression showing more variance in the negative condition relative to the neutral condition (F (1,

437) =4.27, p=.039, d=.20). There was no significant interaction involving group and condition for commission errors, F<1.

Figure 4

Interaction between RT variance in negative and neutral contexts and depression risk



Discussion

This study investigated the effects of affective contexts on sustained attention during adolescence and whether those effects were modulated by depression risk. To this end, we used an adapted affective version of the SART – the aSART, in which participants were required to withhold a response to infrequent targets, while listening to either negative or neutral sounds. Our first hypothesis was that participants would show a decrement in sustained attention performance in negatively valenced compared to neutral contexts. Our findings support this, with participants making significantly more commission errors and showing more RT variance in negative contexts. This demonstrates that adolescents have a relative difficulty in sustaining attention against a backdrop of aversive socio-affective stimuli. This might be because negative stimuli are more effortful and elaborate to process than neutral stimuli (e.g. Gibb, et al., 2016; Wentura,

Rothermund, & Bak, 2000) or because negative stimuli are more likely to shift attentional resources away from task demands (Pratto & John, 1991; Smallwood, Fitzgerald, Miles & Phillips, 2009). Effect sizes for significant findings were small but this is in line with the existing literature of effects of affective context on cognitive task performance (Schweizer et al., 2019). Even small effects such as these are likely to have a clear impact on everyday cognition (Funder & Ozer, 2019), once one considers how frequently we might use our sustained attention in affective contexts when managing daily life situations (Schweizer et al., 2019).

The study also showed that the age-related performance improvements present in typical sustained attention tasks were also present in the aSART. Younger participants made more commission errors and showed more variance in their RTs than their older peers. A previous large-scale study of sustained attention showed a similar pattern of developmental change, with rapid performance improvements in error rate from early to mid-adolescence that were accompanied by a reduction in RT variance (Fortenbaugh et al. 2015). This pattern of results is suggestive of an age-related change in strategy in older adolescents to one of a more inhibitive or cautious approach. We also predicted that the performance of younger participants would be more impacted by affective context than it would in older adolescents. We found no support for this hypothesis, however, with no significant difference between contexts as a function of age. This suggests that the impact of affective context on sustained attention is consistent across adolescent development and therefore likely dependent on different processes to those underpinning the gradual improvement of SART performance overall across the adolescent years. This contrasts with studies showing a linear age-related reduction in interference from affective stimuli on task performance (see Schweizer, Gotlib & Blakemore, 2020 for a review).

Our final two hypotheses were concerned with whether the aSART revealed different cognitive profiles related to risk of mental ill-health. We hypothesized that adolescents at risk of depression would show a decrement in performance on the aSART relative to a group that were at

lower risk and, in addition, whether this worsening in performance would be more prominent in negatively valenced contexts. We based these suppositions on the established relationship between impoverished sustained attention ability and depression (e.g. Weiland-Fiedler, et al., 2004; Cataldo, et al., 2005; Chantiluke, et al., 2012), and evidence that those at risk of depression tend to avoid negative socio-affective stimuli (Harrison & Gibb, 2015; Joorman, Talbot & Gotlib, 2007; Kujawa, et al., 2011). However, we found no support for these hypotheses. There was no suggestion that the 'at risk' group's sustained attention performance was worse overall. Furthermore, in contrast to our prediction, the increase in RT variance conferred by the negative context that was evident in the 'lower risk' group was absent in the 'at risk' group indicating that adolescents at risk for depression are able to maintain consistent sustained attention levels even when the context is negatively charged. It may be that negative contexts (relative to neutral ones) sharpen sustained attention in 'at risk' adolescents compared to their 'lower risk' peers. Indeed, arousal states for sustained attention tasks have been shown to have a U-shaped function (The Yerkes-Dodson Law; Broadhurst, 1957). Low arousal states can lead to low task engagement and high arousal states to increased distractibility, both of which can negatively impact performance. It is possible then that the negative contexts in the aSART were enough to selectively raise arousal in the 'at risk' group to an extent that their responses were not impacted by context, though this hypothesis would require further specific testing by independently varying the intensity of affective stimuli.

Conclusion

We used an adapted affective version of the SART to investigate the effects of a negative affective context (negative auditory stimuli) on sustained attention performance across adolescence. Across the sample as whole, sustained attention was poorer in the affective context relative to the neutral one. However, the extent of this decrement appeared invariant across adolescent development, despite a developmental improvement in SART performance overall. This suggests that age-related versus affective-context related decrements in performance are underpinned by different

mechanisms. We further found that the decrement in performance was eliminated in adolescents at risk for depression, suggesting that the low levels of emotional arousal associated with moderate mental health symptomatology may help mitigate the expected deleterious effects of negative stimuli on sustained attention performance in 'at risk' adolescents. Although it will be important to assess if the aSART is truly affective or negative specific, these results suggest that the aSART is a criterion-valid measure of sustained attention in affective contexts that might be useful in identifying cognitive markers of depression risk in adolescents.

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