

Autonomic Nervous System Correlates of Emotion Regulation in Autistic Adults

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Abstract

Emotion regulation difficulty is commonly experienced by autistic adults and has been explored as a transdiagnostic mechanism contributing to anxiety and depression in autistic adults.

Previous research has found that emotion regulation strategies and autonomic nervous system (ANS) responses involved in emotion regulation differ between autistic and non-autistic individuals. These findings highlight the role of the ANS as a measure of emotion regulation; however, this has not been studied in an autistic adult sample. The current study examined ANS activity, as measured by respiratory sinus arrhythmia (RSA), root mean square successive differences (rMSSD), and skin conductance level (SCL), and subjective ratings of valence and arousal at rest and while viewing emotional film clips and engaging in emotion regulation in autistic adults. The study consisted of 31 autistic and 31 non-autistic adults, matched on age, intellectual ability, sex, and race/ethnicity. Participants also self-reported their daily emotion regulation use via the Emotion Regulation Questionnaire. Results demonstrated group differences in baseline RSA and rMSSD, self-reported valence of viewing neutral and negative stimuli, and cognitive reappraisal used in daily life. There was also increased SCL and self-reported arousal and decreased self-reported valence to negative stimuli across the whole sample. Exploratory results also showed that SCL and self-reported arousal to negative stimuli were correlated for autistic participants, and that emotion regulation changed physiological and subjective experiences of negative emotion across the whole sample. Supplementary analyses explored the covarying role of co-occurring depression and anxiety and antidepressant use, and showed that these covariates may explain variance in some physiological and self-reported

responses whereas in other models, they may suppress these changes. This study extends previous research on emotion regulation in daily life of autistic adults and is the first investigation that demonstrates how an objective measure, such as correlates of ANS, provides additional insight in emotion regulation in autistic adults beyond subjective ratings. This study is important insofar as it shows how emotion regulation strategies manifest in autistic adults and its implications for informing the use of emotion regulation treatment intervention.

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General Audience Abstract

Autistic adults struggle to regulate their emotions which may contribute to their anxiety and depression. It is previously known that autistic people emotionally regulate differently than non-autistic people, and that their autonomic nervous system (ANS) reacts differently too. These differences may lead to information about how the ANS may measure emotion regulation, yet no one has ever studied this in autistic adults. Therefore, the following study examined ANS activity, as measured by respiratory sinus arrhythmia (RSA), root mean square successive differences (rMSSD), and skin conductance level (SCL), and self-reported ratings of positivity and excitement at rest and while watching emotional film clips and regulating their emotional responses in autistic adults. The study included 31 autistic and 31 non-autistic adults, who had similar age, intellectual ability, sex, and race/ethnicity. Participants also self-reported how often they emotionally regulated, specifically by changing their thoughts (“reappraisal”) and keeping a blank face (“suppression”) in their daily life using the Emotion Regulation Questionnaire. Based on this study, autistic adults had lower levels of RSA and rMSSD when they were watching a baseline video of swimming fish. They also rated lower levels of positivity when watching both neutral and negative themed film clips and shared that they used reappraisal less frequently in daily life than non-autistic adults. Everyone in the study showed increased SCL and rated lower levels of positivity when watching negative themed film clips. Also, autistic adults with higher SCL also felt greater levels of excitement when watching negative film clips. For everyone, regulating emotional experiences changed the body’s responses (i.e., RSA, rMSSD, and SCL) and experiences of positivity and excitement when watching negative themed film clips.

However, since having depression and anxiety and taking antidepressants may affect how participants emotionally regulate, additional analyses also explored the impact of these factors; these extra analyses found that some of the previously reported findings may be because of depression, anxiety, and antidepressants, rather than being autistic. Overall, this is the first study to explore the relationship between emotion regulation and autism in adults by looking at the ANS. It is important because it shows how autistic people emotionally regulate which can help experts design mental health treatments.

Dedication

My scholarly accomplishments would not be without the love and support of my family and friends, and my work is dedicated to them.

Most importantly, my dissertation is dedicated to my parents, Julia and Joe, for supporting all my pursuits in life. I would not be where I am today without their faith and insistence that hard work always prevails.

Thank you to my life partner, CJ, for walking with me every step of this PhD journey, reading all drafts, good and bad, and teaching me everything I know about research.

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Autonomic Nervous System Mechanisms of Emotion Regulation in Autistic Adults

This study addresses the gap in research on autonomic nervous system (ANS) correlates of emotion regulation in autistic adults. Autism spectrum disorder (hereafter referred to as “autism”) is characterized by deficits of social communication and restricted, repetitive behaviors and is often co-occurring with other mental health disorders (American Psychiatric Association [APA], 2022). There is limited literature that aims to understand differences in emotion regulation between autistic and non-autistic adults across multiple levels of analysis, which has a negative impact on understanding, assessing, and treating difficulties with these emotional processes. To date, Richey et al. (2015) is the only study that has examined physiological processes (i.e., neural activation of the nucleus accumbens and amygdala) during cognitive reappraisal between autistic and non-autistic adults, but they did not measure across different levels of analysis. Therefore, the current cross-sectional study is among the first to explore how emotion regulation is characterized in an autistic adult sample using multiple methods of measurement.

Background

Autistic adults report less adaptive emotion regulation strategies, including less reappraisal and more suppression (Samson et al., 2012). Emotion regulation difficulty is believed to underlie mental health disorders, such as anxiety and depression, in autism and is therefore a significant research area for improving the well-being of autistic adults (Bruggink et al., 2016; Chandrasekhar & Sikich, 2015; Gotham et al., 2015; Mazefsky et al., 2012). Current evaluation of emotion regulation, however, is limited by the reliance of subjective judgment of the client, caregiver, and clinician, especially considering variability in language and intellectual functioning that can impact self-report. Incorporating objective methods for measuring emotion

regulation, such as ANS measures, may improve our insight into anxiety and depression by offering an additional perspective beyond subjective reporting. By examining physiological measures of emotion regulation, we can discern if emotion regulation processes differ in autistic and non-autistic adults and thus provide greater insight into potential treatment targets.

Therefore, a multi-method approach that uses both ANS and self-report methods of emotion regulation is warranted. Research that leverages physiological measurement can provide objective information to supplement subjective reports in autistic adults.

Emotion Regulation Model

Emotion regulation refers to the use of strategies to increase, maintain, or decrease the feelings, behaviors, and/or physiological responses that make up an emotion (Gross, 1998a). Gross' process model posits five emotion regulation stages: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. The first four stages are antecedent-focused, whereas the fifth is response-focused. Two specific emotion regulation strategies are reappraisal and suppression. Reappraisal occurs at the cognitive change stage to modify emotional meaning and change the emotional impact of a situation, and suppression occurs at the response modulation stage to inhibit the emotional expression. The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) is a self-report questionnaire of cognitive reappraisal and emotional suppression strategies that align with the process model. Few studies have reported autistic adult's self-reported emotion regulation according to the ERQ (Cai et al., 2019; Samson et al., 2012). Samson et al. (2012) reported autistic adults use less reappraisal strategies, have lower self-efficacy of reappraisal strategies, and use more suppression strategies when compared to non-autistic adults and Cai et al. (2019) found significant negative correlation between reappraisal frequency and autistic traits within their

whole sample of autistic and non-autistic adults; overall, autistic adults report using cognitive reappraisal less frequently than non-autistic adults.

Physiological Variables

Psychophysiological research on correlates of emotion regulation has included mainly cardiovascular variables of parasympathetic functioning such as heart rate variability (HRV), as measured by respiratory sinus arrhythmia (RSA) and root mean square of successive differences of beat-to-beat interval (rMSSD), and electrodermal variables of sympathetic functioning like skin conductance. The vagus nerve, which is the tenth cranial nerve that originates in the brainstem and innervates other viscera (e.g., heart, gastrointestinal tract), contributes to the parasympathetic beat-to-beat variations of heart rate via the myelinated vagal pathway (Berntson et al., 2016). RSA, a frequency domain method of measuring HRV, reflects the interbeat differences that vary due to respiration and rMSSD, a time domain method, measures the beat-to-beat heart period variance (Berntson et al., 2016). Electrodermal activity (EDA) refers to the electrical skin potentials, or changes in sweat gland secretions, as innervated by the cholinergic sympathetic system and is measured using exosomatic or endosomatic methods; the exosomatic method refers to the resistance changes to small external currents applied directly to the skin and is measured by skin conductance (e.g., skin conductance level [SCL], skin conductance response [SCR]) and used widely in psychophysiological research whereas the endosomatic method measures the internal electrical potential and is not as commonly used (Dawson et al., 2016).

High levels of resting HRV and increases in HRV reactivity during stressful situations indicate greater vagal activity and flexibility within the central autonomic network, which is the regulatory system in the brain that controls necessary visceromotor, neuroendocrine, pain, and behavioral responses (Benarroch, 1993), reflecting better emotion regulation to external demands

(Friedman, 2007; Porges, 2007). In typical development, resting HRV increases linearly from infancy to adolescence (Beauchaine & Webb, 2016). However, findings in children with emotional behavioral concerns have been mixed. For example, in a meta-analysis, greater RSA withdrawal was associated with fewer externalizing and internalizing symptoms and less RSA withdrawal in children with clinical disorders, such as attention-deficit/hyperactivity disorder (ADHD; Graziano & Derefinko, 2013). Beauchaine et al. (2013) found that greater RSA withdrawal was associated with lower prosocial behavior and emotion regulation skills. In general, research has shown that autistic youth have underactive parasympathetic functioning (e.g., reduced resting HRV and HRV reactivity; Guy et al., 2014; Scarpa, 2015). The few studies investigating parasympathetic functioning in autistic adults (Cai et al., 2019; Thapa et al., 2019) provide support to the idea that autism is associated with reduced HRV measured at baseline across the lifespan. Cai et al. (2019) found that high frequency HRV and rMSSD measured during a 10 minute resting baseline (i.e., supine position with eyes closed) were negatively correlated with autism characteristics, as measured by the Autism Spectrum Quotient, suggesting that lower resting HRV baseline was correlated with greater autistic traits; these were a result of correlations conducted across an autistic and non-autistic sample.

Regarding the sympathetic nervous system, Cappadocia et al. (2009) documented hypo-sympathetic response in children with externalizing behavior problems without neurodevelopmental disorders. Baker et al. (2018) discovered that autistic children with low number of nonspecific SCR were associated with greater externalizing behavior problems; however, there is mixed evidence for autistic youth having a hyper- and hypo-sympathetic nervous system response (Fenning et al., 2019). These studies highlight patterns of ANS activity

linked to emotional and behavioral difficulties in both clinical and non-clinical groups and limited autonomic flexibility in autistic children.

Certain emotion regulation strategies during emotional experiences have shown different physiological patterns. For example, in non-autistic adults, greater reappraisal use was correlated with limited sympathetic nervous system and amygdala activation, whereas greater suppression use was correlated with increased sympathetic response and amygdala activation (Gross & Thompson, 2007). Others have also found that suppression emotion regulation strategies led to greater sympathetic activity as measured by EDA (Demaree et al., 2006; Gross, 1998b). On the other hand, some research has shown similar reductions in SCR between reappraising and suppressing emotions while viewing negative pictures despite participants reporting greater efficacy of reappraisal in decreasing their subjective negative reaction (Mohammad et al., 2022). Collectively, these studies suggest physiological processes underlying specific emotion regulation strategies in non-autistic adults, but no studies have examined ANS response in autistic adults while using emotion regulation strategies.

One systematic review examined how emotion regulation was measured in autism and identified different physiological measures used (e.g., RSA/heart rate, SCL); however, none of the included studies were conducted among adults (Weiss et al., 2014). In another review, the authors concluded that autonomic flexibility differed between autistic individuals with and without co-occurring intellectual impairment, but they did not speak to potential age-related differences (Patriquin et al., 2019). Dijkhuis et al. (2019) found maladaptive cardiac arousal measured by HRV reactivity (i.e., rMSSD) during a social stressor in autistic and non-autistic adults, but did not measure specific emotion regulation strategies. Cai et al. (2019) found a positive correlation between self-reported emotion regulation reappraisal, not suppression per the

ERQ, and resting HRV for both autistic and non-autistic adults. While previous studies have examined differences between autistic and non-autistic adults in their self-reported emotion regulation strategies and baseline measures of physiological activity, there have been no studies that have utilized both objective and subjective methods of measurement during an emotion regulation task in an autistic adult sample.

Hypotheses

Based on the literature reviewed above, ANS measures of emotion regulation in autism may provide information on emotion regulation processes observed in autistic adults in addition to self-reported experiences. The current study on autistic and non-autistic adults consisted of a multi-method investigation of emotion regulation via RSA/rMSSD/SCL and self-reported arousal and valence ratings while viewing dynamic neutral and negative emotional stimuli and engaging in reappraisal and suppression emotion regulation, and emotion regulation used in daily life. The following four hypotheses were tested and additional exploratory objectives were examined:

Hypothesis 1

Hypothesis 1 posited that autistic adults would demonstrate lower RSA and rMSSD and greater SCL at baseline than non-autistic adults.

Hypothesis 2

Hypothesis 2 proposed an Emotion (neutral, negative) x Group interaction, such that autistic adults would demonstrate less change in RSA, rMSSD, and self-reported arousal and valence and more change in SCL while viewing negative film clips than non-autistic adults; there would be no group differences in RSA, rMSSD, or SCL reactivity or subjective experiences in arousal and valence while viewing neutral film clips.

Hypothesis 3

Hypothesis 3 suggested a group main effect on the day-to-day use of emotion regulation strategies as measured by the ERQ, whereby autistic adults would report less use of cognitive-reappraisal and more use of expressive suppression than non-autistic adults.

Hypothesis 4

Hypothesis 4 proposed a main effect for emotion regulation strategy and a Strategy (reappraisal, suppression) x Group interaction, such that RSA, rMSSD, and SCL change (i.e., less RSA/rMSSD change and more SCL change) would be stronger in the suppression vs. reappraisal condition, and these effects would be more pronounced for autistic vs. non-autistic adults when asked to use an emotion regulation strategy.

Exploratory Objectives

Additional objectives explored the relationship between self-reported emotion regulation via the ERQ with RSA, rMSSD, and SCL during the emotion regulation tasks within each group. Although exploratory, there would be a hypothesized positive relationship between participants' self-report and ANS measurement of emotion regulation such that greater endorsement of emotion regulation in daily life would correlate with greater HRV and skin conductance while emotionally regulating; however, the relationship would be larger for those within the non-autistic group than those in the autistic group.

Also, the relationships between self-reported valence and arousal with RSA, rMSSD, and SCL during the emotion induction and emotional regulation tasks were explored within each group.

Further analyses explored whether engaging in reappraisal and suppression resulted in distinct physiological responses and self-reported ratings of arousal and valence while viewing

negative film clips. It was hypothesized that there would be a main effect of strategy such that there would be changes in RSA, rMSSD, SCL, and self-reported arousal and valence when reappraising and suppressing. This explored the impact of emotion regulation on multiple methods of measurement in response to negative emotion.

Method

Participants

The current study included 62 participants recruited from the southwest Virginia community; participants were also recruited from the Virginia Tech graduate training psychology clinic's waitlist for receiving an adult autism assessment. A total of 127 participants screened into the study and self-selected into either the autism group (i.e., "Has autism or thinks has autism") or the non-autism group (i.e., "Does not have autism nor has ever thought to have autism") using an online form.

Inclusion/Exclusion Criteria

All participants were required to be at least 18 years old, self-identify as verbally fluent (i.e., uses phrase speech or complex sentences), and be their own legal guardian. Participants were excluded if they did not speak or understand English fluently, had uncorrected vision or hearing impairments, a history of cardiac arrhythmia and other cardiovascular problems, or a pacemaker, or reported taking beta-adrenergic blocking agents. Additionally, participants who had a history of fainting, hyperventilating, or vasovagal syncope, or a blood-injury-injection phobia, were excluded.

Upon completing the initial screening, participants completed the Social Responsiveness Scale, 2nd Edition (SRS-2) Adult Self-Report (ASR) questionnaire and intake assessment, consisting of the Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2) and Wechsler

Abbreviated Scale of Intelligence, 2nd edition (WASI-II), to determine meeting the criteria for the autism and non-autism group. To be included in the autism group, participants scored above the SRS-2 cutoff (total T -score ≥ 60), ADOS-2 cutoff for an autism classification (total score ≥ 8), and WASI-II full-scale IQ (FSIQ) ≥ 80 . Those in the autism group were not requested to have a prior professional diagnosis of autism; however, ten participants reported having a prior diagnosis of autism spectrum disorder and two Asperger's syndrome. Participants in the non-autism group scored below the SRS-2 cutoff (total T -score < 60) and the ADOS-2 cutoff for a non-autism classification (total score < 8), and scored above the WASI-II FSIQ ≥ 80 . Figure 1 details participant inclusion at each inclusion step resulting in the final sample size for both groups, $n = 31$ each. Those who were determined ineligible by the SRS-2 ASR were compensated a \$5 Amazon gift card and those who did not meet the ADOS-2/WASI-II criteria were compensated a \$30 Amazon gift card. Participants who completed all study procedures were compensated \$60 cash.

Demographic Information (Appendix A)

The average age of the total sample was 25.73 years (SD = 6.65) consisting of participants between 18 and 46 years of age. Regarding biological sex, 32.26% of the sample was male and 67.74% was female. To be inclusive of expansive gender identities, participants were able to identify with more than one gender identity resulting in the following: 30.65% male, 56.45% female, 11.29% nonbinary, 3.23% genderqueer, 1.61% agender, 1.61% other (specified: "Demi-girl"). The participants identified as a majority (74.19%) White sample; however, other racial identities were represented: 20.97% Asian, 1.61% Black or African American, 1.61% Native American or Native Alaskan, 4.84% Other, and 3.23% unknown. Just 4.84% of the total sample selected being Hispanic/Latinx. Regarding highest education level achieved, nearly half

of the participants reported having a college degree at the baccalaureate (20.97%) or graduate/professional (29.03%) level, whereas 37.10% were currently enrolled in college, 4.84% had an associate degree, and 8.06% graduated high school.

Previous Psychological Disorders (Appendix B)

The study did not exclude participants who had any previous psychological diagnoses. As such, 53.23% of the total sample reported having any history of a psychological diagnosis. There was a greater proportion of people with diagnoses in the autism group (77.42%) compared to the non-autism group (29.03%), $\chi^2(1, N = 62) = 14.58, p < .001, \omega = 0.49$. The following diagnoses were endorsed: ADHD, anxiety, (e.g., generalized anxiety disorder, panic disorder), depression/mood disorders, (e.g., major depressive disorder, dysthymia), social anxiety disorder, obsessive-compulsive disorder, eating disorder (e.g., bulimia, anorexia, avoidant restricted food intake disorder), and posttraumatic stress disorder (PTSD). Anxiety and depression were the most frequently endorsed within the autism group and anxiety within the non-autism group (Table 1). When examining group differences regarding specific diagnoses, the autism group had a larger percentage of individuals with ADHD, anxiety, depression/mood disorder, social anxiety disorder, and PTSD, $ps < .05$ (Table 1).

Procedures

Intake

Participants completed consent (Appendix B) and questionnaires online prior to their first in-person visit, at which time they completed a two hour psychological assessment to determine eligibility (ADOS-2, WASI-II).

Experimental Visit

Eligible participants then were invited to a second two-hour in-person visit to complete

the following experimental procedures, and received \$60 for participation. Participants also received a summary of their assessment results after they were scored. Participants were instructed to refrain from consuming caffeine 6 hours and alcohol 24 hours prior to this visit.

At the beginning of their in-person laboratory visit, participants completed a health screening questionnaire (Appendix C) to evaluate medication intake (Table 2) and recent food, alcohol, caffeine, sleep, and exercise, and menstrual cycle for females as detailed in Table 3. Everyone abstained from alcohol 24 hours before their visit. Some participants in both groups consumed caffeine within the 6-hour window, but did not significantly differ across groups.

After completing the health screening questionnaire, participants completed the series of tasks: baseline/recovery, negative and neutral film clips, and rating scales (Figure 2A).

Baseline/Recovery. Participants completed four 5 min baseline/recovery recording tasks, which were to watch videos of fish swimming in a coral reef. The order of these videos was not randomized across the four tasks.

