

Using temporal distancing to regulate emotion in adolescence: modulation by reactive aggression.

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Abstract

Adopting a temporally distant perspective on stressors reduces distress in adults. Here we investigate whether the *extent* to which individuals project themselves into the future influences distancing efficacy. We also examined modulating effects of age across adolescence and reactive aggression: factors associated with reduced future-thinking and poor emotion regulation. Participants (N=83, aged 12-22) read scenarios and rated negative affect when adopting a distant-future perspective, near-future perspective, or when reacting naturally. Self-report data revealed significant downregulation of negative affect during the distant-future condition, with a similar though non-significant skin conductance pattern. Importantly, participants who projected further ahead showed the greatest distress reductions. While temporal distancing efficacy did not vary with age, participants reporting greater reactive aggression showed reduced distancing efficacy, and projected themselves less far into the future. Findings demonstrate the importance of temporal extent in effective temporal distancing; shedding light on a potential mechanism for poor emotional control associated with reactive aggression.

Keywords: adolescence, emotion regulation, reactive aggression, temporal distancing, skin conductance.

Introduction

Emotion regulation has been broadly defined as the monitoring, evaluation and modification of emotional reactions in order to accomplish goals (Thompson, 1994). One of the most researched emotion regulation strategies across the lifespan is reappraisal, which involves cognitively reframing the way we think about events to change their emotional impact (Gross, 1998), for example imagining that injured individuals will be fine and help is on the way or imagining that an individual is crying tears of joy, not sadness (Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner et al., 2004). While studies have demonstrated that reappraisal is effective at downregulating negative affect at behavioural, physiological and neural levels (McRae Ochsner, Mauss, Gabrieli, & Gross, 2008; Ochsner & Gross, 2008; Ochsner, Silvers, & Buhle, 2012; Ray, McRae, Ochsner, & Gross, 2010; Schartau, Dalgleish, & Dunn, 2009), reappraisal represents a broad category of emotion regulation strategies and thus recent studies have sought to more precisely delineate the efficacy of specific strategies encompassed by this definition. One such strategy is distancing, which involves mentally changing the interpretation of an emotional event by increasing or decreasing one's psychological distance from it (Kross, Ayduk & Mischel, 2005; Ochsner et al., 2004). This can be accomplished in multiple ways. For instance, psychological distance can be changed by varying the perceived temporal (e.g. 'it happened a long time ago') or physical (e.g. 'it's happening far away') closeness of an emotional situation, or instead by viewing it from the perspective of an impartial observer (e.g. 'I don't know anyone involved') (Denny & Ochsner, 2014).

Behavioural, physiological and neuroimaging studies have shown that distancing is a particularly effective strategy for downregulating negative affect in both adults (e.g. Denny & Ochsner, 2014) and children (Kross, Duckworth, Ayduk, Tsukayama, Mischel, 2011). For example, training in adopting a self-distanced perspective reduced self-reported negative affect in response to aversive photos longitudinally over a two-week period (Denny & Ochsner, 2014), with distancing shown to be more effective than the use of a situational reinterpretation strategy (a key category within reappraisal which involves generating an alternate meaning for the stimulus in an effort to

reduce negative affect). Further, blood pressure responses are reduced while recalling a frustrating experience from a self-distanced perspective both during and after the experiment (Ayduk & Kross, 2008). Neurally, distancing oneself from aversive photos by adopting a detached perspective has been found to modulate amygdala response, and engage brain networks implicated in cognitive control (Dörfel et al., 2014; Koenigsberg et al., 2010).

Evidence to date suggests that distancing shows clear efficacy as an emotion regulation strategy. However, the majority of studies investigating specific strategies within distancing, i.e. temporal, spatial and impartial observer strategies, have focused on the latter (especially on 'self-distancing' as discussed above, e.g. Ayduk & Kross, 2008; Kross et al., 2011; Park, Ayduk & Kross, 2016). While it is currently unknown whether the different types of distancing have different regulatory effects (although see Nook, Schleider & Somerville, 2017), recent research on temporal distancing has been promising. For example, studies have shown that thinking about whether a stressful life event would affect you in the distant (as opposed to near) future reduces distress (Bruehlman-Senecal & Ayduk, 2015), and that use of this strategy in everyday life is associated with greater wellbeing (Bruehlman-Senecal, Ayduk, & John, 2016). However, this evidence derives from asking participants to regulate distress associated with only one stressful event that participants had recently experienced. While this demonstrates the efficacy of temporal distancing in response to real-world stressors, it is necessarily at the expense of experimental control. Furthermore, while previous research has shown that thinking of the distant future is an effective strategy, the importance of temporal extent during future thinking (e.g. thinking of one year vs. five years into the future) on its efficacy has not been investigated. Investigating this would inform our understanding as to *why* such a strategy may be effective: does temporal extent actually matter for efficacy, or does the mere act of representing future events have the same effect, regardless of temporal extent? It is also unknown whether there may exist temporal boundaries within which temporal distancing is particularly effective. Understanding why strategies such as temporal distancing are effective in regulating emotion could inform both strategies for everyday emotion regulation and

clinical intervention. Therefore one aim of the present study is to evaluate the degree to which a manipulation of the *magnitude of temporal distance* modulates emotional responses in a novel experimental task comprising multiple stressful events, repeated across participants.

A second objective was to examine the development of temporal distancing efficacy from adolescence to adulthood. Adolescence is a key time for the emergence of internalising and externalising conditions (Bask, 2015; Moffitt, 1993; Paus, Keshavan, & Giedd, 2008). Many of these symptoms, such as reactive aggression, are associated with poor emotion regulation (Eisenberg, Spinrad & Eggum, 2010; Lewis et al., 2008). This may be at least in part due to on-going development of frontolimbic circuitry involved in regulatory processes (Ahmed, Bittencourt-Hewitt, & Sebastian, 2015; Casey, Jones, & Hare, 2008; Sebastian, Viding, Williams, & Blakemore, 2010; Somerville & Casey, 2010). Experimental studies of reappraisal efficacy suggest development may be protracted. For example, McRae et al. (2012) found a linear improvement in reappraisal ability with age (10–22 years), accompanied by a concomitant age-related increase in left ventrolateral prefrontal cortex (vlPFC) response, associated with cognitive control. Regarding distancing specifically, Silvers et al. (2012) instructed participants to imagine being further away from the scene and to focus more on facts than emotional details (i.e. a combination of spatial and impartial observer aspects of distancing). There was a pattern of linear improvement in regulation success from ages 10-18, with a tapering thereafter. In an fMRI study consisting of 112 participants (aged 6–23 years) using the same paradigm, Silvers et al. (2016) found that during distancing age predicted reduced amygdala activation, with vlPFC recruitment mediating this relationship.