Passive Emotion Induction Tasks. Participants completed passive emotion induction tasks consisting of one block of ten negative trials and another block of ten neutral trials. The order of trials within each block were presented randomly and these blocks were counterbalanced between participants (Figure 2A). Each trial consisted of viewing a 20-30 s emotionally dynamic film clip followed by completion of three ratings about each film clip (familiarity, valence, arousal; Figure 2B). After each block, participants completed a 5 min recovery period, as described previously.

Emotion Regulation Tasks. Participants completed additional emotion induction tasks while engaging in emotion regulation strategies (i.e., “emotion regulation tasks”) in order to capture physiological responding during reappraisal and suppression of negative emotional states

induced by negative film clips. For the emotion regulation tasks, participants completed one block of 10 reappraisal trials and one block of 10 suppression trials; the ten trials were presented randomly within each block and each block consisted of ten trials and the order of the two blocks were counterbalanced between participants (Figure 2A). During the reappraisal trial, participants were instructed to reappraise (e.g., “Think about the film in such a way that you would feel nothing”) while viewing the negative emotion clips (Figure 2C). During the suppression trial, participants were instructed to suppress (e.g., “Behave in such a way that someone watching you would not know you were feeling anything”) while viewing the negative emotion clips (Figure 2C). Participants were asked to provide four ratings about the clip (familiarity, valence, arousal, effort; Figure 3). The first emotion regulation block was followed by a 5 min recovery period during which participants viewed a video of fish, as described above. After the last emotion regulation block, participants viewed a positive film clip so they ended the visit positively.

Physiological Measurement

Participant’s HRV and skin conductance were recorded using MindWare hardware by collecting continuous signals recordings during the baseline/recovery periods and emotion induction and emotion regulation blocks. Electrocardiogram (ECG) signals were collected on a second-by-second basis with wearable sensors worn on the chest following a standard lead II configuration (i.e., one below the right collarbone, one on the bottom of each rib cage) and exosomatic direct current (DC) EDA through disposable Ag-AgCl electrodes applied to the distal phalanges of the middle and pointer fingers on the non-dominant hand. Multiple channels of analog information were processed using MindWare signal processing system.

Procedures outlined by the Task Force of the European Society of Cardiology & The North American Society of Pacing and Electrophysiology (Task Force; 1996), the Society for

Psychophysiological Research Ad Hoc Committee on Electrodermal Measures (2012), and Tronstad et al. (2022) informed how the ECG and EDA data were collected and processed.

Quantification of RSA and rMSSD. Frequency domain methods were used to analyze the short-term ECG signals to calculate composite RSA, which is a measure of the parasympathetically-mediated high-frequency component of heart rate (HF-HRV). Using MindWare HRV analysis software, data were sampled at a rate of 500 Hz and transformed using a Fast Fourier Transform and the Hamming spectral window with the recommended frequency range of 0.15-0.40 Hz for HF-HRV (Task Force, 1996). To meet assumptions of normality, values were computed as the natural-logged (\ln) spectral power value of the HF band resulting in RSA values measured in $\ln(\text{ms})^2$. In addition, rMSSD was included to provide another parasympathetic measure of HF-HRV using time domain methods. rMSSD was derived by the MindWare HRV analysis software and reported in units of milliseconds (ms). To control for respiration, trials that contained a respiration peak frequency that fell outside the HF frequency band were excluded (Berntson et al., 2016).

Quantification of SCL. Skin conductance was derived from EDA signals and taking the average SCL following the stimulus onset for each task. Signals were scaled to units of microsiemens (μS) and visually inspected for artifacts in the MindWare EDA analysis software.

Scoring for Data Analysis. RSA, rMSSD, and SCL recordings during the 5 min baseline/recovery periods were averaged across the four periods to compute an overall baseline score for each three physiological measures: RSA-baseline, rMSSD-baseline, SCL-baseline. Baseline/recovery periods that occurred before each block served as the baseline period for calculating physiological change scores as outlined further below. Within each block, RSA, rMSSD, and SCL were measured during each trial and averaged across the ten trials to calculate

a change score from the immediately preceding baseline/recovery period (i.e., task minus baseline subtraction based difference scores) such that negative Δ RSA/rMSSD scores indicated a decrease in vagal activity (e.g., vagal withdrawal) whereas positive indicated an increase (e.g., vagal augmentation) and negative Δ SCL scores indicated lowered skin conductance and positive indicated increased skin conductance: Δ RSA-neutral, Δ RSA-negative, Δ RSA-reappraisal, Δ RSA-suppression, Δ rMSSD-neutral, Δ rMSSD-negative, Δ rMSSD-reappraisal, Δ rMSSD-suppression, Δ SCL-neutral, Δ SCL-negative, Δ SCL-reappraisal, and Δ SCL-suppression.

Questionnaires

ERQ (Gross & John, 2003; Appendix D)

The ERQ is a self-report questionnaire that assesses the use of cognitive reappraisal and expressive suppression emotion regulation strategies on a seven-point Likert scale (1 = *strongly disagree* to 4 = *neutral* to 7 = *strongly agree*). The ERQ consists of ten items that are summed to yield two total scores for Reappraisal (6 items) and Suppression (4 items). Only one study has reported the reliability of the ERQ from an autistic adult sample (Samson et al., 2012), and found it to be acceptable for Reappraisal (Cronbach's $\alpha = .86$) but not for Suppression (Cronbach's $\alpha = .52$). In the current sample, the reliability for Reappraisal was good for both groups (Cronbach's α s = 0.81-87). The reliability for Suppression was acceptable for the non-autism group (Cronbach's $\alpha = 0.72$), but questionable for the autism group (Cronbach's $\alpha = .69$; George & Mallery, 2018). To adjust for differing number of items asked per strategy, average scores were computed for each: Reappraisal: autism, $M (SD) = 3.45 (1.23)$, non-autism, $M (SD) = 4.83 (1.10)$; Suppression: autism, $M (SD) = 4.01 (1.33)$, non-autism, $M (SD) = 3.47 (1.22)$.

SRS-2 ASR (Constantino & Gruber, 2012; Appendix E)

The SRS-2 ASR is a 65-item self-report measure of autistic characteristics for adults rated on a four-point scale (1 = *not true*; 2 = *sometimes true*; 3 = *often true*; 4 = *almost always true*) that best describes their behavior in the past six months. The items are summed and normed to yield a total *T*-score and for five subscales: Social Awareness, Social Motivation, Social Cognition, Social Communication, and Repetitive, Restricted Behaviors. The SRS-2 ASR demonstrates excellent reliability (Cronbach's $\alpha = .94-.97$; Bemmer et al., 2021; Kerr-Gaffney et al., 2020; White et al., 2022). *T*-scores at or above 60 are considered to reflect autism related characteristics in the clinically significant range with at least mild social functioning difficulties (66-75 = moderate difficulties; ≥ 76 = severe difficulties). Sensitivity and specificity of the SRS-2 ASR for identifying autism using the *T*-score cutoff of 60 (compared to anxiety and nonclinical adults) is 0.75 and 0.66 (South et al., 2017). In this sample, the autism group scored a total average within the severe difficulties range (Table 4).

Achenbach System of Empirically Based Assessment Adult Self Report (Achenbach & Rescorla, 2003; Appendix F)

The Achenbach System of Empirically Based Assessment (ASEBA) Adult Self Report (ASR) is the self-report questionnaire that characterized the severity of Diagnostic and Statistical Manual of Mental Disorders (5th Edition; DSM-5; APA, 2013) disorders and related symptomology in adults. The ASEBA ASR consists of 135 items rated on a three-point scale of how each item (behavior, thought, or feeling) is applicable for them in the past six months (0 = *not true*, 1 = *somewhat true*, 2 = *very true*). The ASEBA ASR provides gender-normed *T*-scores for a total of two broadband scales (Internalizing Domain, Externalizing Domain) and eight syndrome scales (Anxious Depressed, Withdrawn, Somatic Complaints, Thought Problems, Attention Problems, Aggressive Behavior, Rule-Breaking Behavior, and Intrusive), six DSM-

oriented scales (Depressive Problems, Anxiety Problems, Somatic Problems, Avoidant Personality Problems; Attention Deficit/Hyperactivity Problems with Inattention and Hyperactivity/Impulsivity subscales, and Antisocial Personality Problems). The ASEBA ASR in autistic adults has yielded acceptable reliability for all scales (Cronbach's α s = .72-.90; Brewé et al., 2020; Gadke et al., 2016). This measure characterized the presence of any (co-)occurring psychological problems in the sample by utilizing the *T*-scores of the broadband and syndrome scales.

In the current sample, the autism group reported significantly higher *T*-scores across all scales ($ps < .001$) except for the Intrusive Problems syndrome scale (Table 5).

Assessment

ADOS-2 (Lord et al., 2012; Appendix G)

The ADOS-2 is a standardized semi-structured observational assessment in which a clinician rates a participant's social-emotional reciprocity and communication and restricted, repetitive behaviors using different modules based on the individual's chronological age and expressive language level. Module 4 is designed for the assessment of verbally fluent adults and older adolescents and was used for the current study. Fifteen clinician reported ratings span the two DSM-5 categories of autism (*Social Affect* and *Restricted, Repetitive Behavior*) and are summed to yield a total score (Hus & Lord, 2014). Total scores ≥ 8 served as the cutoff for autistic participants to be included in the autism group whereas non-autistic participants were required to be below. The Hus and Lord (2014) algorithm for determining a total score cutoff of 8 on the ADOS-2 module 4 in autistic adults with verbal IQ (VIQ) ≥ 85 has a sensitivity of 0.72 (VIQ 85-115) and 0.87 (VIQ > 115) and specificity of 77.3 (VIQ 85-115) and 0.93 (VIQ > 115). Calibrated severity scores (CSS) are standardized total scores for the ADOS-2 that are less

sensitive to non-autism related developmental factors, such as age and language level, and can be used to compare total scores across different modules of the ADOS-2 (Gotham et al., 2007; Hus & Lord, 2014).

The ADOS-2 was administered by graduate student clinicians who have achieved research reliability and regularly assess for and diagnose autism. Table 6 shows the subtotal scores for *Social Affect* and *Restricted, Repetitive Behavior* and the overall total score and CSS per each group of the final sample, and that there were significant group differences, as expected, on all three. Of the 91 participants who completed the ADOS-2, 14 out of 52 in the autism group ($M = 3.43$, min.-max. = 0-6) and 6 out of 39 in the non-autism group ($M = 9.00$, min.-max. = 8-13) did not meet their group-specific inclusion criteria.

WASI-II (Wechsler & Zhou, 2011; Appendix H)

The WASI-II is a 30-45 minute test of verbal and nonverbal cognitive skills that provides aged based normed composite IQ scores ($M = 100$, $SD = 15$): Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), and FSIQ-4. Those with FSIQ-4 scores below 80 were excluded from the study; two participants in the autism group fell below cut off (71-75). The WASI-II has been used in autistic adults and has strong reliability and validity (Wechsler & Zhou, 2011). In the current study, the average FSIQ-4 was 111.79 (VCI = 112.16, PRI = 108.44); the autism group was comparable across all three WASI-II indices to the non-autism group (Table 6).

Laboratory Tasks

Participants watched a total of 40 different film clips which consisted of 30 negative and ten neutral clips, each lasting approximately 20-30 s. First, they watched two blocks counterbalanced between participants: a block of ten negative film clips and a block of ten

neutral film clips. Then, they watched a block of ten additional negative film clips while engaging in emotion regulation reappraisal/suppression, and a block of ten additional negative film clips while engaging in emotion regulation suppression/reappraisal; the order of regulation strategy was counterbalanced between participants and the order of individual film clips were presented randomly for each participant. Film clips were selected from an established standardized film library that have been previously identified to induce neutral and negative emotion (Samson et al., 2016).

Film Ratings (Appendix I)

After viewing each film clip, participants rated their 1) familiarity to the film clip (yes or no), 2) valence and 3) arousal (Self-Assessment Manikin [SAM]; Bradley & Lang, 1994) and, for the emotion regulation blocks only, 4) regulation effort (Figure 3). Valence and arousal ratings using the SAM was on a 9-point pictorial scale and ratings for regulation effort (i.e., “During the film, I tried not to feel anything at all,” “During the film, I felt emotions but tried to hide them.”) were rated on a 9-point Likert scale (0 = *Strongly Disagree*, 4 = *Neither Disagree nor Agree*, 8 = *Strongly Agree*). Regarding familiarity to the film clips, 43 participants had never seen any of the film clips shown during the experiment, and for the remaining 19 participants, an average of two total film clips were familiar (min. to max. = 1-8). Participants provided individual ratings for arousal and valence for each film clip and the ten ratings within each block were averaged to yield composite scores for each block: neutral (arousal-neutral, valence-neutral), negative (arousal-negative, valence-negative), reappraisal (arousal-reappraisal, valence-reappraisal), and suppression (arousal-suppression, valence-suppression). Similarly, participants rated their individual regulation effort for each film clip and the ten ratings were averaged within the reappraisal and suppression blocks resulting in two composite scores of regulation effort:

effort-reappraisal, effort-suppression. The SAM reliability within each group for each block was good to excellent for arousal (Cronbach's α s = 0.85-0.96) and valence (Cronbach's α s = 0.82-0.91). The reliability for rating regulation effort for both blocks was also excellent for both groups (Cronbach α s = 0.93-0.95).

Selection of Film Clips (Appendix J)

Film clips previously categorized as negative and neutral were selected from a predetermined film library consisting of positive, negative, mixed, and neutral emotional states (Samson et al., 2016). These film clips were approximately 20-30 s long videos and have been empirically validated to elicit neutral and negative emotions (i.e., repulsion, fear, anger, and sadness). In a broad validation study described in Samson et al. (2016), participants rated each film clip on a 6-point scale for valence (1 = *very negative* to 6 = *very positive*) and arousal (1 = *not at all* to 6 = *very strong*). The film library consists of 199 different film clips; given that the current study is focused on measuring emotion regulation to negative emotion, film clips categorized as positive and mixed emotion were excluded from the selection of the current film clips. As established by Samson et al. (2016), there are 50 different film clips categorized as neutral emotion (valence: $M = 3.36$, $SD = 0.31$, min.-max. = 2.89-4.39; arousal: $M = 1.45$, $SD = 0.19$, min.-max. = 1.21-2.08) and 39 different film clips categorized as negative emotion (valence: $M = 2.26$, $SD = 0.34$, min.-max. = 1.60-3.06; arousal: $M = 2.52$, $SD = 0.31$, min.-max. = 1.93-3.23).

For trials consisting of neutral emotion, ten film clips from the total 50 neutral film clips with a valence score closest to the overall M (3.36) were selected (valence: $M = 3.36$, $SD = 0.04$, min.-max. = 3.29-3.41; arousal: $M = 1.42$, $SD = 0.15$, min.-max. = 1.26-1.69) and were randomly presented between each participant during the neutral induction block. For the trials in the

negative induction block and reappraisal and suppression regulation blocks, 30 film clips from the total 39 negative film clips with a valence score closest to the overall M (2.26) were selected (valence: $M = 2.22$, $SD = 0.22$, min.-max. = 1.77-2.62; arousal: $M = 2.53$, $SD = 0.30$, min.-max. = 1.93-2.99) and were randomly presented across tasks between each participant. The two sets of film clips (neutral, negative) significantly differed on arousal, $t(34) = -15.39$, $p < .001$, and valence, $t(34) = 27.50$, $p < .001$. A list of the names and brief description of each film clip are reported in Appendix I.

Statistical Analyses

Statistical analyses were conducted in IBM SPSS Statistics software (Version 28) to describe (M , SD , range) the demographic information (e.g., age, sex, gender, race, ethnicity), relevant health background information (e.g., medication use, height/weight, exercise habits, caffeine/tobacco use, menstrual cycle for females), and the variables collected from the self-report questionnaires (ERQ Reappraisal and Suppression, SRS-2 ASR subscale and total T -scores, ASEBA ASR T -scores), intake assessment (ADOS-2, WASI-II), and the experiment (RSA, rMSSD, and SCL variables, self-reported composite scores for valence, arousal, and effort, and film clip familiarity response). To manage outliers in the physiological data, datapoints that fell beyond 2.5 standard deviations from the median were winsorized, specifically they were transformed to values at exactly 2.5 standard deviations below or above the median score (Leys et al., 2013).

To demonstrate validity of the negative induction task and the emotion regulation tasks, a series of paired samples t -tests across the sample determined the self-reported ratings of valence and arousal were significantly different from the ratings during the neutral induction block. Furthermore, to determine whether participants put in effort during the reappraisal and

suppression conditions of the emotion regulation tasks, separate one-sample *t*-tests across the sample tested whether self-reported ratings of effort differed significantly from the value of 4 (*Neither agree nor disagree*), which reflects no effort according to this rating scale.

Hypothesis Testing

Hypothesis 1. To determine whether autistic adults experience lower RSA and rMSSD and greater SCL at baseline, independent-samples *t*-tests assessed group differences in RSA-baseline, rMSSD-baseline and SCL-baseline between the autism and non-autism groups.

Hypothesis 2. Five separate 2 (condition: negative, neutral) x 2 (group: autism, non-autism) mixed factorial analyses of variance (ANOVA) tested whether autistic adults respond to negative emotion induction differently from non-autistic adults, on Δ RSA, Δ rMSSD, Δ SCR, and self-reported ratings of arousal and valence.

Hypothesis 3. One 2 (condition: reappraisal, suppression) x 2 (group: autism, non-autism) mixed factorial ANOVA tested group differences on reappraisal and suppression strategy use from the ERQ questionnaire.

Hypothesis 4. To test differences in emotion regulation at the physiological level between autistic and non-autistic adults, three separate 2 (condition: reappraisal, suppression) x 2 (group: autism, non-autism) mixed factorial ANOVAs with dependent variables of Δ RSA, Δ rMSSD, and Δ SCL explored main effects of condition and group and interactions.

Exploratory Objectives. To explore the relationship between self-reported ERQ scores and Δ RSA, Δ rMSSD, and Δ SCL during the emotion regulation tasks, several Pearson correlation analyses within each group were conducted between measures of reappraisal (ERQ Reappraisal with Δ RSA-reappraisal, Δ rMSSD-reappraisal, and Δ SCL-reappraisal) and of suppression (ERQ Suppression with Δ RSA-suppression, Δ rMSSD-suppression, and Δ SCL-suppression).

Additionally, the relationships between Δ RSA, Δ rMSSD, and Δ SCL and self-reported arousal and valence ratings during the emotion induction and emotion regulation blocks were examined using Pearson correlation analyses for each block within each group.

Further, physiological responses (RSA, rMSSD, and SCL) and self-reported arousal and valence ratings during the emotion regulation blocks were compared to responses during the negative emotion induction block to examine how emotion regulating affected responses to viewing negative stimuli; five separate mixed factorial ANOVAs examined these changes for reappraisal and five additional ANOVAs for suppression.

Determining Covariates

Demographic and other health variables (e.g., medication use, BMI, caffeine/alcohol/food intake prior to recording) variables were explored to determine whether they should be included as covariates in the main analyses by assessing for group differences and significant correlations with the dependent variables in the main analyses (e.g., RSA, rMSSD, SCL, SAM ratings, ERQ).

Other related psychological variables, such as having any previous diagnosis of a co-occurring psychological disorder and the ASEBA ASR scores, were not explored as covariates in the main analyses given that these factors may contribute the underlying mechanism of emotion regulation as a mediating variable instead. However, the role of co-occurring psychological diagnoses was explored in the supplementary analyses as covariates.

Supplementary Analyses. To explore how covariates may have affected the hypothesis testing analyses, analyses of covariance (ANCOVA) were included as a supplement. One-way ANCOVAs and 2x2 mixed factorial ANOVAs were conducted to reproduce the models performed for the hypotheses testing and exploratory analyses with the addition of covariates.

Power Analysis

According to an *a priori* power analysis using G*Power (Faul et al., 2007), at least 30 participants were needed in each group ($N = 60$ total) to detect medium-to-large effect sizes ($d > 0.72$) with power set to .80 and alpha at .05 for group differences in independent-samples *t*-tests. For ANOVAs, a sample size of 60 with two equal sized groups is sensitive enough to detect medium-to-large effect sizes ($\eta^2_p > 0.11$) when powered at .80 and alpha at .05.

Given the many group comparisons used to explore group differences of multiple demographic/health variables for determining potential covariates, the Bonferroni correction was applied to lower the alpha value to .001 to address Type I error. For hypothesis-testing, exploratory analyses, and supplementary analyses, alpha value remained at .05 (Rothman, 2014).

Results

Demographic and Health Group Differences

The following analyses that tested for group differences between potential demographic and health information covariates utilized a Bonferroni correction to correct for multiple comparisons and address Type I error. Therefore, the following analyses were regarded as significant with the alpha level at .001.

Demographic Variables

The autism ($M = 26.68$ years, $SD = 7.77$, min.-max. = 18-46) and non-autism ($M = 24.77$ years, $SD = 5.26$, min.-max. = 18-35) groups did not differ in age, $t(60) = 1.13$, $p = .263$. There were also no differences in biological sex by group (Table 7). The autism group were more gender diverse than the non-autism group; specifically, only participants in the autism group selected identities outside of the binary male and female. The groups did not differ in male and female gender. The autism group had a significantly greater proportion of those with a gender identity that was not the binary male and female, hereinafter referred to as “other gender

identity,” $\chi^2(1,62) = 11.92, p < .001$. Table 7 demonstrates the specific group by gender identity breakdown and chi-square tests of proportional differences.

Regarding race, the non-autism group reported more diverse racial identities (Table 7); however, there were no significant group differences. Furthermore, the groups did not differ in Hispanic/Latinx ethnicity status. The education levels also did not differ between groups (Table 7).

Further independent sample *t*-tests for having an “other gender identity” did not demonstrate differences in the dependent variables of the main analyses ($ps > .035$); therefore, demographic variables were not included as covariates in the main analyses.

Medication Use and Lifestyle Health Behaviors

Psychotropic medication use on the day of the physiological recording between the two groups did not reach statistical significance at the .001 alpha level (Table 2). Across both groups, the most common psychotropic medications were antidepressants. Although group differences in the number of participants who reported taking antidepressants did not reach significance at the correct alpha level (.001), antidepressant use was included as a covariate in the supplementary analyses; participants who reported taking antidepressants before their physiological recording ($n = 16$) showed lower scores than those who did not ($n = 46$) in RSA-baseline ($p = .008, g = -0.79$), rMSSD-baseline ($p = .007, g = -0.80$), and valence-neutral ($p = .014, g = -0.73$).

The body mass index (BMI) did not differ at the corrected alpha level (.001) between the autism ($M = 28.01, SD = 5.96, \text{min.-max.} = 18.84\text{-}45.73$) and non-autism ($M = 25.02, SD = 5.53, \text{min.-max.} = 17.38\text{-}37.42$), $t(60) = 2.05, p = .045, d = 0.52$.

Prior to their experimental visit, groups did not differ on the number of hours since last eaten, last caffeine use, last exercise, and sleep, and number of days since last alcohol use and, for female participants only, start of last menstrual cycle (Table 3).

Regarding lifestyle health behaviors, the autism group did not differ from the non-autism group in alcohol and tobacco use and exercise (Table 8). Participants reported the average number of hours they spend per week with over half of each group reporting exercising at least 3 hours on average per week (Table 8).

Co-occurring Depression and Anxiety

Several group differences emerged as potential covariates in physiological outcomes and were explored in the supplementary analyses. There were significantly more in the autism group with a diagnosis of depression/mood disorder, $\chi^2(1, 62) = 13.81, p < .001$, and of anxiety, ¹ $\chi^2(1, 62) = 11.33, p < .001$. Participants with a diagnosis of depression ($n = 22$) demonstrated lower scores than those without ($n = 40$) in RSA-baseline ($p = .003, g = -0.82$), rMSSD-baseline ($p = .004, g = -0.78$), arousal-negative ($p = .025, g = -0.60$), and valence-neutral ($p < .001, g = -1.05$), and higher scores in Δ RSA-reappraisal ($p = .010, g = 0.69$) and Δ RSA-suppression ($p = .014, g = 0.66$). Those with a diagnosis of anxiety ($n = 25$) had lower scores than those without ($n = 37$) in RSA-baseline ($p = .012, g = -0.66$), rMSSD-baseline ($p = .019, g = -0.62$), and valence-neutral ($p < .001, g = -1.08$), and higher scores in Δ RSA-reappraisal ($p = .017, g = 0.63$), Δ RSA-suppression ($p = .001, g = 0.92$), Δ rMSSD-reappraisal ($p = .017, g = 0.63$), and Δ rMSSD-suppression ($p = .002, g = 0.84$).

Validity Check

¹ Includes those with a self-reported diagnosis of social anxiety disorder.

Paired samples *t*-tests for self-reported ratings of arousal and valence between the neutral and negative emotion induction blocks determined the validity of the emotion induction condition. Across the whole sample, the negative film clips successfully induced changes in arousal, $t(61) = -14.41, p < .001, d = 1.53$, and valence, $t(61) = 14.22, p < .001, d = 1.68$. One-sample *t*-tests examining if perceived effort of reappraisal and suppression differed from a rating of 4, which reflected no effort (*Neither agree nor disagree*), demonstrated that across the whole sample, participants engaged in regulation during the reappraisal, $t(61) = 15.29, p < .001, d = 1.31$, and suppression, $t(61) = 8.93, p < .001, d = 1.71$, regulation blocks.

Hypothesis Testing and Exploratory Analyses

For the following main hypothesis testing and exploratory analyses, alpha level remained at .05 (Rothman 2014).

Hypothesis 1: Baseline RSA, rMSSD, and SCL

Three independent samples *t*-tests tested group differences in RSA, rMSSD, and SCL measured across all four baseline/recovery periods. The autism group had lower RSA-baseline, $t(55) = -2.14, p = .037, d = -0.54$, and lower rMSSD-baseline, $t(60) = -2.12, p = .038, d = -0.54$, than the non-autism group. The groups did not differ in SCL-baseline, $p = .547, d = 0.15$ (Table 9).

Hypothesis 2: Emotion Induction Blocks

Five mixed factorial ANOVAs tested group differences in changes in Δ RSA, Δ rMSSD, Δ SCR, and self-reported ratings of arousal and valence (SAM-arousal, SAM-valence) from the neutral to negative emotion induction blocks.

Regarding Δ RSA during the emotion induction blocks, there were no main effects for group or block, $ps > .152, \eta^2_p = 0.01-0.03$ (Figure 4A; Table 9). For Δ rMSSD, there were no

main effects for group or block, $ps > .070$, $\eta^2_p = 0.01-0.05$ (Figure 4B; Table 9). Regarding ΔSCL , there was a large main effect for block, $F(1, 60) = 48.42$, $p < .001$, $\eta^2_p = 0.45$, such that skin conductance increased during the negative block compared to the neutral block; there was no main effect for group or an interaction effect, $ps > .357$, $\eta^2_p = 0.004-0.01$ (Figure 4C; Table 9). For self-reported arousal, there was a large main effect for block, $F(1, 60) = 220.43$, $p < .001$, $\eta^2_p = 0.79$, indicating that participants rated higher arousal during the negative block compared to neutral block; there was no main effect for group or an interaction effect, $ps > .057$, $\eta^2_p = 0.04-0.06$ (Figure 4D; Table 9). For self-reported valence, there was a large main effect for block, $F(1, 60) = 224.38$, $p < .001$, $\eta^2_p = 0.79$, indicating that participants rated lower valence, or more negativity, during the negative block than during the neutral block (Figure 4E). Additionally, there was a significant small Block x Group interaction effect, $F(1, 60) = 7.03$, $p = .010$, $\eta^2_p = 0.11$. Bonferroni post hoc comparisons showed that during the neutral block, the autism group rated lower valence, or lower positivity, than the non-autism group, $t = -3.03$, $p = .018$ (Figure 4E; Table 9). There was no main effect for group of self-reported valence, $p = .120$, $\eta^2_p = 0.04$.

Hypotheses 3 and 4: Emotion Regulation

Hypothesis 3: ERQ. One 2 (ERQ strategy) x 2 (group) mixed factorial ANOVA evaluated group differences on reappraisal and suppression strategy use from the ERQ questionnaire. Results yielded no significant main effect for group, $p = .103$, $\eta^2_p = 0.04$, but a significant main effect for ERQ strategy use, $F(1, 60) = 5.20$, $p = .026$, $\eta^2_p = 0.08$, such that participants rated using reappraisal more often than suppression. There was a significant Group x ERQ strategy interaction, $F(1, 60) = 29.90$, $p < .001$, $\eta^2_p = 0.33$ (Figure 5). Bonferroni post hoc tests showed that Reappraisal scores were lower in the autism group relative to the non-autism

group, $t = -4.47, p < .001$, and that the non-autism group rated higher scores for Reappraisal than for Suppression, $t = 5.48, p < .001$, on the ERQ; there were no significant differences in Suppression between groups, $p = .508$, and in ERQ strategy use within the autism group, $p = .167$ (Figure 5).

Hypothesis 4: Emotion Regulation Blocks. Three 2 (block: reappraisal, suppression) x 2 (group) mixed factorial ANOVAs tested differences in emotion regulation at the physiological level between autistic and non-autistic adults for Δ RSA, Δ rMSSD, and Δ SCL. Across all three models, there were no main effects for group nor block and no interaction effect, $ps > .189, \eta^2_p = 0.00-0.02$ (Figure 6A, 6B, and 6C; Table 9).

Exploratory Analyses

Correlations. As an exploratory objective, Pearson correlations described the relationship between ERQ scores and Δ RSA, Δ rMSSD, and Δ SCL during the emotion regulation blocks. In only the non-autism group, ERQ Reappraisal was negatively correlated with Δ RSA-reappraisal, $r(29) = -.42, p = .019$, and Δ rMSSD-reappraisal, $r(29) = -.41, p = .023$, such that greater use of cognitive reappraisal in daily life related to lower Δ RSA and Δ rMSSD, or vagal withdrawal, during the reappraisal block of the experiment for non-autistic participants. The other correlations for reappraisal and suppression for both groups were not significant ($ps > .192$; Table 10). Additional correlations explored the relationship between the self-reported arousal and valence ratings and Δ RSA, Δ rMSSD, and Δ SCL during the emotion induction and emotion regulation tasks (Table 11). In the autism group, Δ RSA-neutral was negatively correlated with arousal-neutral, $r(29) = -.39, p < .05$, showing that vagal augmentation was correlated with decreased arousal ratings during neutral emotional stimuli. Also in the autism group, Δ SCL-negative was positively correlated with arousal-negative, $r(29) = .38, p < .05$,

indicating that increase in skin conductance was correlated with higher arousal ratings during negative emotional stimuli. In the non-autism group, the only significant correlations were within the reappraisal block. Δ RSA, Δ rMSSD, and Δ SCL were positively correlated with self-reported valence while the non-autistic participants engaged in reappraisal while viewing negative videos; this suggests that vagal augmentation and increases in skin conductance were correlated to greater levels of positivity.

Negative Emotion Induction and Emotion Regulation. Mixed factorial ANOVAs examined how emotion regulation strategies affected ANS correlates (Δ RSA, Δ rMSSD, and Δ SCL) and self-reported arousal (arousal-negative, arousal-reappraisal/arousal-suppression) and valence (valence-negative, valence-reappraisal/valence-suppression) to negative film clip.

Reappraisal. Five separate 2 (blocks: negative, reappraisal) x 2 (group) ANOVAs examined changes in physiological and self-reported changes when engaging in reappraisal while viewing negative film clips (Figure 7). For Δ RSA and Δ rMSSD, there were no main effects for block nor group, $ps > .164$, $\eta^2_p = 0.004-0.03$ (Figure 7A, 7B). For Δ SCL, there was a main effect of block, $F(1,60) = 22.72$, $p < .001$, $\eta^2_p = 0.28$, such that Δ SCL was lower during the reappraisal block; there was no main effect for group or an interaction effect, $ps > .411$, $\eta^2_p = 0.001-0.02$ (Figure 7C). Regarding self-reported arousal, there was a main effect of block, $F(1,60) = 81.75$, $p < .001$, $\eta^2_p = 0.58$, showing that participants reported lower arousal ratings during the reappraisal block. There was also a main effect for group, $F(1,60) = 7.75$, $p = .007$, $\eta^2_p = 0.11$, indicating that the autism group reported lower arousal ratings than the non-autism group; there was no interaction effect, $p = .557$, $\eta^2_p = 0.01$ (Figure 7D). For self-reported valence, there was a main effect of block, $F(1,60) = 60.55$, $p < .001$, $\eta^2_p = 0.50$, such that

participants reported higher valence during the reappraisal block; there was no main effect for group or an interaction effect, $ps > .264$, $\eta^2_p = 0.001-0.02$ (Figure 7E).

Suppression. Five separate 2 (blocks: negative, suppression) x 2 (group) ANOVAs examined changes in physiological and self-reported changes when engaging in suppression while viewing negative film clips (Figure 8). For Δ RSA, there was a main effect of block, $F(1, 60) = 6.59$, $p = .013$, $\eta^2_p = 0.10$, such that Δ RSA was higher during the suppression block; there was no main effect for group or an interaction effect, $ps > .413$, $\eta^2_p = 0.003-0.01$ (Figure 8A). Similarly for Δ SCL, there was a main effect of block, $F(1, 60) = 28.21$, $p < .001$, $\eta^2_p = 0.32$, such that Δ SCL was lower during the suppression block; there was no main effect for group or an interaction effect, $ps > .080$, $\eta^2_p = 0.008-0.01$ (Figure 8C). For Δ rMSSD, there were no main effects for block or group, $ps > .080$, $\eta^2_p = 0.001-0.05$ (Figure 8B). Regarding the self-reported arousal, there was a main effect of block, $F(1, 60) = 36.35$, $p < .001$, $\eta^2_p = 0.38$, indicating that participants rated lower arousal during the suppression block, and group, $F(1, 60) = 7.41$, $p = .010$, $\eta^2_p = 0.11$, such that the autism group rated lower arousal than the non-autism group; there was no interaction effect, $p = .558$, $\eta^2_p = 0.01$ (Figure 8D). For self-reported valence, there was a main effect of block, $F(1, 60) = 14.86$, $p < .001$, $\eta^2_p = 0.20$, meaning that participants rated higher valence, or more positivity, during the suppression block; there was neither a group nor interaction effect, $ps > .206$, $\eta^2_p = 0.01-0.03$ (Figure 8E).

Supplementary Analyses

Supplementary analyses for testing hypotheses 1, 2, and 4, and exploring changes due to reappraisal and suppression were conducted to include covariates for having depression or anxiety, and taking antidepressants. One-way and mixed factorial ANCOVAs included each of the three covariates separately.

Hypothesis 1 with Covariates

Three separate one-way ANCOVAs compared RSA-baseline between the autism and non-autism groups while controlling for having co-occurring depression and anxiety, and taking antidepressants. There were no significant group differences for any of these three models, $ps > .210$, $\eta^2_p = 0.002-0.03$. Therefore, the results in the main analysis for hypothesis 1 that found significant group differences in RSA-baseline are likely explained by participants' co-occurring depression or anxiety, or use of antidepressant medication on the day of their physiological recording.

An additional three separate one-way ANCOVAs compared rMSSD-baseline between the autism and non-autism groups while controlling for having co-occurring depression and anxiety, and taking antidepressants. There were no significant group differences for any of these three models, $ps > .139$, $\eta^2_p = 0.01-0.04$. This suggests that the main results for hypothesis 1 that found significant group differences in rMSSD-baseline may be explained by participants' co-occurring depression or anxiety, or use of antidepressant medication.

A final set of three one-way ANCOVAs comparing between groups while controlling for depression, anxiety, and antidepressant use demonstrated no significant group difference for SCL-baseline, $ps > .194$, $\eta^2_p = 0.001-0.03$. Adding any of these three covariates did not change the main results for nonsignificant group differences for SCL measured at baseline.

Hypothesis 2 with Covariates

Fifteen 2 (block: neutral, negative) x 2 (group) mixed factorial ANCOVAs were conducted to adjust for the role of three separate covariates on differences in RSA, rMSSD, SCL, and self-reported arousal and valence.

RSA. There were no main effects of block or group on Δ RSA for any of the three ANCOVAs that were conducted when covarying for having a co-occurring depression diagnosis, $ps > .078$, $\eta^2_p = 0.001-0.05$, and a co-occurring anxiety diagnosis, $ps > .093$, $\eta^2_p = 0.01-0.05$, and the effects of antidepressant use, $ps > .055$, $\eta^2_p = 0.02-0.06$. These ANCOVA models did not differ from the ANOVA models in hypothesis 2 suggesting that even when controlling for covariates, there were nonsignificant group differences in RSA when viewing negative film clips.

rMSSD. When covarying for having a co-occurring depression diagnosis in an ANCOVA, there was a main effect of group, $F(1, 59) = 4.15$, $p = .046$, $\eta^2_p = 0.07$, and when covarying for taking anti-depressants in another ANCOVA, there was a main effect of group, $F(1, 59) = 5.17$, $p = .027$, $\eta^2_p = 0.08$. For both models, the non-autism group had greater Δ rMSSD scores across both groups compared to the autism group. There were no main effects for block or interactions, $ps > .147$, $\eta^2_p = 0.002-0.004$. These findings stand out from the main ANOVA models such that when controlling for depression or for antidepressant use, group differences in Δ rMSSD during the emotion induction blocks emerged suggesting that antidepressant use was suppressing this main effect in the ANOVA.

There were no main effects of block or group on Δ rMSSD for the ANCOVA that covaried for having a co-occurring anxiety diagnosis, $ps > .106$, $\eta^2_p = 0.02-0.04$. This showed that covarying for anxiety did not differ from the ANOVA models that showed no main effects for block or group for Δ rMSSD during emotion induction.

SCL. In the three ANCOVAs that were conducted to include covariates, there were main effects of block for having co-occurring depression, $F(1, 59) = 49.95$, $p < .001$, $\eta^2_p = 0.46$, and co-occurring anxiety, $F(1, 59) = 51.79$, $p < .001$, $\eta^2_p = 0.47$, and for taking antidepressants, $F(1,$

59) = 40.45, $p < .001$, $\eta^2_p = 0.41$. For all three models, the negative block had greater Δ SCL scores than the neutral block for both groups. There was no main effect for group or an interaction, $ps > .156$, $\eta^2_p = 0.00-0.01$. Running these ANCOVAs model showed that even when covarying for depression, anxiety, or antidepressants, Δ SCL differed between blocks, similar to when no covariate was added as done in the main analyses.

Self-Reported Arousal. In the three ANCOVAs that were conducted for self-reported arousal to include covariates, there were main effects of block for having co-occurring depression, $F(1, 59) = 190.55$, $p < .001$, $\eta^2_p = 0.76$, and co-occurring anxiety, $F(1, 59) = 208.53$, $p < .001$, $\eta^2_p = 0.78$, and for taking antidepressants, $F(1, 59) = 154.52$, $p < .001$, $\eta^2_p = 0.72$. For all three models, participants rated greater arousal in the negative block compared to the neutral block. There were no main effects for group or interactions, $ps > .109$, $\eta^2_p = 0.01-0.04$. These results are similar to the ANOVAs that did not include any covariates.

Self-Reported Valence. In the three ANCOVAs that were conducted for self-reported arousal to include covariates, there were main effects of block for having co-occurring depression, $F(1, 59) = 195.49$, $p < .001$, $\eta^2_p = 0.77$, and co-occurring anxiety, $F(1, 59) = 217.69$, $p < .001$, $\eta^2_p = 0.79$, and for taking antidepressants, $F(1, 59) = 155.20$, $p < .001$, $\eta^2_p = 0.73$. For all three models, participants rated lower valence, or less positivity, in the negative block compared to the neutral block. There were no main effects of group across the three models, $ps > .282$, $\eta^2_p = 0.01-0.02$. Similar to self-reported arousal, these results for block differences in self-reported valence are similar to the ANOVA models that did not covary at all.