Thus, a second aim of the present study was to isolate the developmental progression of effective temporal distancing. In the study by Bruehlman-Senecal and Ayduk (2015), the temporal distancing instruction required participants to imagine how they would feel about a recent event in the distant future, i.e. in several years' time. However, episodic future thinking, i.e. the ability to 'pre-experience' events before they happen and project oneself into the future (Schacter, Benoit, De Brigard, & Szpunar, 2015), continues to develop into adolescence, along with underlying episodic

memory and executive function skills (Gott & Lah, 2014). Relatedly, research investigating temporal discounting has found that adolescents opt for smaller immediate rewards over larger longer-term rewards to a greater extent than do adults (Steinberg et al., 2009; Whelen & McHugh, 2009), suggesting that adolescents may be less able to take into account their future selves and anticipate consequences when making these types of decisions. Together, these data suggest that adolescents may be more 'present-oriented' than adults, and may thus have more difficulty implementing a temporal distancing strategy.

A final research question concerns the role of individual differences in aggressive behaviour. Experimental studies in adults suggest that while reappraisal is effective at reducing reactive anger (Fabiansson & Denson, 2012) and vengeance (Barlett & Anderson, 2011), high trait aggression is negatively associated with questionnaire-based measures of reappraisal (e.g. Martin & Dahlen, 2005). Moreover in a large-scale study of over one thousand adolescents, self-reported adaptive emotion regulation negatively predicted self- and peer-reported aggressive behaviour (Calvete & Orue, 2012). Despite this, there is a clear lack of experimental studies on emotion regulation and aggression across adolescence, thus the relationship between aggression in everyday life and instructed reappraisal ability is currently unknown.

Adolescence in particular is associated with a peak in reactive aggression (Moffitt, 1993), i.e. aggression occurring in response to a perceived provocation or threat (Berkowitz, 1993). In contrast, proactive aggression, which tends to be more stable over the lifespan, is a relatively non-emotional display of aggression that is unprovoked and used for instrumental gain (Dodge & Coie, 1987). Studies investigating adults, adolescents and children have found that reactive aggression is associated with low frustration tolerance and high affective-physiological arousal that is poorly regulated (Chase, O'Leary, & Heyman, 2001; Marsee & Frick, 2007; Vitaro, Brendgen, & Tremblay, 2002). Poor emotion regulation is thus particularly associated with reactive as opposed to proactive aggression (Eisenberg et al., 2010) and thus we would predict that reactive aggression would be specifically associated with difficulties in implementing reappraisal strategies. Reactive aggression

may also be predicted to be associated with poor temporal distancing. Evidence shows that adolescents characterised by oppositional defiant disorder and conduct disorder demonstrate increased temporal discounting compared to community control adolescents (Barkley et al., 2001). This suggests reduced ability to take the future self into account during value-based decisions. Whether this would generalise to reduced efficacy in a future thinking-based emotional regulation strategy such as temporal distancing is an empirical question which our study aims to address. In the present study, we combine an experimental manipulation of reappraisal and characterisation of aggression subtypes to test how age, individual differences in temporal distancing ability and aggression in daily life interact.

Although the current study is concerned with externalising problems, it is important to note that reactive aggression tends to be highly correlated with internalising problems such as anxiety, with both being associated with heightened emotional reactivity (Kunimatsu & Marsee, 2012; Richards, Benson, Donnelly, & Hadwin, 2014). Internalising symptoms are also strongly associated with poor emotion regulation, including reduced use of reappraisal in general (Garnefski, Kraaij & van Etten, 2005) and temporal distancing specifically (Bruehlman-Senecal, Ayduk, & John, 2016). Therefore when examining reactive aggression, anxiety will be controlled for, to demonstrate that the effects are not driven by variance shared between anxiety and aggression.

The present study investigated the efficacy of temporal distancing as an emotion regulation strategy across the transition from adolescence to adulthood, and examined the role of individual differences in aggressive behaviour. To do so, we adapted a standard protocol for investigating reappraisal of emotional images (e.g., Denny & Ochsner, 2014; McRae et al., 2012; Ochsner et al., 2002, 2004). We report a novel version with stimuli comprising written stressful 'everyday' scenarios, to facilitate episodic future thinking. While autobiographical memories, as used in the previous temporal distancing studies, may be more immersive than written scenarios, it is difficult to control such stimuli across participants. Further, IAPS images commonly used in emotion regulation studies would not be ideal for the current task as they depict events happening to others whereas in

this study we wanted participants to imagine events happening to themselves, in line with prior studies investigating temporal distancing in response to a personal stressor (e.g. Bruehlman-Senecal & Ayduk, 2015; Bruehlman-Senecal et al., 2016). The scenarios chosen were tailor-made such that they could plausibly happen to individuals of all ages included in the study, and ensured that all participants were reflecting on specific situations in as similar way as possible. Similar to the task by Bruehlman-Senecal and Ayduk (2015), participants were instructed to take a distant-future perspective, a near-future perspective, or to react naturally to each scenario, and then to rate their distress and arousal. The relative difficulty of distancing over simply reacting could distract from the distress elicited, therefore the near-future condition was included to control for the cognitive processes involved in taking a distant perspective.

Emotion comprises both subjective and physiological aspects (Lang, 1995), and therefore we obtained skin conductance data in addition to self-report measures in order to obtain a more complete summary of emotional response. Including an objective physiological measure alongside explicit measures also helps to address potential demand characteristics associated with self-report (Williamson, 2007). Skin conductance has been found to be a good index of emotional arousal (e.g., Bradley, Miccoli, Escrig, & Lang, 2008; Lang, Greenwald, Bradley, & Hamm, 1993) and several emotion regulation studies have demonstrated reduced skin conductance response patterns during regulation relative to control conditions (e.g., Feeser, Prehn, Kazzer, Mungee, & Bajbouj, 2014; Matejka et al., 2013; Urry, van Reekum, Johnstone, & Davidson, 2009), generally making it a good accompaniment to ratings of subjective affect in the present study (although see a recent study by Shermohammed et al. (in press) that found no effects of valence or reappraisal on skin conductance).

We predicted: 1) Distant future versus near future distancing would be an effective emotion regulation strategy as indexed by self-report and skin conductance data (i.e. lower self-reported ratings and skin conductance responses during the Distant condition). 2) The efficacy of temporal distancing would increase with age from adolescence to young adulthood. 3) Reactive, but not

proactive, aggression would peak in adolescence and be associated with reduced efficacy of temporal distancing.