In the ANCOVA that covaried for antidepressant use, there was a Block x Group interaction, $F(1, 59) = 4.99$, $p = .029$, $\eta^2_p = 0.08$, where Bonferroni post hoc comparisons showed valence decreased from neutral to negative block for the autism ($M_{diff} = 2.44$, $t = 8.37$, $p < .001$)

and the non-autism group ($M_{diff} = 3.39, t = 10.02, p < .001$) indicating that autistic participants experienced less decrease in their subjective experiences of valence than non-autistic participants; there were no significant group differences during the neutral and negative blocks ($ps > .110$). These post hoc results suggest that the effects of antidepressant use explain the differences in perceived valence during the neutral block between the autistic and non-autistic groups, as previously observed in the main analyses. There were no interactions in the two other ANCOVA models that covaried for depression and anxiety, $ps > .164, \eta^2_p = 0.03-0.03$. While this interaction when covaried for antidepressant use is similar to the main ANOVA model that showed an interaction effect, post hoc comparisons showed differences in where the interaction was significant; this suggests that, when controlling for antidepressants, there were no group differences while viewing neutral film clips as previously found but that autistic participants experienced less decrease in positivity from viewing neutral to negative film clips.

Hypothesis 4 with Covariates

Nine 2 (block: reappraisal, suppression) x 2 (group) mixed factorial ANCOVAs were conducted to adjust for the role of three separate covariates on differences in Δ RSA, Δ rMSSD, and Δ SCL.

RSA. In an ANCOVA that included having a co-occurring anxiety diagnosis as a covariate, there was a main effect of group, $F(1, 59) = 4.31, p = .042, \eta^2_p = 0.07$, such that the autism group showed lower Δ RSA across both emotion regulation blocks than the non-autistic groups. There was no main effect for block or an interaction, $ps > .162, \eta^2_p = 0.0002-0.03$. This differs from the main analyses that showed no significant main effects suggesting that having co-occurring anxiety may have been suppressing any group differences in the original ANOVA model.

There were no main effects of block or group on Δ RSA for the two ANCOVAs that were conducted when covarying for the effects of antidepressant use, $ps > .600$, $\eta^2_p = 0.004-0.01$, and having a co-occurring depression diagnosis, $ps > .054$, $\eta^2_p = 0.02-0.06$.

rMSSD. There were no main effects of block or group on Δ rMSSD for any of the three ANCOVAs that were conducted when covarying for the effects of antidepressant use, $ps > .454$, $\eta^2_p = 0.001-0.01$, and having a co-occurring depression diagnosis, $ps > .416$, $\eta^2_p = 0.01$, and a co-occurring anxiety diagnosis, $ps > .242$, $\eta^2_p = 0.02$. These ANCOVA models did not differ from the ANOVA models in hypothesis 4 suggesting that even when controlling for covariates, there were nonsignificant group differences in Δ rMSSD when engaging in either emotion regulation strategies.

SCL. There were no main effects of block or group on Δ SCL for any of the three ANCOVAs that were conducted when covarying for the effects of antidepressant use, $ps > .255$, $\eta^2_p = 0.002-0.02$, and having a co-occurring depression diagnosis, $ps > .772$, $\eta^2_p = 0.00-0.001$, and a co-occurring anxiety diagnosis, $ps > .385$, $\eta^2_p = 0.002-0.01$. Similarly, these results did not differ when not adjusting for any covariates.

Exploratory Analyses with Covariates

Reappraisal. Fifteen 2 (block: negative, reappraisal) x 2 (group) mixed factorial ANCOVAs were conducted to adjust for the role of three separate covariates on differences in Δ RSA, Δ rMSSD, Δ SCL, and self-reported arousal and valence.

RSA. There was a main effect of group in the ANCOVA model that covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 4.68$, $p = .035$, $\eta^2_p = 0.07$, such that the autism group showed lower Δ RSA scores than the non-autism group overall; there was no main effect of block or an interaction, $ps > .066$, $\eta^2_p = 0.002-0.06$. There were no main effects of group or block

for the other two ANCOVAs that each covaried for having anxiety and taking antidepressants, $ps < .074$, $\eta^2_p = 0.03-0.05$. Given that in the main ANOVA model there were no main effects, having a depression disorder likely suppressed any group differences in Δ RSA between the negative and reappraisal blocks in the original analyses.

rMSSD. There were no main effects of group or block for any of the three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression or anxiety or taking antidepressants, $ps > .102$, $\eta^2_p = 0.00-0.05$. Adding any of these three covariates did not change the original results of the ANOVAs for Δ rMSSD between the negative and reappraisal blocks.

SCL. There was a main effect of block for all three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 24.14$, $p < .001$, $\eta^2_p = 0.29$, and anxiety, $F(1, 59) = 23.08$, $p < .001$, $\eta^2_p = 0.28$, and for the effects of antidepressant use, $F(1, 59) = 16.43$, $p < .001$, $\eta^2_p = 0.22$, such that Δ SCL was lower in the reappraisal block. There were no main effects for group or interactions across all three ANCOVAs, $ps > .423$, $\eta^2_p = 0.00-0.01$. The inclusion of any of the three covariates did not change the results of the ANOVAs for SCL between the negative and reappraisal blocks.

Self-Reported Arousal. There was a main effect of block for all three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 67.74$, $p < .001$, $\eta^2_p = 0.53$, and anxiety, $F(1, 59) = 74.08$, $p < .001$, $\eta^2_p = 0.56$, and for the effects of antidepressant use, $F(1, 59) = 62.46$, $p < .001$, $\eta^2_p = 0.51$, such that participants perceived lower arousal during the reappraisal block. There was a main effect of group for two ANCOVA models, specifically the model that included the covariate for anxiety disorder, $F(1, 59) = 5.29$, $p = .025$, $\eta^2_p = 0.08$, and for taking antidepressants, $F(1, 59) = 6.26$, $p = .015$, $\eta^2_p = 0.10$, where autistic participants perceived lower arousal than non-autistic participants overall. There was no

main effect of group for the ANCOVA with a covariate for having a depression disorder, $p = .057$, $\eta^2_p = 0.06$; this may indicate that having a co-occurring depression diagnosis better explains the group differences for change in self-reported arousal, which was previously found in the main exploratory analyses. There were no interactions for any of the three models, $ps > .276$, $\eta^2_p = 0.004-0.02$.

Self-Reported Valence. There was a main effect of block for all three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 52.20$, $p < .001$, $\eta^2_p = 0.47$, and anxiety, $F(1, 59) = 56.91$, $p < .001$, $\eta^2_p = 0.49$, and for the effects of antidepressant use, $F(1, 59) = 50.18$, $p < .001$, $\eta^2_p = 0.46$, such that participants perceived greater valence, or more positivity, during the reappraisal block. There were no main effects for group or interactions for any of the models, $ps > .316$, $\eta^2_p = 0.00-0.02$. Adding any of these three covariates did not change the original results of the ANOVAs for subjective experiences of valence.

Suppression. Fifteen 2 (block: negative, suppression) x 2 (group) mixed factorial ANCOVAs were conducted to adjust for the role of three separate covariates on differences in Δ RSA, Δ rMSSD, Δ SCL, and self-reported arousal and valence.

RSA. There was a main effect of block for the two ANCOVAs that each covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 8.70$, $p = .005$, $\eta^2_p = 0.13$, and anxiety, $F(1, 59) = 11.09$, $p = .002$, $\eta^2_p = 0.16$, where Δ RSA was greater during the suppression block compared to the negative block. There were no main effects of group or interactions for either model, $ps < .089$, $\eta^2_p = 0.00-0.05$. In the ANCOVA with a covariate for antidepressant use, there were no main effects for group or block, $ps < .085$, $\eta^2_p = 0.01-0.05$; given that the main analyses

showed significant block effects, antidepressant use explains more of the variance in Δ RSA than differences between the two blocks.

rMSSD. There was a main effect of block for the ANCOVA that each covaried for having a co-occurring diagnosis of anxiety, $F(1, 59) = 5.19, p = .026, \eta^2_p = 0.08$, where Δ rMSSD was greater during the suppression block compared to the negative block. This significant result differs from the original analyses that found no main effect of block suggesting that anxiety may have been suppressing any differences previously. There was no main effect of group or interaction, $ps < .212, \eta^2_p = 0.00-0.03$. There were no main effects of block or group on Δ rMSSD for the two ANCOVAs that were conducted when covarying for the effects of antidepressant use, $ps > .208, \eta^2_p = 0.002-0.02$, and having a co-occurring depression diagnosis, $ps > .096, \eta^2_p = 0.01-0.03$; these analyses were similar to ones that were conducted previously without the covariates for depression and antidepressants.

SCL. There was a main effect of block for all three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 27.13, p < .001, \eta^2_p = 0.32$, and anxiety, $F(1, 59) = 28.91, p < .001, \eta^2_p = 0.33$, and for the effects of antidepressant use, $F(1, 59) = 16.37, p < .001, \eta^2_p = 0.22$, such that higher Δ SCL scores were observed for the suppression block. This parallels findings from the main exploratory analyses that found differences across blocks when there were no covariates. In the ANCOVA that covaried for antidepressant use, there was a significant Block x Group interaction, $p = .046, \eta^2_p = 0.07$. Bonferroni post hoc comparisons found that for the autism group only, Δ SCL was lower in the suppression block than the negative block, $M_{diff} = 0.66, t = 4.73, p < .001$; these differences were not significant for the non-autism group, $p = .799$. This interaction suggests that autistic participants experienced a significant decrease in their sympathetic arousal when suppressing and non-autistic did not;

given that there were no interactions in the ANOVA models that did not include covariates, antidepressant use may have been suppressing the variance in Δ SCL between autistic and non-autistic participants. There were no interactions in the other ANCOVA models and no main effects for group across all three ANCOVAs, which map onto the previous ANOVA results that also found no group differences.

Self-Reported Arousal. There was a main effect of block for all three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 28.11, p < .001, \eta^2_p = 0.32$, and anxiety, $F(1, 59) = 32.14, p < .001, \eta^2_p = 0.35$, and for the effects of antidepressant use, $F(1, 59) = 27.74, p < .001, \eta^2_p = 0.32$, such that participants perceived lower arousal during the suppression block. There was a main effect of group for two ANCOVA models, specifically the model that included the covariate for anxiety disorder, $F(1, 59) = 4.62, p = .036, \eta^2_p = 0.07$, and for taking antidepressants, $F(1, 59) = 5.83, p = .019, \eta^2_p = 0.09$, where autistic participants perceived lower arousal than non-autistic participants overall. There was no main effect of group for the ANCOVA with a covariate for having a depression disorder, $p = .057, \eta^2_p = 0.06$; this may indicate that having a co-occurring depression diagnosis better explains the group differences for change in self-reported arousal, which was previously found in the main exploratory analyses. There were no interactions for any of the three models, $ps > .251, \eta^2_p = 0.004-0.02$.

Self-Reported Valence. There was a main effect of block for all three ANCOVAs that separately covaried for having a co-occurring diagnosis of depression, $F(1, 59) = 12.62, p = .001, \eta^2_p = 0.18$, and anxiety, $F(1, 59) = 14.22, p < .001, \eta^2_p = 0.19$, and for the effects of antidepressant use, $F(1, 59) = 16.05, p < .001, \eta^2_p = 0.21$, such that participants perceived greater valence, or more positivity, during the suppression block. There were no main effects for group

or interactions for any of the models, $ps > .274$, $\eta^2_p = 0.00-0.02$. Adding any of these three covariates did not change the original results of the ANOVAs for subjective experiences of valence.

Discussion

This study is the first to explore ANS measures of emotion regulation in autistic adults by utilizing dynamic film clips to induce negative emotions. To summarize, there were baseline group differences indicating reduced HRV in autistic participants, group differences in valence between viewing neutral and negative stimuli such that autistic participants self-reported lower valence while viewing neutral stimuli, and less use of cognitive reappraisal in day-to-day emotion regulation. Although not part of the hypothesis testing, there were also group differences in co-occurring psychological diagnoses and symptoms, as measured by self-reported diagnosis and the ASEBA ASR. Finally, exploratory analyses indicated some significant effects for changes in HRV, SCL, and self-reported arousal and valence between different emotion induction and regulation conditions for both the autism and non-autism groups, and supplemental analyses suggested that having depression and anxiety and taking antidepressant medications contributed significantly to these physiological and emotional processes.

As predicted in hypothesis 1, the autism group demonstrated lower levels of baseline HRV as measured by both RSA and rMSSD. While it was hypothesized that the autism group would exhibit greater SCL at baseline, results indicated no group differences. Differences in baseline HRV have been previously found in autistic adults (Thapa et al., 2019) and children (Guy et al., 2014; Scarpa, 2015). In the broader literature, high baseline HRV is generally associated with good psychological functioning (Friedman, 2007). On the other hand, the existing literature in skin conductance in autistic individuals is more mixed. Several studies have

found evidence of hyper- and hypo-sympathetic nervous system response in autistic individuals (Fenning et al., 2019; Gaigg & Bowler, 2008; Schoen et al., 2008). The current study yielded no significant group differences in baseline SCL in a sample of average to high-average IQ adults; this contributes to the heterogenous patterns of baseline skin conductance also found in studies conducted in autistic youth. While there are some studies (Hubert et al., 2009; Schneider et al., 2015) that found low sympathetic response in autistic adults, these findings were based on mean SCR amplitude, not SCL, measured in response to a task, not at baseline. Therefore, future research furthering the current study's baseline SCL analyses in autistic adults is greatly warranted.

Regarding hypothesis 2, change in RSA and rMSSD did not differ from neutral to negative emotion induction nor between groups. On the other hand, there was a large difference in SCL between viewing neutral and negative film clips for all participants, such that viewing negative stimuli induced a significant increase in skin conductance overall. This reflects existing understanding of skin conductance as an index of emotional arousal (Bradley & Lang, 1994). Similarly, participants across the whole sample reported an increase in arousal level and decrease in valence level, or less positivity, when viewing negative film clips compared to neutral film clips. For self-reported valence only, there was a significant interaction effect such that autistic participants reported less change in self-reported valence levels than non-autistic participants between viewing the neutral and negative videos during the emotion induction condition. Autistic participants' blunted decrease of perceived valence in response to the study's social film clips parallel research that show alexithymia and reduced interoception in autistic adults (Gaigg et al., 2018; Kinnaird et al., 2019).

Regarding hypothesis 3, there was a significant interaction effect for differences in emotion regulation strategy use according to the ERQ between groups, as hypothesized. Autistic participants reported less cognitive-reappraisal in their daily life when compared to the non-autistic participants. This finding corroborates previous group differences in the ERQ as observed by Samson et al. (2012), which found that those in the autism group reported using less reappraisal than the non-autism group, and extends the work of Cai et al. (2019), which demonstrated a negative relationship between ERQ reappraisal and autistic traits.

Finally, with respect to hypothesis 4, there were no differences in physiological responding (RSA, rMSSD, SCL) between reappraising and suppressing during the negative film clips for both groups. This finding suggests that the physiological processes that occur during emotion regulation while viewing negative film clips were not different between autistic and non-autistic adults in this study, and they do not support the initial hypotheses that predicted group differences. These findings are similar to the work of Mohammed et al. (2021) which found similar skin conductance reductions in non-autistic adults during reappraisal and suppression while viewing negative stimuli. However, in other non-clinical samples of adults, emotion regulation strategies showed differing physiological patterns such that reappraisal was linked to limited sympathetic response and suppression led to greater sympathetic activity (Demaree et al., 2006; Gross, 1998b; Gross & Thompson, 2007). Yet, no study to date has reported HRV and SCL patterns in emotion regulation strategies in autistic adults and therefore, the current study's analyses in exploring ANS patterns in reappraisal and suppression in autistic adults should be furthered examined in future research.

Exploratory Analyses

Analyses that explored the concordance of emotion regulation used in daily life and measured in the experimental lab setting yielded few significant correlations. For non-autistic participants only, greater endorsement of cognitive reappraisal in day-to-day emotional experiences was significantly related to vagal withdrawal, as measured by RSA and rMSSD in response to viewing negative emotional stimuli. This relationship is surprising given that cognitive reappraisal is considered a more effective emotion regulation strategy (Gross et al., 1998b) and greater RSA, which reflects the parasympathetic influences of social-emotional behavior, is related to cognitive reappraisal (Butler et al., 2006). Furthermore, it may speak to the poor translation of measuring emotion regulation in lab settings as it is applied in everyday life (MacNamara et al., 2023). In the existing autism literature, just one study reported that autistic adults who used more reappraisal strategies in their life had greater baseline HRV (Cai et al., 2019); exploring the relationship between emotion regulation measured in the lab compared to daily life within autistic adults is limited.

Autistic participants' ratings of perceived arousal were significantly related to increased SCL during the negative emotion induction task. These findings are similar to the work done by Gaigg et al. (2018) which also found significant correlations between SCR and arousal while viewing negative IAPS images in autistic adults. Together, skin conductance represents a reliable physiological correlate of autistic participant's self-reported experiences of arousal when viewing negative stimuli. Regarding RSA, autistic participants who experienced vagal augmentation while viewing neutral film clips perceived their arousal levels to be lower, suggesting that RSA may be another physiological correlate of autistic participant's subjective experiences of arousal during neutral stimuli.

Additional exploratory analyses examined how physiological and self-reported responses to negative emotional stimuli were impacted by the use of emotion regulation strategies. For the most part, there were very few group differences in emotion regulation between autistic and non-autistic adults than previously hypothesized and many of the significant results indicated changes across the whole sample.

Engaging in cognitive reappraisal while watching negative film clips did not change RSA or rMSSD responses compared to viewing negative film clips without being told to emotionally regulate, but did reduce SCL across the whole sample. Across the sample, participants also reported feeling more positive while viewing negative film clips when they were reappraising their thoughts compared to just watching the film clips. Autistic and non-autistic participants differed in their self-reported arousal ratings; specifically, autistic participants reported experiencing lower arousal levels while viewing negative film clips regardless of whether they were reappraising or suppressing.

Engaging in expressive suppression while watching negative film clips increased RSA and decreased SCL across the whole sample. That is, participants in both groups engaged in vagal augmentation and had lowered skin conductance during emotion regulation when asked to behave in a way that someone watching would not know you were feeling anything. Interestingly, rMSSD did not demonstrate this effect. While rMSSD is a measure of vagally mediated HRV, it relies less on respiration and participants may have been utilizing breath-based strategies, a common coping skill, to control their behaviors; however, the current study did not specifically measure respiration or ask participants how they suppressed their behaviors. Lower skin conductance during suppression lends further support to skin conductance as an ANS correlate of emotion regulation across autistic and non-autistic adults. Regarding self-reported

ratings of valence, participants experienced an increase in positivity while viewing negative film clips when suppressing their expressions. Similarly to reappraisal, autistic participants reported lower arousal levels while viewing negative film clips whether or not they engaged in suppression.

Supplementary Analyses with Covariates

ANCOVAs explored the potential role of having a co-occurring diagnosis of depression and anxiety and the effects of taking an antidepressant the day of the physiological recording as covariates. Several differences emerged when adding these three covariates. The main group differences in RSA and rMSSD at rest may have been explained by the variance of these psychological and medication factors. Regarding group differences in the models examining changes within the emotion induction and emotion regulation blocks, having a co-occurring psychological disorder and taking an antidepressant may explain variance in physiological responses and self-reported arousal and valence as shown by nonsignificant results when covariates were included; on the other hand, they may suppress other relationships as evidenced by analyses that became significant after covariates were considered. This suggests that there is a separate relationship between emotional regulation and emotional disorders that may be beyond having autism. Future research should more carefully examine the role of having emotional disorders in autistic people, for example conducting research in adults with autism only, with autism and co-occurring depression or anxiety, with depression or anxiety only, and without any psychological disorder.

Limitations

This study has several limitations and considerations for future direction. Largely, they are conceptualized into four areas of concern: external and internal validity, power and sample size, unrepresented emotion regulation, and other co-occurring psychological presentations.

External and Internal Validity

The current study examined physiological and self-rated responses during 20 to 30 s long segments, which may have been too brief of a recording segment to capture any variability associated with emotion regulation. Longer film clips may change the outcome of the results if participants were given a longer time to experience the gradual unfolding of emotion regulation. The brief length of film clips may have been difficult to induce emotional states necessary to elicit valid regulatory strategy use, which presents as a concern for external validity. Regarding internal validity, participants watched 40 film clips which may have allowed for desensitization of negative stimuli by the time they reached the emotion regulation blocks. To address this concern, no film clip was repeated, film clips were previously standardized to elicit negative and arousal affective states (Samson et al., 2016), reliability for self-reported valence and arousal were good to excellent. and paired samples *t*-tests ensured that videos elicited negative emotion and arousal across the whole sample. Another key validity concern is the lack of measuring the extent to which participants engaged in emotion regulation, beyond their self-reported effort. For example, the study did not measure how participants suppressed their emotional response by collecting behavioral data for facial coding or recording electromyography (EMG) for facial muscle movements. Future research should also consider ambulatory methods of measurement (e.g., ecological momentary assessment) to capture daily emotion regulation as they naturally occur in addition to utilizing other units of analysis (e.g., behavioral facial coding, EMG).

The current sample of autistic adults included in the study represents a specific presentation of autism. Not only were they highly educated and presented with high average cognitive abilities, but most of the autism group also did not have a formal autism diagnosis so their autistic presentation does not reflect samples that are typically represented in existing research of autism (Bal & Taylor, 2019). Additionally, the sample is majority non-male and it is known that women with average to high average cognitive abilities are more likely to engage in social camouflaging (Hull et al., 2020), particularly if they do not have a childhood diagnosis of autism (McQuaid et al., 2022). Therefore, this study is limited in its lack of accounting for the effects of camouflaging especially since emotion regulation (e.g., expressive suppression) may be considered a type of social camouflaging. Future research that explores emotion regulation in autistic adults should include those with more heterogenous cognitive abilities and survey their camouflaging behavior.

Power and Sample Size

While the study included enough participants to reliably detect medium-to-large effects, there were a considerable number of analyses that yielded non-significant group differences with effect sizes that may have been too small to be detected by the current sample size. Therefore, interpretation of null group findings should be approached cautiously given that the study would benefit from a larger sample size. In addition to seeking more participants, the autism group consisted of a homogenous white sample and future research should intentionally include participants of more diverse racial backgrounds. Likewise, the non-autism group consisted of only cis-gender participants with gender binary identities and future research would benefit from recruiting more gender diverse individuals.

Unrepresented Emotion Regulation

The 30 film clips depicting negative emotion largely represented fear and disgust (e.g., broken bones, jumping off high levels). There was no representation of sadness as a negative emotion which may be more appropriate for capturing the emotion regulation processes that are dysfunctional with depression.

Another limitation of this study is the lack of accounting for whether participants were already engaging in emotion regulation during the emotion induction tasks. Kreibig et al. (2023) described the notion of unregulated emotion regulation strategies characterized by different goals and strategies (e.g., having no specific goal can lead to a specific emotion regulation strategy). This study only measured emotion regulation when participants were explicitly instructed to engage in specific emotion regulation strategies as outlined in the process model; yet it cannot be assumed that participants did not engage in reappraisal or suppression on their own during the first two blocks.

Co-occurring Psychological Presentations

Other psychological disorders and co-occurring symptoms may be related to the results in the current study. Participants in both groups reported having a previous diagnosis of anxiety or depression, which are psychological presentations characterized by poor emotion regulation (e.g., ruminative thinking, persistent negative affect). Additionally, the autism group held more psychological diagnoses and reported higher ASEBA ASR scores than the non-autism group. While supplementary analyses explored the covarying role of these factors, the current study did not examine the potential mediating role of anxiety and depression or other psychological concerns on emotion regulation processes, and such analysis will be explored in continued analysis of these data.

Conclusion

This study is one of very few to examine ANS correlates of emotion regulation in autistic adults using multiple methods of measurement. Thus, this study extends the field in several different directions. Mainly, there were group differences indicating that autistic compared to non-autistic participants showed reduced baseline HRV, lower valence when viewing neutral stimuli, and reduced use of cognitive-reappraisal as an emotion regulation strategy in daily life. Reduced baseline HRV in autistic adults extends previous research (Thapa et al., 2019), is consistent with the literature of other clinical populations (e.g., Cheng et al., 2022; Schiweck et al., 2019), and supports existing theories, such as the Neurovisceral Integration Model (Thayer & Lane, 2000) and Polyvagal Theory (Porges, 2001). Additionally, reduced self-reported use of cognitive reappraisal in everyday experiences in autistic adults is consistent with previous findings (Samson et al., 2012; Thapa et al., 2019) and may suggest difficulties in flexibly engaging in cognitive strategies to ameliorate emotional experiences. While both groups experienced increased skin conductance to negative stimuli, autistic adults may have less flexibility when faced with other negative scenarios given their reduced baseline HRV and reappraisal strategy use.

Regarding ANS activity during the emotion regulation tasks, both groups experienced reduced sympathetic arousal while reappraising and increased parasympathetic activity while suppressing. Both groups also reported feeling decreased arousal and more positivity while emotionally regulating their feelings and behaviors during negative stimuli. These findings across the whole sample may suggest that direct instruction to engage in emotion regulation may be beneficial at the physiological and subjective levels; however, interpretation should be taken with caution given that the current sample may have been underpowered to detect group differences.

Overall, the findings of the current study may have implications for implementing treatment that highlights emotion regulation skill development like cognitive behavior therapy and dialectical behavior therapy, treatment approaches originally not developed with autistic individuals in mind. In conclusion, understanding the ways emotional processes in autistic adults are similar to and different from non-autistic adults contributes to our understanding of developmental trajectories of social-emotional abilities in autism across the lifespan.

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Tables

Table 1

Previous Psychological Disorder

	Autism	Non-Autism	χ	p	ω
	%	%			
ADHD	38.71%	0%	14.80	<.001	-0.49
Anxiety	58.06%	19.35%	9.79	.002	-0.40
Depression/Mood Disorder	58.06%	12.90%	13.81	<.001	0.47
Social Anxiety Disorder	19.35%	0%	6.64	.010	-0.33
OCD	12.90%	6.45%	0.74	.390	-0.11
Eating disorder	3.23%	6.45%	0.35	.554	-0.08
PTSD	19.35%	0%	6.64	.010	-0.33

ADHD = attention-deficit/hyperactivity disorder; OCD = obsessive-compulsive disorder; PTSD

= posttraumatic stress disorder.

Table 2*Psychotropic Medication Use Prior to Physiological Recording*

	Autism %	Non-Autism %	df	χ	p	ω
Psychotropic Medication Use	48.39%	16.13%	1	7.38	.007	0.35
Antidepressants	38.71%	12.90%	1	5.39	.020	0.30
Stimulants	6.45%	3.23%	1	0.35	.554	0.08
Mood Stabilizers	6.45%	0%	1	2.07	.151	0.18
Antipsychotics	6.45%	0%	1	2.07	.151	0.18
Hypnotics	3.23%	0%	1	1.02	.313	0.13

Note. Bonferroni correction to lower alpha value to .001 was made to prevent Type I error.

Table 3*Health Behaviors Prior to Physiological Recording*

	Autism			Non-Autism			<i>t</i>	<i>p</i>	<i>g</i>
	<i>n</i>	<i>M</i> (SD)	Min.-Max.	<i>n</i>	<i>M</i> (SD)	Min.-Max.			
Hours since last food eaten	31	3.62 (4.77)	0-16.98	31	1.39 (1.21)	0.13-5.05	2.52 ^a	.008	0.63
Hours since last caffeine use ^b	14	14.12 (7.70)	3.00-24.00	14	13.17 (9.27)	1.00-23.50	0.30	.769	0.11
Days since last alcohol use ^c	9	3.37 (1.52)	1.01-5.62	17	4.05 (2.06)	1.57-7.00	-0.88	.389	-0.35
Hours since last exercise	30	33.61 (35.51)	0.10-144.12	30	29.83 (35.01)	0.05-168.03	0.42	.679	0.11
Hours of sleep	31	7.45 (1.80)	4-12	31	7.61 (1.30)	5-10	-0.41 ^a	.687	-0.10
Days since start of last menstrual cycle ^d	14	20.57 (32.69)	1-129	20	18.40 (19.73)	1-91	0.24	.811	0.08

Note. Bonferroni correction to lower alpha value to .001 was made to prevent Type I error.

^aEqual variances not assumed.

^bFor those who regularly consume caffeine.

^cFor those who reported alcohol use within the past week.

^dFor female (sex) participants who reported having menstruation cycles.

Table 4*SRS-2 T-Scores*

	Autism		Non-Autism	
	<i>M</i> (SD)	Min.-Max.	<i>M</i> (SD)	Min.-Max.
Social Awareness	68.03 (7.71)	49-81	45.65 (6.06)	32-55
Social Cognition	72.10 (8.03)	58-90	48.06 (4.32)	41-56
Social Communication	73.71 (6.55)	61-90	45.58 (5.33)	38-56
Social Motivation	73.65 (7.46)	56-89	51.00 (7.62)	37-74
Restricted, Repetitive Behavior	80.10 (7.96)	63-90	49.29 (7.17)	40-77
Total	76.42 (5.75)	67-90	47.48 (4.99)	39-58

Table 5*ASEBA ASR Broadband Domain and Syndrome Scale T-Scores*

Domain <i>Syndrome</i>	Autism		Non-Autism		<i>t</i>	<i>p</i>	<i>d</i>
	<i>M</i> (SD)	Min.-Max.	<i>M</i> (SD)	Min.-Max.			
Internalizing	70.77 (10.10)	55-90	50.10 (9.68)	32-79	8.23	<.001*	2.09
- <i>Anxious/Depressed</i>	71.58 (13.95)	50-98	55.10 (7.33)	50-85	5.82 ^a	<.001*	1.48
- <i>Withdrawn/Depressed</i>	66.87 (7.83)	51-85	52.52 (4.40)	50-70	8.90 ^a	<.001*	2.26
- <i>Somatic Complaints</i>	64.06 (7.14)	51-84	54.10 (5.36)	50-67	6.22	<.001*	1.58
Externalizing	59.03 (7.71)	45-74	45.48 (9.39)	29-70	6.21	<.001*	1.58
- <i>Rule Breaking Behavior</i>	60.68 (7.01)	50-79	51.84 (3.65)	50-66	6.23 ^a	<.001*	1.58
- <i>Aggressive Behavior</i>	58.65 (7.46)	50-73	52.13 (4.52)	50-73	4.16 ^a	<.001*	1.06
<i>Intrusive Problems</i>	55.90 (5.79)	50-70	53.77 (5.67)	50-70	1.46	.149	0.37
<i>Thought Problems</i>	72.52 (6.32)	56-85	53.74 (6.39)	50-78	11.63	<.001*	2.95
<i>Attention Problems</i>	68.68 (9.87)	51-90	52.19 (4.19)	50-69	8.56 ^a	<.001*	2.17

*Bonferroni correction to lower alpha value to .001 was made to prevent Type I error.

^aEqual variances not assumed.

Table 6*Intake Assessment (ADOS-2, WASI-II)*

	Autism		Non-Autism		<i>t</i>	<i>p</i>	<i>d</i>
	<i>M</i> (SD)	Min.-Max.	<i>M</i> (SD)	Min.-Max.			
ADOS-2 Social Affect	9.32 (3.16)	5-18	1.87 (1.88)	0-7	11.30 ^a	<.001*	2.87
ADOS-2 RRB	3.13 (1.69)	0-7	0.90 (0.87)	0-3	6.53 ^a	<.001*	1.66
ADOS-2 Total	12.45 (3.70)	8-21	2.77 (1.93)	0-7	12.90 ^a	<.001*	3.28
ADOS-2 CSS	6.68 (1.70)	4-10	1.58 (0.62)	1-3	15.68 ^a	<.001*	3.98
WASI-II VCI	113.00 (9.17)	93-130	111.32 (8.11)	95-130	0.76	.449	0.19
WASI-II PRI	108.42 (12.01)	82-130	108.45 (9.25)	93-132	-0.01	.991	-0.00
WASI-II FSIQ-4	112.39 (8.31)	98-131	111.19 (7.86)	93-130	0.58	.563	0.15

*Bonferroni correction to lower alpha value to .001 was made to prevent Type I error.

^aEqual variances not assumed.

RRB = Restricted, Repetitive Behavior; CSS = Calibrated Severity Score; VCI = Verbal Comprehension Index; PRI = Perceptual

Reasoning Index; FSIQ = Full Scale IQ-4.

Table 7*Demographic Variables by Group*

	Autism	Non-Autism	df	χ	p	ω
Biological Sex:			1	0.30	.587	0.07
Male	35.48%	29.03%				
Female	64.52%	70.97%				
Gender Identity: Male	32.26%	29.03%	1	0.08	.783	0.04
Gender Identity: Female	41.94%	70.97%	1	5.31	.021	0.29
Gender Identity: Nonbinary	22.58%	0%	1	7.89	.005	0.36
Gender Identity: Genderqueer	6.45%	0%	1	2.07	.151	0.18
Gender Identity: Gender Nonconforming	6.45%	0%	1	2.07	.151	0.18
Gender Identity: Agender	3.23%	0%	1	1.02	.313	0.13
Gender Identity: Other ^a	32.26%	0%	1	11.92	<.001*	0.44
Race: White	87.10%	61.29%	1	5.37	.020	0.30
Race: Black or African American	0%	3.23%	1	1.02	.313	0.13
Race: Asian	16.13%	25.81%	1	0.88	.349	0.12
Race: Native American/Alaskan	3.23%	0%	1	1.02	.313	0.13
Race: Other	0%	9.68%	1	3.15	.076	0.23
Race: Unknown	6.45%	0%	1	2.07	.151	0.18
Ethnicity:			1	0.35	.554	0.08
Hispanic or Latinx	3.23%	6.45%				
Not Hispanic or Latinx	96.77%	93.55%				
Highest Level of Education:			4	6.92	.140	0.33
High School Graduate	12.90%	3.23%				
Associate Degree	9.68%	0%				
Some College	35.48%	38.71%				
Baccalaureate Degree	22.58%	19.35%				
Graduate/Professional Degree	19.35%	38.71%				

*Bonferroni correction to lower alpha value to .001 was made to prevent Type I error.

Note. Participants were able to select multiple gender identities and racial categories.

^aGender identity selections that were not “male” or “female” collapsed into one “other” group.

Table 8*Lifestyle Health Behaviors*

	Autism %	Non-Autism %	df	χ	p	ω
Lifestyle Alcohol Use (% yes)	38.71%	67.74%	1	525	.022	0.29
Lifestyle Tobacco Use (% yes)	6.45%	0%	1	2.07	.151	0.18
Lifestyle Exercise Average Hours Per Week	-	-	3	3.82	.028	0.30
Less than 1 hour	0%	3.70%				
1-2 hours	37.50%	14.81%				
3-6 hours	43.75%	66.67%				
7 or more hours	18.75%	14.81%				

Note. Bonferroni correction to lower alpha value to .001 was made to prevent Type I error.

Table 9*RSA, rMSSD, and SCL and Self-Reported Arousal, Valence, and Effort Ratings*

	Autism		Non-Autism	
	<i>M</i> (SD)	Min.-Max.	<i>M</i> (SD)	Min.-Max.
RSA-baseline	4.99 (1.43)	2.75-8.64	5.66 (1.03)	3.21-7.78
ΔRSA-neutral	-0.36 (0.52)	-1.90-0.56	-0.21 (0.42)	-0.91-0.84
ΔRSA-negative	-0.29 (0.62)	-1.61-1.29	-0.13 (0.58)	-1.36-1.36
ΔRSA-reappraisal	-0.10 (0.62)	-1.31-1.02	-0.04 (0.72)	-2.96-1.04
ΔRSA-suppression	0.05 (0.78)	-1.43-2.42	0.05 (0.81)	-1.35-2.39
rMSSD-baseline	28.33 (25.79)	7.71-146.60	36.57 (19.85)	9.26-87.68
ΔrMSSD-neutral	-2.03 (7.62)	-34.62-12.98	1.15 (5.57)	-8.46-14.82
ΔrMSSD-negative	-1.92 (10.89)	-40.09-15.36	1.74 (12.74)	-27.26-50.05
ΔrMSSD-reappraisal	2.07 (6.40)	-18.08-16.52	2.25 (11.90)	-42.50-29.80
ΔrMSSD-suppression	3.40 (6.26)	-6.26-13.72	2.91 (14.70)	-35.81-48.11
SCL-baseline	11.52 (6.84)	2.24-29.98	10.51 (6.81)	2.05-33.54
ΔSCL-neutral	-0.16 (0.81)	-2.99-0.90	-0.09 (0.72)	-1.86-0.97
ΔSCL-negative	0.98 (1.17)	-0.45-5.89	0.70 (0.78)	-0.48-2.54
ΔSCL-reappraisal	0.31 (0.91)	-2.80-3.28	0.28 (0.52)	-1.00-1.46
ΔSCL-suppression	0.17 (0.46)	-1.20-1.20	0.33 (0.72)	-1.02-2.51
Arousal-neutral	3.08 (1.24)	1.30-6.67	3.18 (1.38)	1.00-6.00
Arousal-negative	5.51 (1.86)	2.10-8.50	6.37 (1.20)	3.50-8.60
Arousal-reappraisal	3.62 (1.67)	1.30-7.60	4.70 (1.50)	1.60-7.90
Arousal-suppression	4.24 (1.72)	1.70-7.80	5.32 (1.60)	1.30-8.20
Valence-neutral	5.51 (1.02)	4.00-8.40	6.34 (1.11)	4.20-8.80
Valence-negative	3.02 (1.07)	1.30-5.50	2.76 (1.10)	1.00-5.00
Valence-reappraisal	3.99 (0.79)	1.70-5.10	3.78 (0.84)	1.60-5.00
Valence-suppression	3.53 (1.14)	1.10-6.30	3.15 (1.01)	1.10-5.00
Effort-reappraisal	6.42 (1.40)	2.00-8.00	6.66 (1.23)	3.40-8.00
Effort-suppression	5.68 (1.66)	1.30-8.00	6.20 (1.74)	1.00-8.00

Table 10*Pearson r Correlations between ERQ and Δ RSA, Δ rMSSD, and Δ SCL*

	Autism	Non-Autism
	ERQ Reappraisal	
Δ RSA-reappraisal	-.24	-.42*
Δ rMSSD-reappraisal	-.16	-.41*
Δ SCL-reappraisal	-.14	.06
	ERQ Suppression	
Δ RSA-suppression	-.16	-.22
Δ rMSSD-suppression	-.18	-.08
Δ SCL-suppression	.13	.09

* $p < .05$.