Method

Participants

Eighty-four participants were recruited from Harvard University Secondary School Program and the local Boston community. Data for one participant were excluded from all analyses due to a failure to adhere to task instructions leaving a total of 83 participants (50 females, age range 12-22 years: 12 participants aged 12-14; 33 aged 15-17; 38 aged 18-22). One participant did not complete the questionnaire measures, and two participants were excluded from the skin conductance response (SCR) analyses due to experimenter error in one case and a non-responsive dataset (no $SCR > 0.05 \mu\text{Siemens}$) in the other. Participants received course credit or were paid \$15 for their participation in the study. Before study participation, participants and their legal guardians provided written assent and consent under a protocol approved by the Committee for Use of Human Subjects at Harvard University.

Behavioural task and stimuli

The stimuli consisted of scenarios (short sentences) that were either negatively valenced (N=30; e.g. 'You fail an important exam') or neutral (N=10; e.g. 'The main hall is being repainted'). Some of these scenarios were adapted from Salemink and Wiers (2012). Prior to the main experiment, stimuli were piloted for valence (Cronbach's alpha (α) =.96), arousal (α =.94) and the length of time over which the scenarios were judged to impact a person's life (α =.86) with an opportunity sample of 16 participants (4 males; aged 16-27). Based on the pilot data, the scenarios were sorted into four sets (three sets containing negative scenarios and one set containing neutral scenarios). Negative sets were matched on valence and arousal ratings from 1–9 (1=very happy, 9=very distressed for the distress rating and 1=very calm, 9=very anxious/stressed for the arousal ratings). Average distress and arousal ratings of the 30 negative scenarios were 6.56 ($SD=1.03$) and

6.58 ($SD= 1.26$) respectively; the ratings between each of the negative sets did not significantly differ from each other ($ps>.99$). The average distress and arousal ratings for the neutral set were 2.78 ($SD=0.62$) and 3.15 ($SD= 1.95$) respectively. There were significant differences between the neutral set and all three negative sets for valence ($ps<.001$) and arousal ($ps<.01$). The negative sets were also matched on the time over which scenarios would impact a person's life (1= up to tonight/tomorrow, 2=one week, 3=one month, 4=six months, 5=one year, 6=five years). Average impact time rating across the three negative sets was 2.38 ($SD=0.10$) and ratings between each of the negative sets did not significantly differ from each other ($ps>.99$). For the actual experiment, this scale was increased to 9 to match the affect rating scales and also to include a longer impact time of 10 years, in response to feedback from pilot participants. Each of the three sets of 10 negative scenarios was randomised to one of the three negative conditions (Read, Near Future, Distant Future) for each participant. The neutral set was always paired with the 'Read' instruction.

As an additional stimulus control measure, the three negative sets were matched for type of stressor and social content (each set contained two scenarios from each of the following: social rejection, embarrassment, anger/frustration, physical pain and threatening future existence). The remaining neutral set contained scenarios that drew on features from a random selection of 10 negative scenarios e.g. the neutral scenario 'your friend has blonde hair' drew on features from the negative scenario 'you have a serious argument with your friend' (matched for social content). Stimuli were presented in blocks, with 5 stimuli from the same condition in each block. Participants completed two runs of the 4 conditions, presented in a different random order each time. The order in which the scenarios were presented within each condition was randomised across participants, and each participant saw each scenario only once.

Participants viewed these scenarios within four conditions. They included 'READ [neutral]' (participants read and rated natural reactions to neutral scenarios), 'READ [negative]' (participants read and rated natural reactions to negative scenarios), 'Think of whether each of the situations would still affect you in the DISTANT future' (negative scenarios where the participant was

instructed to use distancing (further details below)) and ‘Think of whether this would still affect you in the NEAR future’ (negative scenarios where the participant was instructed to use distancing, but only to consider the near future: a control for the cognitive processes involved in distancing). Prior to beginning the task, participants were asked to read the task instructions and were shown examples of negative scenarios (different from those used in the task) and specific instructions for each condition. The task was also verbally explained to them and it was reiterated that for Near and Distant conditions, they had to project themselves into the future to consider how each scenario would likely affect them at the chosen time point, and then consider and rate how they *currently* felt after projecting themselves. This was to increase the likelihood that participants would all be using the same strategy in the same way.

At the beginning of every five trials, the corresponding READ or specific distancing instruction (5 seconds) was presented, followed by the scenario which was displayed on screen for 7 seconds (see *Figure 1* for trial structure). After each scenario, participants rated their distress (worded as “How upset do you feel right now?”) and arousal (worded as “How anxious/stressed do you feel right now?”) on Self-Assessment Manikin scales rated 1-9 (low to high) on the keyboard. As a manipulation check, participants were also asked to rate the approximate distance in time adopted on each trial for Near Future and Distant Future conditions on a timescale (1=tonight/tomorrow, 2=one week, 3=one month, 4=six months, 5=one year, 6=two years, 7=three years, 8=five years, 9=10 years from now). This also enabled us to examine whether the timeframe adopted varied with regulatory efficacy, age and aggression. Participants were given a fixed duration of 7 seconds for each rating (separated by a 0.5 second fixation cross). The task was presented and responses were recorded using Psychtoolbox for Matlab (version R2015a).

Behavioural ratings analysis

For the behavioural data, temporal distancing success was computed as the difference between the Read Negative condition (unregulated reactivity) and Distant Future (regulated

reactivity), comparable to previous emotion regulation studies (e.g. McRae et al., 2012). This was to see how much negative affect has been reduced (or increased) as a result of the instructed strategy, relative to unregulated responding. Similarly, emotional reactivity was computed as the difference between Read Negative and Read Neutral. These two variables were then used to correlate with the manipulation check (distance in time adopted), skin conductance and individual differences measures.

Skin Conductance and analysis

Prior to the task, two skin conductance electrodes were placed on the distal phalanges of the middle and index fingers of the participant's non-dominant hand, attached with a Velcro strap. This arm was also strapped onto the table to ensure that participants kept still throughout the task. A skin conductance recording system (GSR100C Biopac, Goleta, CA) together with AcqKnowledge 4.0 (Biopac; Goleta, CA) software continuously sampled skin conductance data at 100 Hertz during the task.