Table 11

Pearson r Correlations between Δ RSA, Δ rMSSD, and Δ SCL and Self-Reported Arousal and Valence

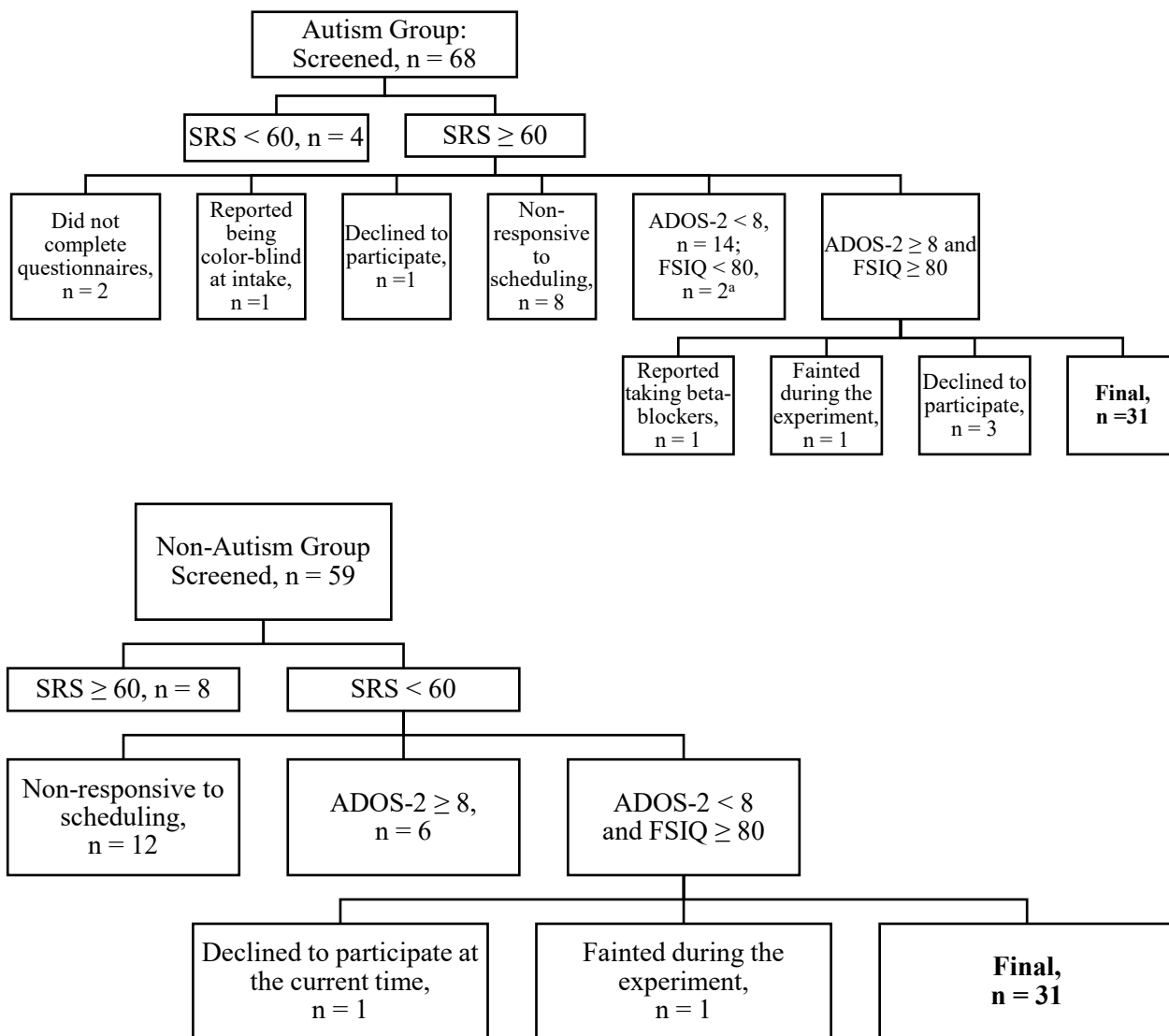
	Autism		Non-Autism	
	Valence	Arousal	Valence	Arousal
				Neutral
Δ RSA	-.11	-.39*	.19	-.12
Δ rMSSD	-.10	-.27	-.02	-.13
Δ SCL	.04	-.19	-.12	-.20
				Negative
Δ RSA	-.21	.10	.09	.00
Δ rMSSD	-.06	-.03	.07	.05
Δ SCL	-.20	.38*	-.05	.06
				Reappraisal
Δ RSA	.29	-.28	.40*	.01
Δ rMSSD	.25	-.03	.57**	.00
Δ SCL	-.12	.22	.40*	-.16
				Suppression
Δ RSA	.04	-.08	.15	-.17
Δ rMSSD	.31	-.27	.16	-.10
Δ SCL	-.12	.32	.11	-.15

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

Figures

Figure 1

Participant Inclusion Flow Chart

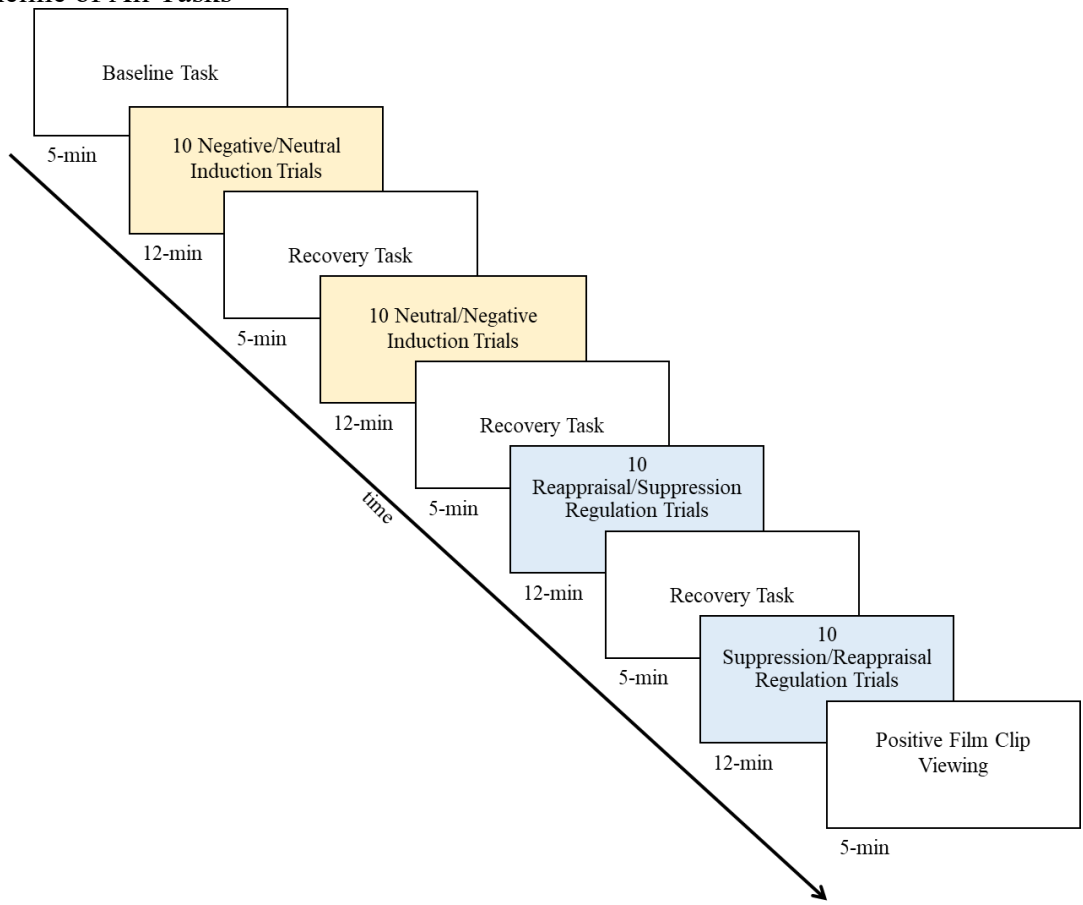


^aOne participant in the Autism Group fell below both cutoffs on the ADOS-2 and FSIQ.

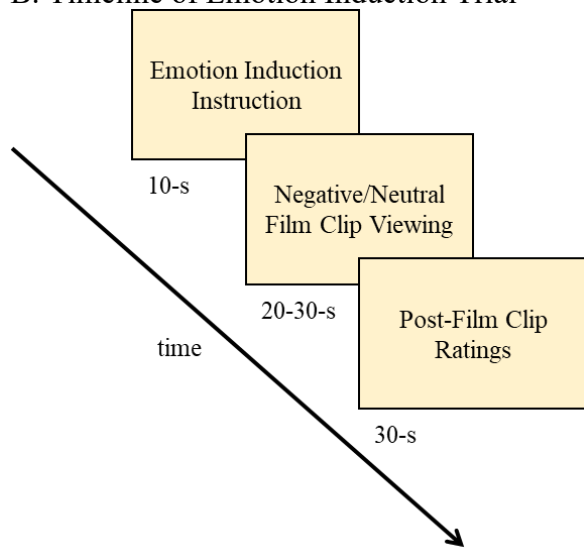
Figure 2

Timeline of Experimental Visit

A. Timeline of All Tasks



B. Timeline of Emotion Induction Trial



C. Timeline of Emotion Regulation Trial

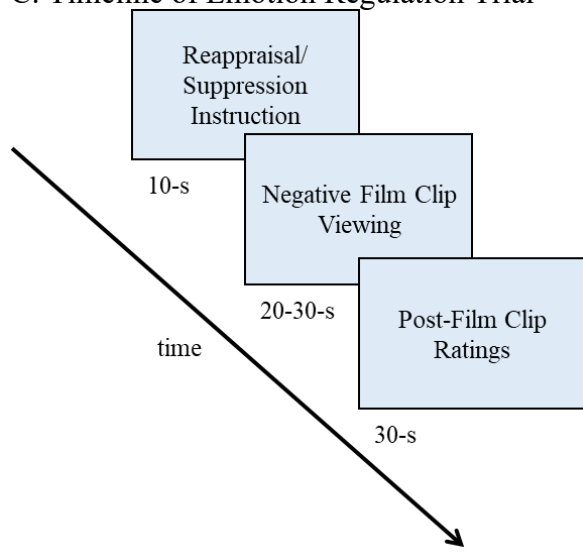
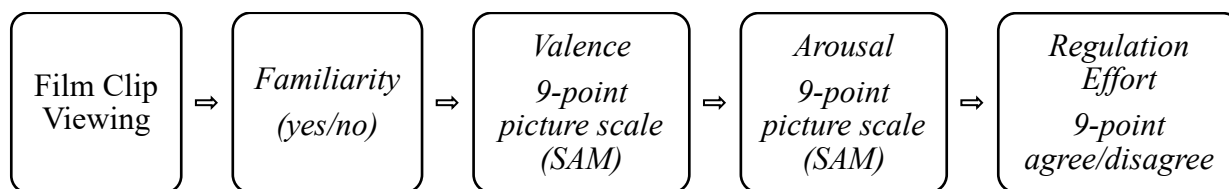


Figure 3

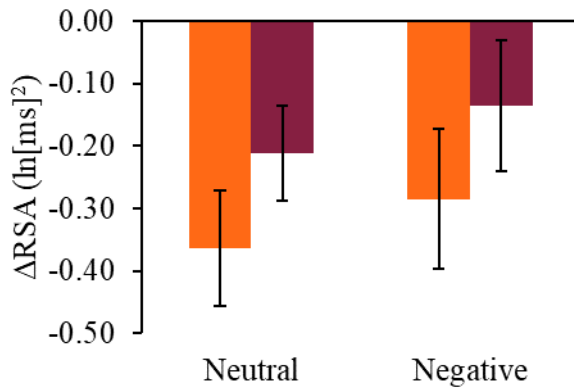
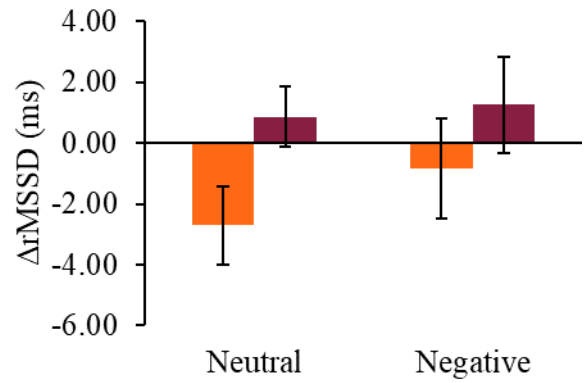
Post-Film Clip Self-Report Ratings



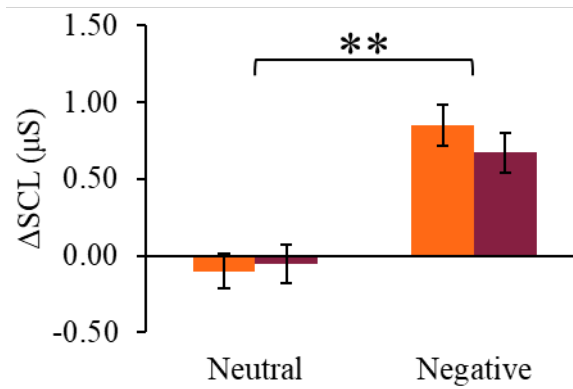
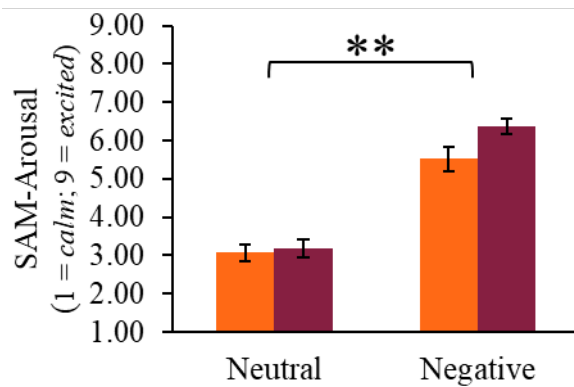
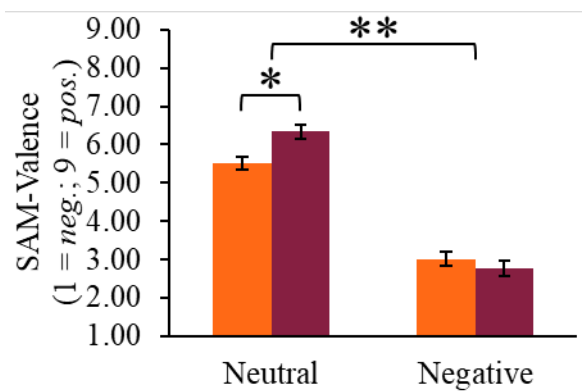
SAM=Self-Assessment Manikin

Figure 4

2 (Emotion Induction Blocks) x 2 (Group) ANOVA

A. Δ RSA**B. Δ rMSSD****C. Δ SCL**

Autism
Non-Autism

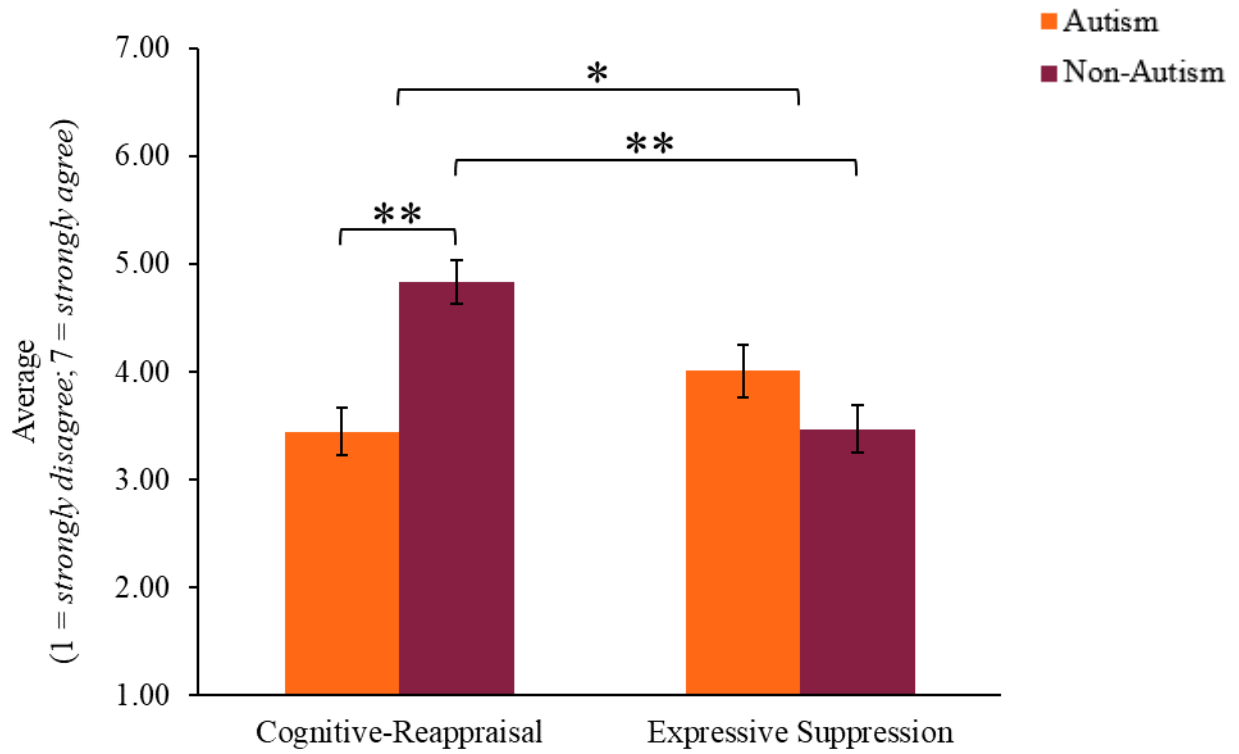
**D. Self-reported arousal****E. Self-reported valence**

Note. Bars indicate standard error.

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

Figure 5

2 (ERQ Reappraisal, ERQ Suppression) x 2 (Group) ANOVA

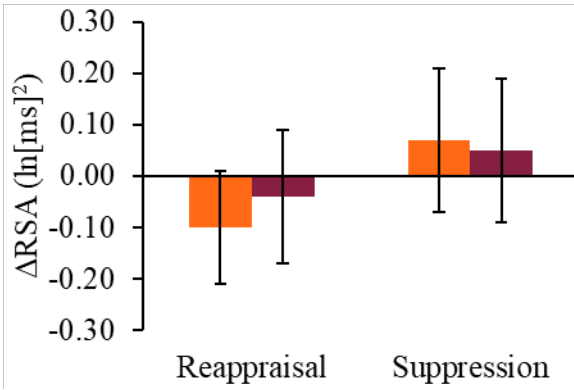
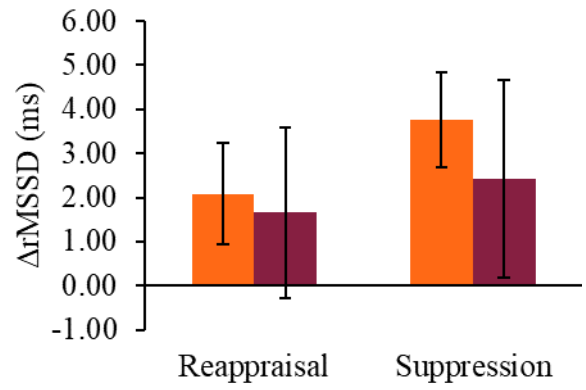


Note. Bars indicate standard error.

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

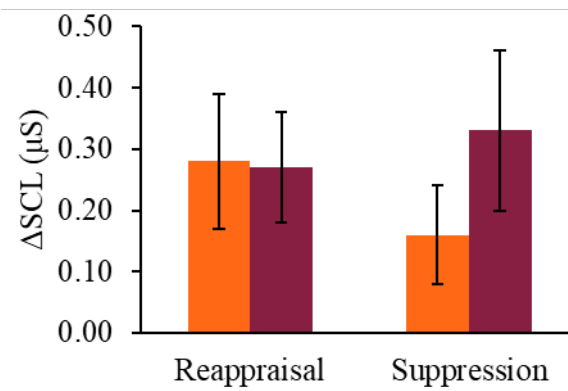
Figure 6

2 (Emotion Regulation Blocks) x 2 (Group) ANOVA

A. Δ RSA**B. Δ rMSSD**

■ Autism

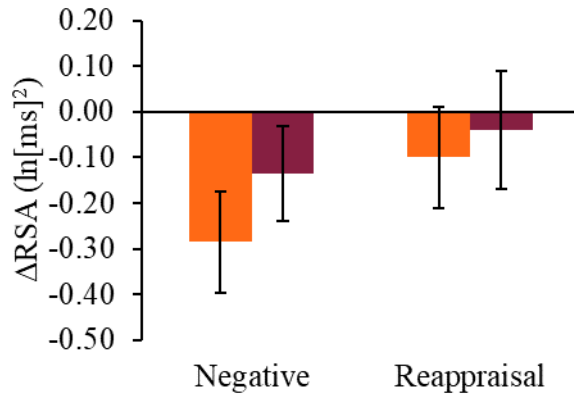
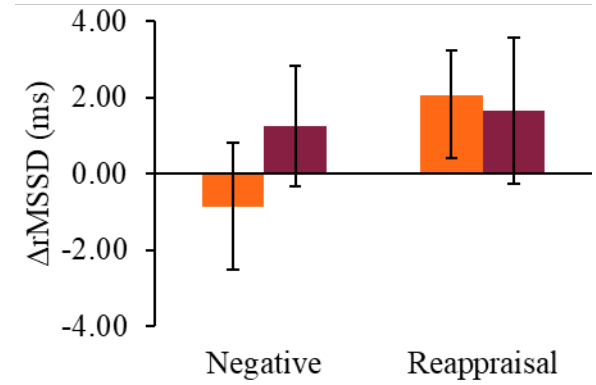
■ Non-Autism

C. Δ SCL

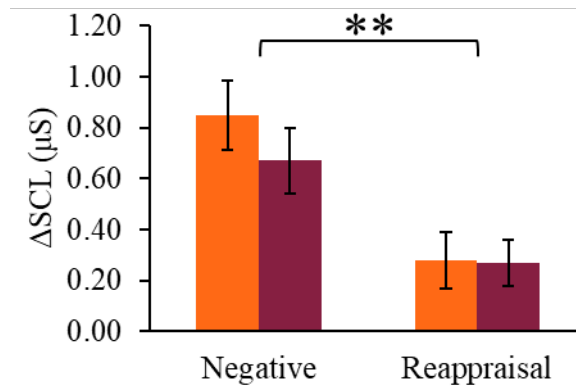
Note. Bars indicate standard error.

Figure 7

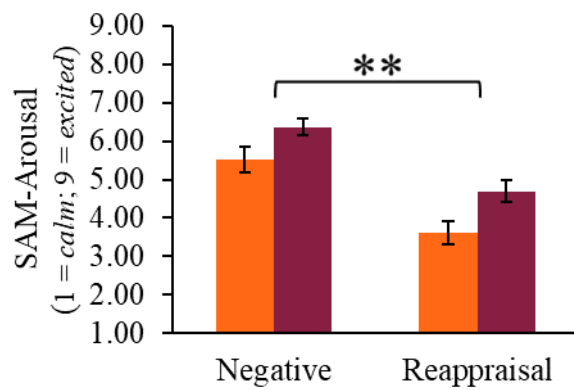
2 (Blocks: Negative, Reappraisal) x 2 (Group) ANOVA

A. Δ RSAB. Δ rMSSD

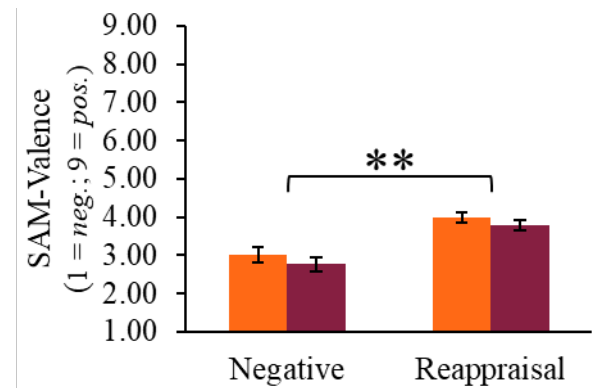
Autism
Non-Autism

C. Δ SCL

D. Self-reported arousal



E. Self-reported valence

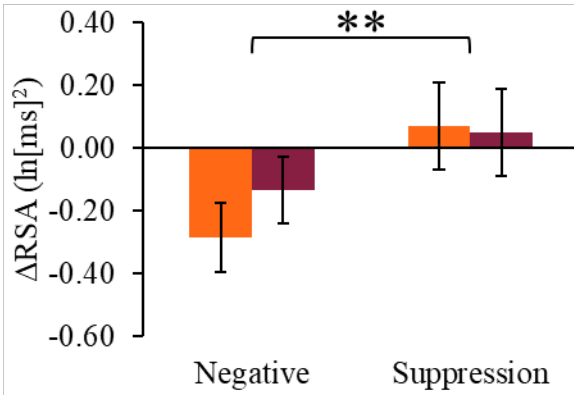
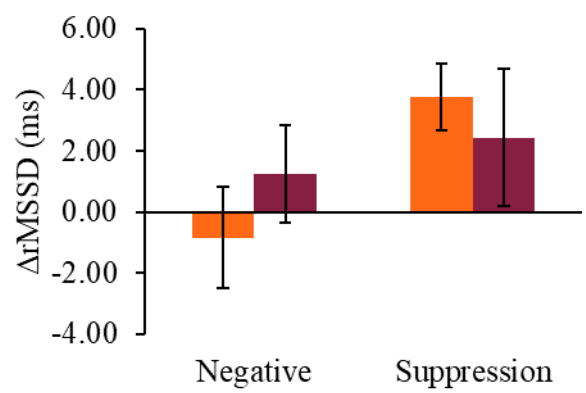
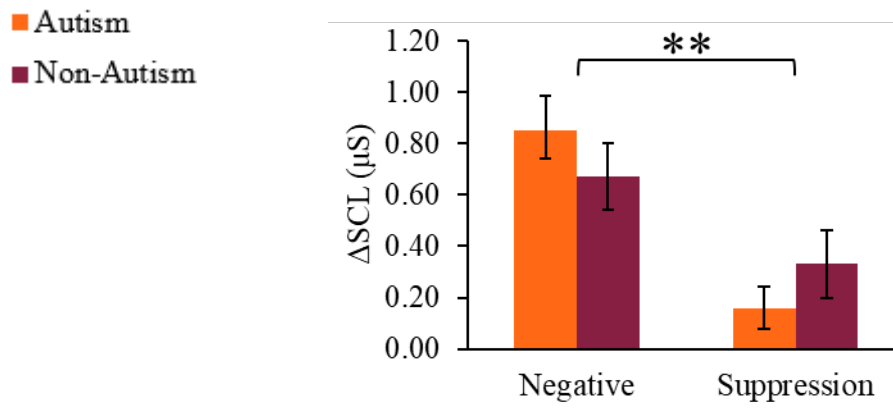
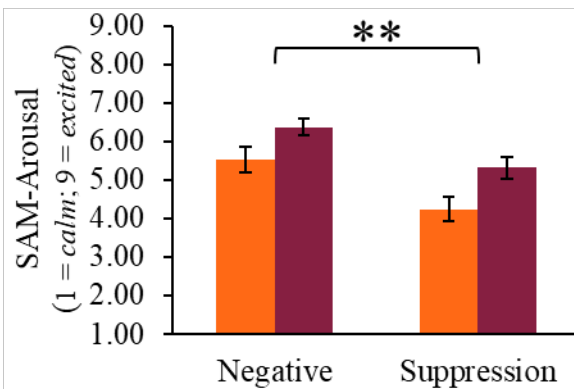
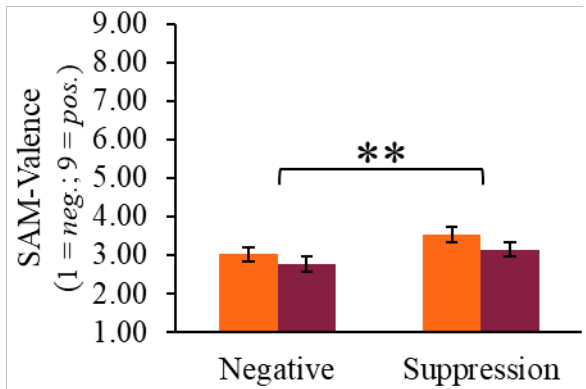


Note. Bars indicate standard error.

** $p < .001$

Figure 8

2 (Blocks: Negative, Suppression) x 2 (Group) ANOVA

A. Δ RSA**B. Δ rMSSD****C. Δ SCL****D. Self-reported arousal****E. Self-reported valence**

Note. Bars indicate standard error.

** $p < .001$

Appendix

Appendix A

Demographic Background Questionnaire

Demographic Background Questionnaire

Page 1

ID _____

Demographic Information

Your biological sex:

- Male
 Female
 Intersex
 Other

If other "sex", please specify: _____

Your current gender identity (select all that apply):

- Male
 Female
 Nonbinary
 Genderqueer
 Gender Nonconforming
 Agender
 Other

If other "gender identity", please specify: _____

Your race (select all that apply):

- White
 Black or African American
 Asian
 Native American or Native Alaskan
 Native Hawaiian or Pacific Islander
 Other
 Unknown

If other "race", please specify: _____

Your ethnicity:

- Hispanic or Latinx
 Not Hispanic or Latinx
 Unknown

Your highest level of education:

- Graduate/Professional Degree (PhD, MD, MS/MA, MBA)
 Baccalaureate Degree (4 year college)
 Some college
 Associate Degree (2 year college)
 High School Graduate
 GED Diploma
 Some High School (no diploma)
 Completed up through 9th grade
 Completed less than 9th grade
 Unknown
 Decline to answer

Health Information

Have you ever been diagnosed with a psychological disorder? Yes No

Psychological disorders that you've been diagnosed with (select all that apply):
 Autism (or Asperger's Syndrome)
 ADHD
 Anxiety (e.g., generalized anxiety disorder)
 Depression (e.g., major depressive disorder)
 Social anxiety disorder
 Obsessive-compulsive disorder
 Bipolar disorder
 Psychotic disorder
 Eating disorder (e.g., bulimia, anorexia, ARFID)
 Intellectual disorder
 Other - not listed

If other psychological disorder not listed, please list here: _____

Do you have any medical or physical conditions or disorders? Yes No

Describe the medical or physical conditions or disorders that you have. _____

How many prescribed medications do you currently take? _____

1. Current medication name _____

2. Current medication name _____

3. Current medication name _____

4. Current medication name _____

5. Current medication name _____

6. Current medication name _____

7. Current medication name _____

8. Current medication name _____

Do you use tobacco? Yes No

Confidential

Page 3

How often? _____

How much? _____

Do you drink alcohol? Yes
 No

How often? _____

How much? _____

Do you currently exercise? Yes
 No

How many hours per week on average do you exercise? Less than 1 hour
 1-2 hours
 3-6 hours
 7 or more hours

What do you do for exercise? _____

What is your current height? (inches only) _____
(For example, if you are 5 feet 8 inches, please enter 68.)

What is your current weight? (pounds only) _____

Appendix B

Informed Consent Form

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Consent to Take Part in a Research Study

Title of research study: Autonomic Nervous System Mechanisms of Emotion Regulation in Autistic Adults (IRB 23-359)

Principal Investigator: Angela Scarpa, Ph.D., Virginia Tech Autism Clinic & Center for Autism Research (VTAC/CAR), Department of Psychology, Virginia Polytechnic Institute and State University; phone: (540) 231-2615; email: ascarpa@vt.edu.

Other study contact: Megan Fok, M.S., email: mfok@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

Why am I being invited to take part in a research study?

You are invited to be part of a research study by Angela Scarpa, Ph.D., from the Department of Psychology at Virginia Tech. You were selected because you indicated that you are at least 18 years old.

What should I know about being in a research study?

- Someone will explain this research study to you
- Whether or not you take part is up to you
- You can choose not to take part
- You can agree to take part and later change your mind
- Your decision will not be held against you
- You can ask all the questions you want before you decide

Why is this research being done?

The purpose of this study is to understand how autistic adults regulate their negative emotions by measuring their physiological activity (heart rate and skin conductivity) and collecting their self-reported ratings of emotion regulation. This information will inform how similar and different these emotional and physiological processes are to non-autistic adults.

How long will the research last and what will I need to do?

This study involves completing online questionnaires and two in-person visits at our lab space (up to 4.5-hrs total). You will complete a social-emotional interview and an assessment of your verbal and perceptual reasoning skills and watch brief emotional film clips while your heart rate and skin conductivity are measured.

More detailed information about the study procedures can be found under “*What happens if I say yes, I want to be in this research?*”

Consent to Take Part in a Research Study

Is there any way being in this study could be bad for me?

There are no more than minimal risks involved for you to participate in this study. Some of the potential risks include personal discomfort and emotional stress while completing the online questionnaires and assessment activities and viewing the emotional film clips. There is also risk to confidentiality. However, there are measures taken to mitigate these risks and detailed information can be found in the section, *“Is there any way being in this study could be bad for me? (Detailed Risks)”*

Will being in this study help me in any way?

If you are autistic, you may benefit from taking part in this research study by receiving an autism assessment. If you are recruited as a non-autistic participant, there are no benefits to you from your taking part in this research. We cannot promise any benefits to others from your taking part in this research. However, possible benefits to others include the autism and psychological field gaining a better understanding of how emotion regulation is experienced by autistic adults.

What happens if I do not want to be in this research?

Taking part in research is completely up to you. You can decide whether to participate or not to participate. Please see more detailed information under *“What happens if I say yes, but change my mind later?”*

Detailed Information: The following is more detailed information about this study in addition to the information listed above.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at (540) 231-8747 or email vtautismcenter@vt.edu

This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about 90 people in this research study.

What happens if I say yes, I want to be in this research?

If you decide to participate in this study, we will ask you to do the following:

- Online questionnaires: This will take up to 30 minutes total. You will complete questionnaires online prior to your first visit.
- Complete up to 2 in-person visits: These two visits will take up to 4 hours total. Both visits will take place at VTAC/CAR (3110 Prices Fork Road, Blacksburg VA), as follows:

Consent to Take Part in a Research Study

1. **Intake Visit:** You will complete a session up to 2 hours in length in-person. During this visit, you will:
 - a. Complete a 45-60 minute social-emotional interview with a study staff member.
 - b. Complete a 45-60 minute assessment of your verbal and perceptual reasoning skills with a study staff member.
 - c. Be audio/video recorded.
2. **Experimental Visit:** You will complete a session up to 2 hours in length in-person. During this visit you will:
 - a. Complete a brief questionnaire about your recent health behaviors.
 - b. Wear electrodes on your torso (1 on your collarbone and 2 on each ribcage) and fingers secured with hypoallergenic surgical tape that will measure your heart rate and skin conductivity.
 - c. Sit and view a series of film clips on a computer.
 - d. Provide brief ratings of each film clip.
 - **For autistic participants only:** You may include a parent or a caregiver to join the study and complete a developmental history interview to provide information about your early developmental behaviors and autistic characteristics. This interview can be completed in-person, over the phone, or through videoconferencing (i.e., Zoom) and will last up to 3 hours.

NOTE: If you have previously completed an assessment through the Virginia Tech Psychological Services Center, you may have the option to utilize your prior assessment data and only complete a portion of the online questionnaires and intake assessment and the experimental visit if you request permission for the PSC to release the information to this study (you will need to sign an authorization of release of information form at the PSC to do so; you may contact the PSC at 540-231-6914). As such, your participation would only take 2-2.5 hours in total.

What happens if I say yes, but I change my mind later?

Taking part in research is completely up to you. You can leave the research at any time, for any reason, and it will not be held against you.

If you decide to leave the research, contact the investigator so that the investigator can document your withdrawal and remove you from the study records. You will be asked if you would like your data that has been collected to be considered for data analysis. If you do not want your data to be considered for analysis, it will be destroyed. Leaving the current research study does not change your current or future services at the Virginia Tech Psychological Services Center including your status on the waitlist.

If you decide to withdraw your data from the research post-study completion, contact the study team so the investigator can document your data withdrawal. All data will be destroyed.

Consent to Take Part in a Research Study

Is there any way being in this study could be bad for me? (Detailed Risks)

There are no more than minimal risks involved for you to participate in this study. Some of the potential risks include:

- You may experience personal discomfort due to sensitive topics about emotions and relationships being assessed during the online questionnaires and intake visit. You will be able to skip any questions that you do not want to answer due to any personal discomfort. This is considered minimal because all of our measures are commonly used in research and clinical practice.
- You may become anxious or frustrated during the assessment at intake. Some aspects of the assessment are intended to be challenging. This is considered minimal because this measure is commonly used in research and clinical practice.
- You may experience negative affect while viewing some of the film clips. This is considered minimal because the viewing will be brief (less than 1 minute) and these film clips have been published in a library used for psychological research in emotion.
- The film clips contain some visual injury stimuli. You may experience lightheadedness, dizziness, weakness, and faintness while viewing the injury related stimuli during the videos. To reduce this risk, you will be excluded from the study if you have a history of fainting, known blood-injury-injection phobia, hyperventilation syndrome, or vasovagal syncope.
- You may experience mild skin irritation (redness) where the electrodes and/or surgical tape contact the skin. You may experience some physical discomfort while wearing the electrodes and/or tape on your body. The electrodes and tape will be lightly adhered directly to your skin and you may experience discomfort when they are removed; however, this feeling is similar to taking a bandage off. This is considered minimal risk because these procedures are typical during routine physical exams and commonly used in research.
- If you need medical care because of taking part in this research study, contact the investigator and medical resources will be made available. Generally, medical care will be billed to you, your insurance, or other third party. Virginia Tech has no program to pay for medical care for research-related injury.
- There is a risk of loss of confidentiality of the data that will be mitigated by ensuring your data are securely stored. Your data will be kept secure in multiple ways: 1) the data will be de-identified and labeled with a unique, random ID number, 2) de-identified data will be stored separately from your identifiable information (i.e., name, contact information, date of birth) on a secure server at VTAC/CAR or on REDCap, a secure, web-based HIPAA-compliant data collection tool maintained by Virginia Tech, and 3) video files will stored separately from all other data on a secure server at VTAC/CAR.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information only to people who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech.

Consent to Take Part in a Research Study

Upon entry into the study, you will be given a unique confidential code number. Information from questionnaires and visits will be kept in a de-identified format (i.e., with the code number). Paper documentation will be stored in a locked file cabinet in a locked room at VTAC/CAR (3110 Prices Fork Road, Blacksburg VA). Digital recordings and all data will be saved directly and stored to a password-protected computer at VTAC/CAR on a secure server. Data from the online questionnaires will be collected using REDCap, a secure, web-based data collection tool hosted by Virginia Tech that meets HIPAA-compliance standards. Unless otherwise specified, only study staff working directly with subjects will have access to individually identifiable private information or the link between identifiable information and your code number. The link between any your identifiable information and research code number will be destroyed when this study is closed.

All assessment measures (during the Intake Visit) will be conducted by graduate student clinicians and will be supervised by Dr. Angela Scarpa. As such, sessions will be audio/video recorded for training and supervision purposes.

Video-recordings of your intake visit will be stored on password-protected computer at VTAC/CAR on a secure server and kept by VTAC/CAR indefinitely. Information from this study will not be released to anyone without your written consent, except under the conditions listed above. Results may be published, shared, or presented for scientific purposes, but your identity will not be shown in any description or publication of this research.

If identifiers are removed from your private information collected during this research, that information could be used for future research studies or distributed to another investigator for future research studies without your additional informed consent. The results of this research study may be presented in summary form at conferences, in presentations, reports to the sponsor, academic papers, and as part of a thesis/dissertation.

Can I be removed from the research without my OK?

The person in charge of the research study can remove you from the research study without your approval. Possible reasons for removal include not meeting the study's eligibility criteria. In these cases, you will be notified and the session will end.

What else do I need to know?

You will need to meet the eligibility criteria as measured by the online questionnaire and during the intake assessment. You may not be able to continue participating in the study after completing an initial online questionnaire and the intake visit. You will be told after completing the initial online questionnaire if you are eligible to continue on to completing the rest of the online questionnaires and the intake visit. You will be told after completing the intake visit if you are eligible to continue on to completing the experimental visit.

If you agree to take part in this research study, you may receive up to \$60.00 for your time and effort at the end of your study participation, as follows:

- If you complete the online questionnaire and are found to be ineligible to continue participation, you will receive a \$5.00 electronic gift card emailed to you within 1 business day.

Consent to Take Part in a Research Study

- If you complete the intake assessment but are found to be ineligible, you will receive a \$30.00 electronic gift card emailed to you within 3-5 business days
- If you are eligible to continue to the experimental visit, you will receive \$60.00 in cash for completing the experimental visit immediately upon leaving the center.

We will offer to share some of your individual test results in the form of a short summary from your intake visit with you. You may accept or decline these results.

Electronic Signature for Capable Adult

Your electronic signature documents your permission to take part in this research. We will provide you with a signed copy of this form for your records.

Electronic signature of subject	Date
Printed name of subject	
Electronic signature of person obtaining consent	Date
Printed name of person obtaining consent	

Additional options:

 You would like your parent/caregiver to be contacted to participate in this study by providing developmental history for your autism assessment. If so, please provide their name, email address, and phone number for contact:

Initials

First Name: _____

Last Name: _____

Email Address: _____

Phone Number: _____

 You would like to be contacted about future Virginia Tech research studies. If so, please provide your email address for future contact: _____

Initials

Appendix C

Health Screening Questionnaire

1. How many hours of sleep did you sleep last night? What time did you wake up today?
2. When was the last time you ate and what and how much did you eat?
3. When was the last time you consumed caffeine and how much did you consume (e.g., approximate cups/glasses of coffee, tea, or caffeinated soda)?
4. When was the last time you consumed alcohol and how much did you consume (e.g., number of alcoholic beverages)?
5. When was the last time you consumed any prescribed medication and what did you take (include the dosage if possible)?
6. When was the last time you exercised and for how long did you exercise for?
7. Females only: When was your last menstrual cycle?