A 0.05Hz high-pass filter was applied to the tonic electrodermal activity (EDA) signal to yield phasic EDA. Skin conductance responses (SCR) in the following analyses refer to SCRs that were elicited in the 11 seconds following scenario onset (comprising the 7 secs during which each stimulus was presented plus 4 seconds (responses later than 4 secs after the stimulus offset are usually considered a non-specific response (Boucsein et al., 2012)). A minimum threshold detection level of 0.04 μ Siemens was applied during this period. For all SCRs identified during this time window (i.e. for each trial), the peak amplitude was recorded and the average peak height relative to the pre-response baseline across trials of the same condition was used as the dependent variable (amplitude). SCR data were not normally distributed and therefore were square root transformed prior to statistical analysis in line with previous similar studies (e.g. Sokol-Hessner et al., 2009; Wolgast, Lundh & Viborg, 2011).

Developmental analysis

As in our prior work, age was invoked as a continuous predictor of developmental differences to maximize statistical power and to mitigate the need to create semi-arbitrary boundaries between age groups (Somerville et al., 2013). Age was invoked as a linear predictor of change, calculated by mean-centring each participant's actual age. As some previous studies have shown a non-linear pattern of emotion regulation development between adolescence and adulthood (e.g. Silvers et al., 2012), the quadratic predictor (age^2) was also included in statistical analyses (computed by squaring mean-centred age). Both predictors were uncorrelated as regressors ($r(81) = .030, p = .79$) and were therefore placed in the same regression model.

Questionnaire measures

The Reactive Proactive Aggression questionnaire (RPQ; Raine et al., 2006) consists of 23 items, and measures reactive (11 items e.g. "become angry when others threatened you") and proactive (12 items; e.g. "Had fights with others to show who was on top") aggression in child and adolescent samples. Each item was rated by participants as 1 (never), 2 (rarely), 3 (sometimes), or 4 (often) for frequency of occurrence¹.

Participants also completed the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), as aggression and anxiety are typically moderately correlated and this allowed us to examine whether results concerning aggression would hold after controlling for anxiety.

¹ In the course of data checking, we found that participants should have been presented with three options scored as follows: 0 (never), 1 (sometimes), 2 (never). To check consistency with prior studies using the RPQ, we recoded the data from the four-option version as 0 (never), 1 (rarely/sometimes) and 2 (often). Results of analyses using this 0-2 scoring were almost identical to those obtained when scoring the measure using four options, and are available upon request. Mean scores (using the 0-2 scoring) for both Proactive Aggression ($M = 2.99, SD = 2.60$) and Reactive Aggression ($M = 8.53, SD = 2.83$) subscales were similar to those from previous studies in typical adolescents (Raine et al., 2006; Proactive Aggression: $M = 2.79, SD = 3.47$; Reactive Aggression: $M = 7.14, SD = 4.18$).

Participants also completed the Emotion Regulation Questionnaire (Gross & John, 2003) as a measure of reappraisal use in everyday life. This measure was unrelated to task performance, possibly due to differences between the broad conceptualisation of reappraisal in the questionnaire, and our specific operationalisation of temporal distancing; and is not discussed further.

Results

Hypothesis 1: Distancing Efficacy

Behavioural data

Distress

A repeated measures ANOVA revealed the hypothesised main effect of Condition on distress ratings ($F(3, 246)=374.19, p<.001, \text{partial } \eta^2=.82$). Pairwise comparisons were conducted showing that Distress ratings followed the pattern: Read Neutral (Mean (M)=2.89, Standard Deviation (SD)=1.31) < Distant Future ($M=5.97, SD=1.41$) < Near Future ($M=6.54, SD=1.14$) < Read Negative ($M=6.78, SD=.84$), (all $ps<.05$, see *Figure 2a*). This analysis was also conducted without the Read Neutral condition (which could potentially inflate the findings); the main effect remained significant: $F(2, 164)=28.44, p<.001, \text{partial } \eta^2=.26$, Distant Future < Near Future < Read Negative (all $ps<.05$). The results suggest that distancing was effective relative to using no strategy, and that a greater temporal scope of distancing was more successful at reducing distress.

There was also a positive correlation between distancing success and subjective reports of mean distance in time adopted during Distant Future trials ($M=4.37, SD=1.45, \text{range}=1.30-8.67$; $r(81)=.38, p<.001$, see *Figure 3a*), i.e. participants who were more effective in reducing their distress tended to project themselves further into the future. This remained significant after controlling for age ($r(81)=.37, p=.001$). The correlation between distancing success using Near Future distancing (Read Negative – Near Future) and time adopted during this condition ($M=2.68, SD=1.07$,

range=1.00-6.00) was non-significant ($r(81)=.11, p=.33$). The difference between these correlation coefficients was marginally significant ($Z=1.81, p=.063$; Raghunathan, Rosenthal, & Rubin, 1996).

Arousal

A repeated measures ANOVA revealed the hypothesised main effect of Condition on arousal ratings ($F(3, 246)=481.46, p<.001, \text{partial } \eta^2=.85$). Arousal ratings followed the pattern: Read Neutral ($M=1.76, SD=.65$) < Distant Future ($M=5.06, SD=1.52$) < Near Future ($M=5.65, SD=1.37$) < Read Negative ($M=6.02, SD= 1.04$) (all $ps<.005$, see *Figure 2b*). Like the Distress results, the Arousal main effect remained significant without the Read Neutral condition in the analysis: $F(2, 164)=31.57, p<.001, \text{partial } \eta^2=.28$, Distant Future < Near Future < Read Negative (all $ps<.005$). Thus, distancing was effective in reducing arousal as well as distress, relative to control conditions.

There was also a positive correlation between distancing success and distance in time adopted during the Distant Future condition ($r(81)=.35, p=.001$, see *Figure 3b*). This remained significant after controlling for age ($r(81)=.35, p=.001$). The correlation between distancing success and time adopted during the Near Future condition was non-significant ($r(81)=-.023, p=.83$). The difference between these correlation coefficients was significant ($Z=2.46, p=.011$).

Skin Conductance Data

A repeated measures ANOVA on the mean peak amplitude of SCRs revealed a significant main effect of Condition ($F(3, 240)=2.92, p=.035, \text{partial } \eta^2=.035$). Scenarios presented during the Read Neutral condition ($M=.54 \mu\text{S}, SD=.25$) elicited significantly lower amplitudes of SCRs relative to the Read Negative condition ($M=.61, SD=.23, p=.023$) and the Near Future condition ($M=.62, SD=.26; p=.021$, see *Figure 4*) but was not significantly different from the Distant Future condition ($M=.58, SD=.24; p=.16$). There were no significant differences between Read Negative and either Near Future ($p=.72$) or Distant Future ($p=.28$) conditions, neither was there a difference between Distant and Near conditions ($p=.12$). An analysis conducted with three participants removed (potential outliers with amplitudes greater than three SDs from the group mean) yielded identical results.

There were no significant correlations between SCR distancing success and distance in time adopted during the Distant Future condition ($r(79)=.058, p=.61$) or the equivalent for the Near Future condition ($r(79)=.004, p=.97$). There were also no significant correlations between the SCR data and self-report ratings of distress and arousal for any of the conditions or computed reactivity variables.

Hypothesis 2: Developmental effects

Distancing task

In line with previous studies (e.g. McRae et al., 2012; Silvers et al., 2012), regression analyses were performed to test for age effects on emotional reactivity (defined as ratings for Read Negative – Read Neutral) as well as distancing success.

The regression equation for emotional reactivity was not significant as measured by distress ($F(2,80)=.23, p=.80$) or arousal ($F(2,80)=.99, p=.38$) ratings. Linear and quadratic relationships between age and emotional reactivity were all non-significant ($ps>.80$).

The regression equation for distancing success was also non-significant as measured by distress ($F(2,80)=.51, p=.60$) and arousal ($F(2,80)=.42, p=.66$) ratings. Linear and quadratic relationships between age and distancing success were all non-significant ($ps>.66$).

The correlation between age and distance in time adopted during Distant Future ($r(81)=.032, p=.77$) was non-significant, but was marginally significant for the Near Future condition ($r(81)= -.202, p=.065$).

SCR data

Correlation analyses between age and SCR data also revealed non-significant relationships between age and SCR measures of emotional reactivity ($r(79)=-.089, p=.43$) and distancing success ($r(79)=.031, p=.78$).

Aggression and anxiety measures

There were both significant linear ($r(80)=-.24, p=.033$) and quadratic relationships between age and reactive aggression: ($F(2,79)=3.74, p=.028$). The quadratic relationship was an inverted U (see *Figure 5*), showing a peak during mid-adolescence (15.4 years). However there was neither a linear ($p=.54$) nor quadratic ($p=.41$) relationship between proactive aggression and age.

There was no significant linear relationship between Trait Anxiety and age ($p=.68$); however there was a significant quadratic relationship ($F(2,79)=3.93, p=.024$), with peaks during late adolescence (17.6 years).

State and Trait Anxiety were also not significantly correlated with distancing success, either measured by distress or arousal ratings ($ps>.098$).

Hypothesis 3: Distancing success and reactive aggression.

Reactive aggression was negatively correlated with distancing success, as measured by distress ratings ($r(80)=-.28, p=.010$) (*Figure 6a*). This relationship remained significant after controlling for proactive aggression ($r(80)=-.22, p=.047$), age ($r(80)=-.27, p=.013$), and trait anxiety ($r(80)=-.25, p=.027$), all of which showed significant positive correlations with reactive aggression ($ps<.05$). Furthermore, the effect remained significant when controlling for gender, showing that gender did not modulate the relationship ($F(2, 79)=3.56, p=.033$). To investigate whether the negative relationship between reactive aggression and distancing success was driven by baseline reactivity or the distancing condition itself we examined correlations between reactive aggression and distress ratings during the Distant Future and Read Negative conditions separately (*Figure 6b*). There was a positive relationship between reactive aggression and distress levels during the Distant Future condition ($r(80)=.312, p=.004$), but no relationship in the Read Negative condition ($r(80)=.144, p=.20$). While a Steiger's Z test did not show a significant difference between the slopes ($Z=-1.77, p=.077$), the pattern of results seen in *Figure 6b* suggests that the significant negative relationship between distancing success and reactive aggression was driven by the Distant Future

condition. Indeed, inspection of the slopes reveals that for those highest in reactive aggression, distress in the Distant Future condition did not differ from distress during Read Negative (no strategy).

Given the negative relationship between distancing success and reactive aggression, and the positive relationship between distancing success and distance in time adopted, we conducted an exploratory analysis to examine the relationship between reactive aggression and distance in time adopted during the Distant Future condition. This showed a marginal negative correlation ($r(80)=-.213, p=.055$), i.e. those high in reactive aggression projected themselves less far into the future.

There was no significant relationship between reactive aggression and distancing success as measured by arousal ratings ($r(80)=-.19, p=.091$). There were also no significant relationships between proactive aggression and distancing success using either distress or arousal ratings (all $ps>.19$).

There were no significant correlations between reactive aggression and SCR measures of emotional reactivity or distancing success ($ps>.96$).

Finally, we looked for interactions between age and distancing success in predicting reactive aggression, and between age and reactive aggression predicting distancing success using the *PROCESS* toolbox for SPSS. However neither analysis was significant ($b=.062, 95\% \text{ CI } [-.28, .40], t=.36, p=.72; b=.012, 95\% \text{ CI } [-.01, .03], t=1.38, p=.17$, respectively).

Discussion

The present study investigated the efficacy of temporal distancing (thinking how one would be affected by a given scenario in the distant future) as an emotion regulation strategy across adolescence, and the role of individual differences in reactive aggression. Consistent with our hypotheses, temporal distancing was an effective emotion regulation strategy as indicated by

subjective ratings, with a similar though non-significant pattern of skin conductance responses. However, efficacy did not vary with age between adolescence and adulthood. Finally reactive, but not proactive, aggression was associated with reduced efficacy of temporal distancing.

Hypothesis 1: Distancing Efficacy

In line with our first prediction, subjective ratings indicated that temporal distancing (Distant Future) was an effective emotion regulation strategy over and above no strategy (Read Negative) and taking a near future perspective, as measured by both distress and arousal ratings. There was no significant difference in skin conductance between the Distant Future and Read Negative conditions, however the pattern of results was in the predicted direction. Also while SCRs were significantly higher in the Read Negative and Near Future conditions relative to reading neutral scenarios, responses did not significantly differ between taking a distant-future perspective and reading neutral scenarios. Together these findings replicate and significantly extend the existing literature by showing that temporal distancing is effective as an emotion regulation strategy using a controlled experimental task consisting of a range of commonly occurring 'everyday' scenarios. Crucially, participants who projected themselves further into the future benefited most from this strategy. These findings build confidence in the effectiveness of future-oriented regulation strategies.

It could be argued that the mere act of projection into the future is a distraction from the distress elicited, leading to reduced behavioural and physiological responses. We included the Near Future condition specifically to control for the intensity of task demands. The behavioural data showed that distress and arousal were significantly lower during the Distant Future condition relative to Near Future, a condition matched as far as possible for all cognitive processes except distance in time adopted (including following instructions, using episodic future thinking and generating mental imagery). This suggests that adopting a distant perspective specifically is effective over and above any more general effects seen in the Near Future condition; a conclusion bolstered by the correlation discussed above between distancing success and distance in time adopted in the

Distant Future condition. It is worth noting that this relationship was not significant in the Near Future condition, although this may be at least partially driven by the reduced range of temporal extent ratings ($M=2.68$, $SD=1.07$, range=1.00-6.00) for this condition relative to Distant Future ($M=4.37$, $SD=1.45$, range=1.30-8.67).

There are a number of reasons why temporal distancing may be effective. Adopting a distant future perspective on stressful events can highlight one's awareness of the impermanence of the stressor, and relative insignificance of the impact of the stressor in the broader scheme of things, an understanding that may function to reduce their present distress. In contrast, one's view of the near future tends to be more concrete; thus they are more likely to consider how the consequences of the stressor would impact their daily life (Heller et al., 2011; Wakslak et al., 2008). Indeed, Bruehlman-Senecal and Ayduk (2015) found that the extent to which participants focused on the impermanent nature of their stressor consistently mediated the relationship between temporal distancing and reduced distress. Another potential mechanism for temporal distancing efficacy is that psychologically healthy people tend to view their distant future as more positive (Heller, Stephan, Kifer, & Sedikides, 2011) and expect their lives and emotional experiences to be more stable relative to their view of their near future (Liberman, Sagristano, & Trope, 2002; Wakslak, Nussbaum, Liberman, & Trope, 2008). However, it is worth noting that focusing on an ideal future did not consistently mediate the relationship between temporal distancing and reduced distress in Bruehlman-Senecal and Ayduk's (2015) study. Thus, prior evidence suggests impermanence may be the stronger mediator of temporal distancing effects. With regards to the present study, the specific instructions and prior examples given to participants directed them to use episodic future thinking (actually projecting themselves into the future using mental imagery) as opposed to using cognitive rationalisations ('this probably won't affect me in future') or other strategies to reduce their distress. The emphasis in the instructions on participants 'pre-experiencing' their future reactions may have helped them to realise the impermanent nature of the stressors presented. However, future work

could address this empirically to test whether episodic future thinking enhances temporal distancing efficacy over and above cognitive rationalisations.

Hypothesis 2: Developmental Effects

Our second hypothesis was that temporal distancing efficacy would increase with age between adolescence and adulthood as previous studies have shown that this period is associated with on-going development in emotion regulation abilities (e.g. McRae et al., 2012) and the brain systems which subserve them (e.g. Casey et al., 2008; Giedd et al., 1999). However, our data suggest that the efficacy of temporal distancing is both high and stable across the age range tested, i.e. 12-year-old adolescents were just as effective at the task as 22-year-old adults. Only two studies to date have investigated distancing across development (Silvers et al., 2012; 2016) and they found that distancing efficacy improved with age until approximately 18 years (Silvers et al., 2012). Both of these studies used event-related designs whereas the present study used a block design, which was perhaps easier for the younger participants. However, this study also used a very different task, requiring a combination of spatial and interpersonal distancing to regulate distress when viewing aversive images. It is likely that the cognitive processes underlying this strategy differed from those involved in temporal distancing as implemented here in important ways. As discussed above, our temporal distancing instruction required episodic future thinking which relies on component processes including working memory, relational memory, visual-spatial processing and apprehension of time (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010) as well as self-consciousness, which has been found to predict feelings of experiencing the imagined events (D'Argembeau et al., 2010). Additionally, scene construction, which refers to the generation, maintenance and visualisation of complex scenes, has also been implicated in future thinking (Hassabis & Maguire, 2007). Existing evidence on the developmental trajectory of episodic future thinking is scarce. Gott and Lah (2014) found that episodic future thinking continues to develop between late childhood (8-10 years) and mid-adolescence (14-16 years). However, it may be that episodic future thinking in our

adolescent sample (minimum age of 12) was sufficiently developed to meet the requirements of our task.

Temporal discounting research (e.g. Steinberg et al., 2009) suggests that adolescents tend to be less future-focused than adults at least when making decisions between immediate and future rewards. We might also expect adolescents to be less able to project themselves into the future simply because they have less of an idea what their future will look like. However in the present study there was no correlation between age and distance in time adopted during the distancing conditions. Again this suggests that, at least when instructed, adolescents are able to implement the instruction to distance, with equivalent behavioural and physiological consequences regardless of age. It is possible that we did not have enough power to see the predicted developmental effects, particularly as we had a limited number of younger adolescents (aged 12-14). However, we think it unlikely that the null correlation between age and distancing efficacy ($r=.091$, $p=.415$) was related to low power. Even with a sample of ~900 participants we would not achieve 80% power to detect such a small effect ($r^2<.01$). Arguably this effect size is not theoretically interesting. In contrast, individual differences associated with emotional reactivity and regulation, namely reactive aggression and anxiety, did show developmental change in line with previous accounts (e.g. Casey et al., 2008; Ernst, 2014; Moffitt, 1993). If adolescents and adults are equally adept at using temporal distancing, this suggests that it could well be a fruitful strategy to focus on in helping adolescents to manage everyday stressors, regardless of age-specific change in emotional lability.

Hypothesis 3: Distancing Success and Reactive Aggression

In line with the final hypothesis, reactive (but not proactive) aggression was negatively correlated with temporal distancing efficacy as measured by distress ratings. To our knowledge, this is the first study to demonstrate this association using an experimental task as prior research has only looked at reactive aggression in relation to general emotion dysregulation using questionnaire measures (e.g. Marsee & Frick, 2007; Vitaro et al. 2002; Xu & Zhang, 2008). Interestingly, baseline

distress did not vary across different levels of reactive aggression. Instead, the negative correlation was driven by a lower reduction of distress during the Distant Future (temporal distancing) condition relative to Read Negative in those high in reactive aggression, while those lower in reactive aggression were able to reduce their distress relative to baseline (Read Negative) on this condition.

Intriguingly, we found tentative evidence that those higher in reactive aggression projected themselves less far into the future during the Distant Future condition, which may underpin reduced efficacy. Participants high in reactive aggression may therefore benefit from training in how to apply cognitive strategies such as temporal distancing more effectively, which may in turn reduce reactive aggression over time. Fabiansson and Denson (2012) found that instructed reappraisal was effective in reducing self-reported anger during an economic bargaining task and had longer lasting effects on lowering anger than when using a distraction strategy. However, it is still an open question as to whether such training would impact more trait-like reactive aggression over the longer term. If so, training this strategy could be of considerable benefit to individuals who react aggressively to everyday stressors.

A constraint of the present approach is that temporal distancing may not be effective for stressors that have longer-term impacts (e.g. chronic illness). We designed the study to focus on scenarios with a perceived short-medium term impact with reasonably defined endpoints (e.g. exam-related stressors); it is unknown whether the same effects would be present for scenarios containing longer-term impacts. It is also worth noting that the task was relatively fast-paced, with participants given 7 seconds to implement the distancing instructions. While this is in line with timings in prior studies of reappraisal (e.g. McRae et al., 2008; McRae et al., 2012; Ochsner et al., 2004; Ray et al., 2010; Silvers et al., 2012), it could be argued that participants did not have enough time to form a fully elaborated vision of how their life might be impacted by the scenarios in the distant future. Future studies could compare time-limited vs. self-paced (e.g. Ayduk & Kross, 2008) methodologies in the implementation and efficacy of this strategy, and could measure the quality of participants' representations of the future.

In conclusion, placing negative events into a broader temporal perspective facilitates the down-regulation of subjective and physiological negative affect. Temporal distancing is effective and easily implemented for adults and young adolescents alike and thus may be promising as a potential strategy for adolescence stress reduction. However this strategy may be of limited efficacy for those with high levels of reactive aggression, potentially due to difficulties in implementing the instruction to project oneself into the distant future. Future work could explore this link further, extending findings to a sample with clinically relevant levels of reactive aggression, and investigating whether training in this strategy could represent a potential avenue for intervention.

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Figures

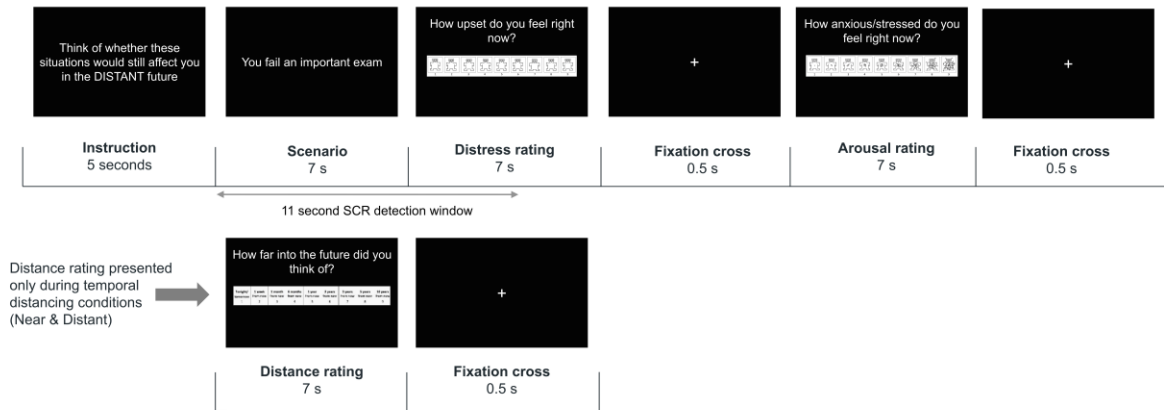


Figure 1: Visual depiction of a Distant Future trial.

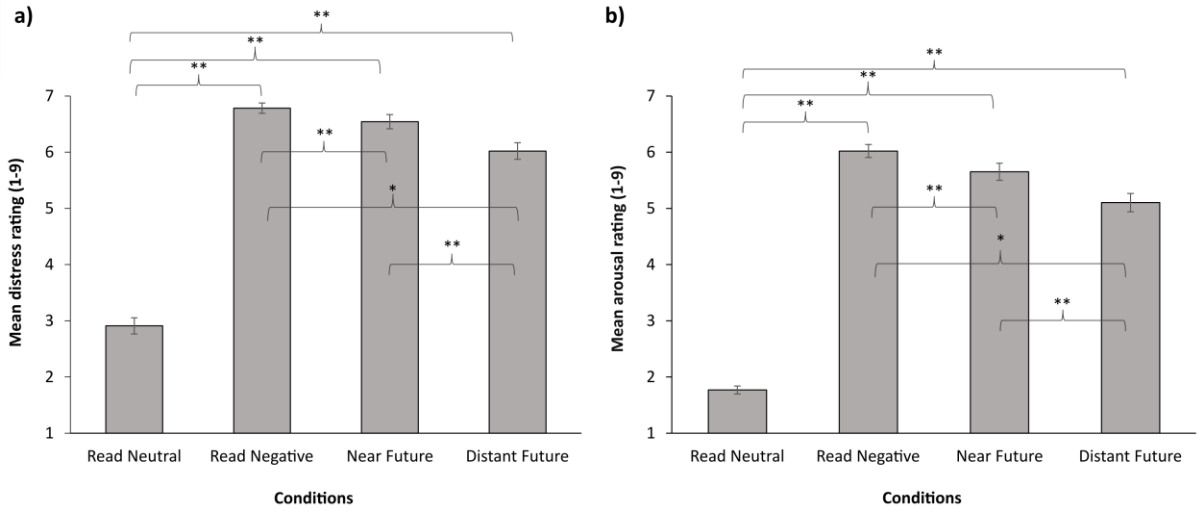


Figure 2: Mean ratings for a) distress and b) arousal for all conditions.

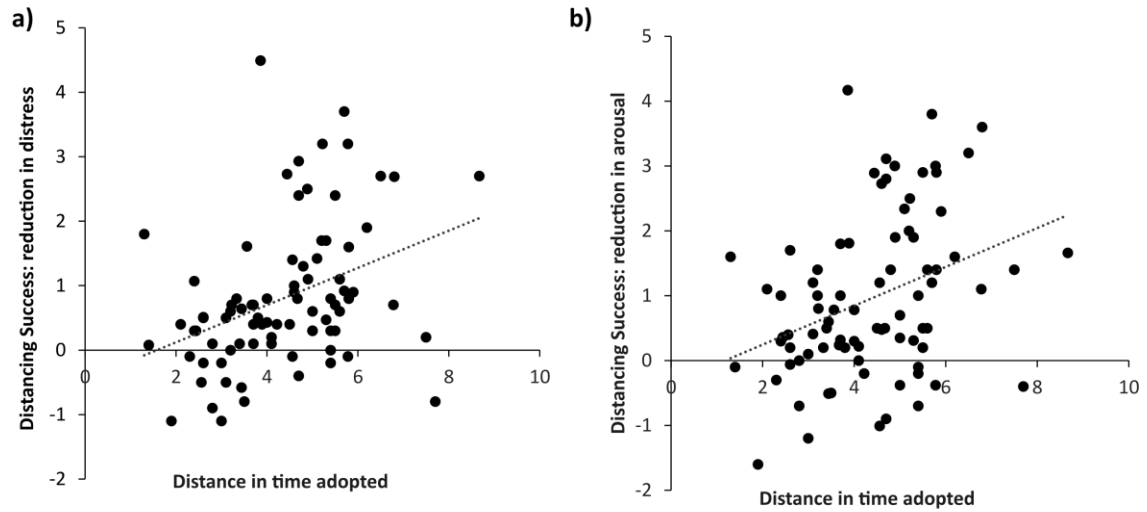


Figure 3: Scatterplots depicting the relationship between distance in time adopted during the distant future condition (x-axis: likert scale (1 = tonight/tomorrow, 9=10 years)) and distancing success (y-axis: reduction in affect (a) and arousal (b) relative to free viewing).

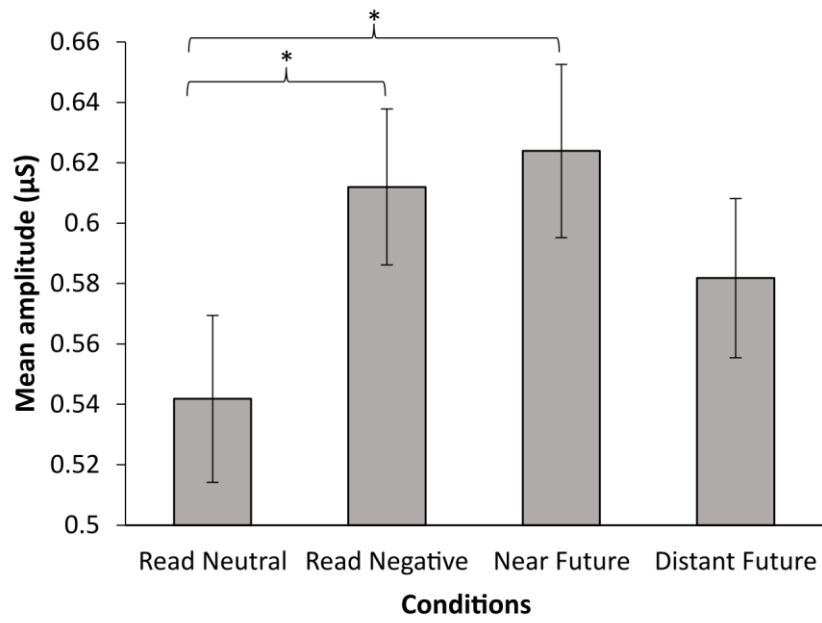


Figure 4: Mean peak skin conductance amplitude for each condition.

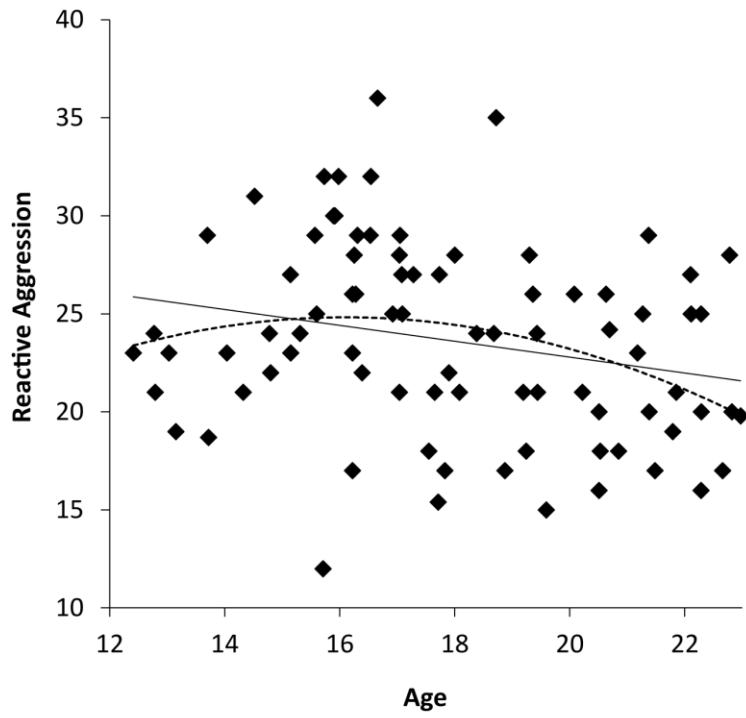


Figure 5: Scatterplot showing that reactive aggression reduces with age and also peaks during mid-adolescence.

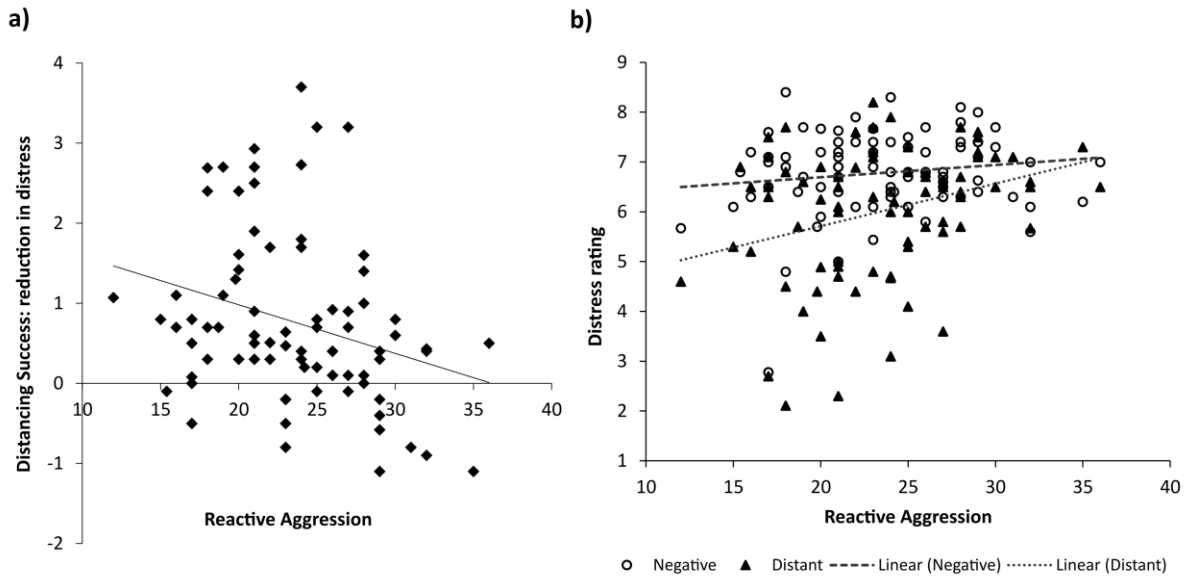


Figure 6: a) Relationship between reactive aggression and distancing success; b) Relationships between distress ratings for distant future and read negative conditions and reactive aggression.