Appendix D

ERQ

Instructions and Items

We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1-----2-----3-----4-----5-----6-----7
 strongly neutral strongly
disagree agree

1. ____ When I want to feel more *positive* emotion (such as joy or amusement), I *change what I'm thinking about*.
2. ____ I keep my emotions to myself.
3. ____ When I want to feel less *negative* emotion (such as sadness or anger), I *change what I'm thinking about*.
4. ____ When I am feeling *positive* emotions, I am careful not to express them.
5. ____ When I'm faced with a stressful situation, I make myself *think about it* in a way that helps me stay calm.
6. ____ I control my emotions by *not expressing them*.
7. ____ When I want to feel more *positive* emotion, I *change the way I'm thinking* about the situation.
8. ____ I control my emotions by *changing the way I think* about the situation I'm in.
9. ____ When I am feeling *negative* emotions, I make sure not to express them.
10. ____ When I want to feel less *negative* emotion, I *change the way I'm thinking* about the situation.

Appendix E

SRS-2 ASR

wps	John N. Constantino, MD	Assessment ID _____
SRS™-2 AutoScore™ Form		Adult (Self-Report) <input type="radio"/> MALE <input type="radio"/> FEMALE

INSTRUCTIONS

For each question, please darken the circle that best describes your behavior **over the past 6 months**.

Rated individual's name _____

Age in years _____ Date of rating _____

PLEASE PRESS HARD WHEN MARKING YOUR RESPONSES.

1 = NOT TRUE 2 = SOMETIMES TRUE 3 = OFTEN TRUE 4 = ALMOST ALWAYS TRUE

1. I am much more uncomfortable in social situations than when I am by myself. (1) (2) (3) (4)
2. My facial expressions send the wrong message to others about how I actually feel. (1) (2) (3) (4)
3. I feel self-confident when interacting with others. (1) (2) (3) (4)
4. When under stress, I engage in rigid or inflexible patterns of behavior that seem odd to people. (1) (2) (3) (4)
5. I do not recognize when others are trying to take advantage of me. (1) (2) (3) (4)
6. I would rather be alone than with others. (1) (2) (3) (4)
7. I am usually aware of how others are feeling. (1) (2) (3) (4)
8. I behave in ways that seem strange or bizarre to others. (1) (2) (3) (4)
9. I am overly dependent on others for help with meeting my everyday needs. (1) (2) (3) (4)
10. I take things too literally, and because of that, I misinterpret the intended meaning of parts of a conversation. (1) (2) (3) (4)
11. I have good self-confidence. (1) (2) (3) (4)
12. I am able to communicate my feelings to others. (1) (2) (3) (4)
13. I am awkward in turn-taking interactions with others (for example, I have a hard time keeping up with the give-and-take of a conversation). (1) (2) (3) (4)
14. I am not well coordinated. (1) (2) (3) (4)
15. When people change their tone or facial expression, I usually pick up on that and understand what it means. (1) (2) (3) (4)
16. I avoid eye contact or am told that I have unusual eye contact. (1) (2) (3) (4)
17. I recognize when something is unfair. (1) (2) (3) (4)
18. I have difficulty making friends, even when trying my best. (1) (2) (3) (4)
19. I get frustrated trying to get ideas across in conversations. (1) (2) (3) (4)
20. I have sensory interests that others find unusual (for example, smelling or looking at things in a special way). (1) (2) (3) (4)
21. I am able to imitate others' actions and expressions when it is socially appropriate to do so. (1) (2) (3) (4)
22. I interact appropriately with other adults. (1) (2) (3) (4)
23. I do not join group activities or social events unless prompted or strongly urged to do so. (1) (2) (3) (4)
24. I have more difficulty than others with changes in my routine. (1) (2) (3) (4)
25. I do not mind being out of step with or "not on the same wavelength" as others. (1) (2) (3) (4)
26. I offer comfort to others when they are sad. (1) (2) (3) (4)
27. I avoid starting social interactions with other adults. (1) (2) (3) (4)
28. I think or talk about the same thing over and over. (1) (2) (3) (4)
29. I am regarded by others as odd or weird. (1) (2) (3) (4)
30. I become upset in situations with lots of things going on. (1) (2) (3) (4)
31. I can't get my mind off something once I start thinking about it. (1) (2) (3) (4)
32. I have good personal hygiene. (1) (2) (3) (4)

Continue on back page

The SRS-2 is available online at platform.wpspublish.com. Additional copies of this form (W-608D) may be purchased from WPS. Please contact us at 800.648.8857 or www.wpspublish.com. Copyright © 2012 by Western Psychological Services. Not to be reproduced, adapted, and/or translated in whole or in part without prior written permission of WPS (rights@wpspublish.com). All rights reserved. Printed in USA. 9 8 7 6 5

PLEASE PRESS HARD WHEN MARKING YOUR RESPONSES.

1 = NOT TRUE 2 = SOMETIMES TRUE 3 = OFTEN TRUE 4 = ALMOST ALWAYS TRUE

33. My behavior is socially awkward, even when I am trying to be polite. ① ② ③ ④
34. I avoid people who want to be emotionally close to me. ① ② ③ ④
35. I have trouble keeping up with the flow of a normal conversation. ① ② ③ ④
36. I have difficulty relating to family members. ① ② ③ ④
37. I have difficulty relating to adults outside of my family. ① ② ③ ④
38. I respond appropriately to mood changes in others (for example, when a friend's mood changes from happy to sad). ① ② ③ ④
39. People think I am interested in too few topics, or that I get too carried away with those topics. ① ② ③ ④
40. I am imaginative. ① ② ③ ④
41. I sometimes seem to wander aimlessly from one activity to another. ① ② ③ ④
42. I am overly sensitive to certain sounds, textures, or smells. ① ② ③ ④
43. I enjoy small talk (casual conversation with others). ① ② ③ ④
44. I have more trouble than most people with understanding chains of causation (in other words, how events are related to one another). ① ② ③ ④
45. When others around me are paying attention to something, I get interested in what they are attending to. ① ② ③ ④
46. Others feel that I have overly serious facial expressions. ① ② ③ ④
47. I laugh at inappropriate times. ① ② ③ ④
48. I have a good sense of humor and can understand jokes. ① ② ③ ④
49. I do extremely well at certain kinds of intellectual tasks, but do not do as well at most other tasks. ① ② ③ ④
50. I have repetitive behaviors that others consider odd. ① ② ③ ④
51. I have difficulty answering questions directly and end up talking around the subject. ① ② ③ ④
52. I get overly loud without realizing it. ① ② ③ ④
53. I tend to talk in a monotone voice (in other words, less inflection of voice than most people demonstrate). ① ② ③ ④
54. I tend to think about people in the same way that I do objects. ① ② ③ ④
55. I get too close to others or invade their personal space without realizing it. ① ② ③ ④
56. I sometimes make the mistake of walking between two people who are trying to talk to one another. ① ② ③ ④
57. I tend to isolate myself. ① ② ③ ④
58. I concentrate too much on parts of things rather than seeing the whole picture. ① ② ③ ④
59. I am more suspicious than most people. ① ② ③ ④
60. Other people think I am emotionally distant and do not show my feelings. ① ② ③ ④
61. I tend to be inflexible. ① ② ③ ④
62. When I tell someone my reason for doing something, it strikes the person as unusual or illogical. ① ② ③ ④
63. My way of greeting another person is unusual. ① ② ③ ④
64. I am much more tense in social settings than when I am by myself. ① ② ③ ④
65. I find myself staring or gazing off into space. ① ② ③ ④

Appendix F

ASEBA ASR



Please print your answers.

ADULT SELF-REPORT FOR AGES 18-59

For office use only
ID# _____

YOUR FULL NAME First _____ Middle _____ Last _____			YOUR USUAL TYPE OF WORK, even if not working now. Please be specific—for example, auto mechanic; high school teacher; homemaker; laborer; lathe operator; shoe salesman; army sergeant; student (indicate what you are studying & what degree you expect). Your work _____ Spouse or partner's work _____		
YOUR GENDER <input type="checkbox"/> Man <input type="checkbox"/> Woman		YOUR AGE _____	ETHNIC GROUP OR RACE _____		
TODAY'S DATE Mo. _____ Date _____ Yr. _____		YOUR BIRTHDATE Mo. _____ Date _____ Yr. _____			
Please fill out this form to reflect your views, even if other people might not agree. You need not spend a lot of time on any item. Feel free to print additional comments. Be sure to answer all items.					
PLEASE CHECK YOUR HIGHEST EDUCATION <input type="checkbox"/> 1. No high school diploma and no CED <input type="checkbox"/> 7. Some graduate school but no graduate degree <input type="checkbox"/> 2. General Equivalency Diploma (GED) <input type="checkbox"/> 8. Master's Degree <input type="checkbox"/> 3. High school graduate <input type="checkbox"/> 9. Doctoral or Law Degree <input type="checkbox"/> 4. Some college but no college degree <input type="checkbox"/> Other education (specify): _____ <input type="checkbox"/> 5. Associate's Degree <input type="checkbox"/> 6. Bachelor's or RN Degree					

I. FRIENDS:

- A. About how many close friends do you have? (Do not include family members.)
 None 1 2 or 3 4 or more
- B. About how many times a month do you have contact with any of your close friends? (Include in-person contacts, phone, letters, e-mail.)
 Less than 1 1 or 2 3 or 4 5 or more
- C. How well do you get along with your close friends?
 Not as well as I'd like Average Above average Far above average
- D. About how many times a month do any friends or family visit you?
 Less than 1 1 or 2 3 or 4 5 or more

II. SPOUSE OR PARTNER:

- What is your marital status? Never been married Married but separated from spouse
 Married, living with spouse Divorced
 Widowed Other—please describe: _____

At any time in the past 6 months, did you live with your spouse or with a partner?
 No—please skip to page 2.
 Yes—Circle 0, 1, or 2 beside items A-H to describe your relationship **during the past 6 months:**
 0 = Not True 1 = Somewhat or Sometimes True 2 = Very True or Often True

0 1 2 A. I get along well with my spouse or partner 0 1 2 B. My spouse or partner and I have trouble sharing responsibilities 0 1 2 C. I feel satisfied with my spouse or partner 0 1 2 D. My spouse or partner and I enjoy similar activities	0 1 2 E. My spouse or partner and I disagree about living arrangements, such as where we live 0 1 2 F. I have trouble with my spouse or partner's family 0 1 2 G. I like my spouse or partner's friends 0 1 2 H. My spouse or partner's behavior annoys me
---	---

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 ASEBA, University of Vermont
 1 South Prospect St., Burlington, VT 05401-3456
 www.ASEBA.org

Please be sure you have answered all items.
 Then see other side.
 07-03-18 - 111

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Please print. Be sure to answer all items.

III. FAMILY:

Compared with others, how well do you:

		Worse than Average	Variable or Average	Better than Average	No Contact
A. Get along with your brothers?	<input type="checkbox"/> I have no brothers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Get along with your sisters?	<input type="checkbox"/> I have no sisters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. Get along with your mother?	<input type="checkbox"/> Mother is deceased	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. Get along with your father?	<input type="checkbox"/> Father is deceased	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. Get along with your biological or adopted children?	<input type="checkbox"/> I have no children				
1. Oldest child	<input type="checkbox"/> Not applicable	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2. 2nd oldest child	<input type="checkbox"/> Not applicable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. 3rd oldest child	<input type="checkbox"/> Not applicable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Other children	<input type="checkbox"/> Not applicable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
F. Get along with your stepchildren?	<input type="checkbox"/> I have no stepchildren	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

IV. JOB: At any time in the past 6 months, did you have any paid jobs (including self-employment and military service)?

No—please skip to Section V.

Yes—please describe your job(s): _____

Circle 0, 1, or 2 beside items A-I to describe your work experience *during the past 6 months*:

0 = Not True 1 = Somewhat or Sometimes True 2 = Very True or Often True

0 1 2	A. I work well with others	0 1 2	F. I do things that may cause me to lose my job
0 1 2	B. I have trouble getting along with bosses	0 1 2	G. I stay away from my job even when I'm not sick or not on vacation
0 1 2	C. I do my work well	0 1 2	H. My job is too stressful for me
0 1 2	D. I have trouble finishing my work	0 1 2	I. I worry too much about work
0 1 2	E. I am satisfied with my work situation		

V. EDUCATION: At any time in the past 6 months, did you attend school, college, or any other educational or training program?

No—please skip to Section VI.

Yes—what kind of school or program? _____

What degree or diploma are you seeking? _____ Major? _____

When do you expect to receive your degree or diploma? _____

Circle 0, 1, or 2 beside items A-E to describe your educational experience *during the past 6 months*:

0 = Not True 1 = Somewhat or Sometimes True 2 = Very True or Often True

0 1 2	A. I get along well with other students	0 1 2	D. I am satisfied with my educational situation
0 1 2	B. I achieve what I am capable of	0 1 2	E. I do things that may cause me to fail
0 1 2	C. I have trouble finishing assignments		

VI. Do you have any illness, disability, or handicap? No Yes—please describe: _____

VII. Please describe your concerns or worries about family, work, education, or other things: No concerns

VIII. Please describe the best things about yourself:

Please print your answers. Be sure to answer all items.

IX. Below is a list of items that describe people. For each item, please circle 0, 1, or 2 to describe yourself over the past 6 months. Please answer all items as well as you can, even if some do not seem to apply to you.

0 = Not True	1 = Somewhat or Sometimes True	2 = Very True or Often True
0 1 2	1. I am too forgetful	0 1 2 37. I get in many fights
0 1 2	2. I make good use of my opportunities	0 1 2 38. My relations with neighbors are poor
0 1 2	3. I argue a lot	0 1 2 39. I hang around people who get in trouble
0 1 2	4. I work up to my ability	0 1 2 40. I hear sounds or voices that other people think aren't there (describe): _____
0 1 2	5. I blame others for my problems	0 1 2 41. I am impulsive or act without thinking
0 1 2	6. I use drugs (other than alcohol and nicotine) for nonmedical purposes (describe): _____	0 1 2 42. I would rather be alone than with others
0 1 2	7. I brag	0 1 2 43. I lie or cheat
0 1 2	8. I have trouble concentrating or paying attention for long	0 1 2 44. I feel overwhelmed by my responsibilities
0 1 2	9. I can't get my mind off certain thoughts (describe): _____	0 1 2 45. I am nervous or tense
0 1 2	10. I have trouble sitting still	0 1 2 46. Parts of my body twitch or make nervous movements (describe): _____
0 1 2	11. I am too dependent on others	0 1 2 47. I lack self-confidence
0 1 2	12. I feel lonely	0 1 2 48. I am not liked by others
0 1 2	13. I feel confused or in a fog	0 1 2 49. I can do certain things better than other people
0 1 2	14. I cry a lot	0 1 2 50. I am too fearful or anxious
0 1 2	15. I am pretty honest	0 1 2 51. I feel dizzy or lightheaded
0 1 2	16. I am mean to others	0 1 2 52. I feel too guilty
0 1 2	17. I daydream a lot	0 1 2 53. I have trouble planning for the future
0 1 2	18. I deliberately try to hurt or kill myself	0 1 2 54. I feel tired without good reason
0 1 2	19. I try to get a lot of attention	0 1 2 55. My moods swing between elation and depression
0 1 2	20. I damage or destroy my things	56. Physical problems without known medical cause:
0 1 2	21. I damage or destroy things belonging to others	0 1 2 a. Aches or pains (not stomach or headaches)
0 1 2	22. I worry about my future	0 1 2 b. Headaches
0 1 2	23. I break rules at work or elsewhere	0 1 2 c. Nausea, feel sick
0 1 2	24. I don't eat as well as I should	0 1 2 d. Problems with eyes (not if corrected by glasses) (describe): _____
0 1 2	25. I don't get along with other people	0 1 2 e. Rashes or other skin problems
0 1 2	26. I don't feel guilty after doing something I shouldn't	0 1 2 f. Stomachaches
0 1 2	27. I am jealous of others	0 1 2 g. Vomiting, throwing up
0 1 2	28. I get along badly with my family	0 1 2 h. Heart pounding or racing
0 1 2	29. I am afraid of certain animals, situations, or places (describe): _____	0 1 2 i. Numbness or tingling in body parts
0 1 2	30. My social relations with the opposite sex are poor	0 1 2 57. I physically attack people
0 1 2	31. I am afraid I might think or do something bad	0 1 2 58. I pick my skin or other parts of my body (describe): _____
0 1 2	32. I feel that I have to be perfect	0 1 2 59. I fail to finish things I should do
0 1 2	33. I feel that no one loves me	0 1 2 60. There is very little that I enjoy
0 1 2	34. I feel that others are out to get me	0 1 2 61. My work performance is poor
0 1 2	35. I feel worthless or inferior	0 1 2 62. I am poorly coordinated or clumsy
0 1 2	36. I accidentally get hurt a lot, accident-prone	

Page 3

Please be sure you have answered all items.
Then see other side.

Please print your answers. Be sure to answer all items.

0 = Not True	1 = Somewhat or Sometimes True	2 = Very True or Often True
0 1 2	63. I would rather be with older people than with people of my own age	0 1 2 93. I talk too much
0 1 2	64. I have trouble setting priorities	0 1 2 94. I tease others a lot
0 1 2	65. I refuse to talk	0 1 2 95. I have a hot temper
0 1 2	66. I repeat certain acts over and over (describe): _____	0 1 2 96. I think about sex too much
0 1 2	67. I have trouble making or keeping friends	0 1 2 97. I threaten to hurt people
0 1 2	68. I scream or yell a lot	0 1 2 98. I like to help others
0 1 2	69. I am secretive or keep things to myself	0 1 2 99. I dislike staying in one place for very long
0 1 2	70. I see things that other people think aren't there (describe): _____	0 1 2 100. I have trouble sleeping (describe): _____
0 1 2	71. I am self-conscious or easily embarrassed	0 1 2 101. I stay away from my job even when I'm not sick or not on vacation
0 1 2	72. I worry about my family	0 1 2 102. I don't have much energy
0 1 2	73. I meet my responsibilities to my family	0 1 2 103. I am unhappy, sad, or depressed
0 1 2	74. I show off or clown	0 1 2 104. I am louder than others
0 1 2	75. I am too shy or timid	0 1 2 105. People think I am disorganized
0 1 2	76. My behavior is irresponsible	0 1 2 106. I try to be fair to others
0 1 2	77. I sleep more than most other people during day and/or night (describe): _____	0 1 2 107. I feel that I can't succeed
0 1 2	78. I have trouble making decisions	0 1 2 108. I tend to lose things
0 1 2	79. I have a speech problem (describe): _____	0 1 2 109. I like to try new things
0 1 2	80. I stand up for my rights	0 1 2 110. I wish I were of the opposite sex
0 1 2	81. My behavior is very changeable	0 1 2 111. I keep from getting involved with others
0 1 2	82. I steal	0 1 2 112. I worry a lot
0 1 2	83. I am easily bored	0 1 2 113. I worry about my social relations with the opposite sex
0 1 2	84. I do things that other people think are strange (describe): _____	0 1 2 114. I fail to pay my debts or meet other financial responsibilities
0 1 2	85. I have thoughts that other people would think are strange (describe): _____	0 1 2 115. I feel restless or fidgety
0 1 2	86. I am stubborn, sullen, or irritable	0 1 2 116. I get upset too easily
0 1 2	87. My moods or feelings change suddenly	0 1 2 117. I have trouble managing money or credit cards
0 1 2	88. I enjoy being with people	0 1 2 118. I am too impatient
0 1 2	89. I rush into things without considering the risks	0 1 2 119. I am not good at details
0 1 2	90. I drink too much alcohol or get drunk	0 1 2 120. I drive too fast
0 1 2	91. I think about killing myself	0 1 2 121. I tend to be late for appointments
0 1 2	92. I do things that may cause me trouble with the law (describe): _____	0 1 2 122. I have trouble keeping a job
		0 1 2 123. I am a happy person
		124. <i>In the past 6 months</i> , about how many times per day did you use tobacco (including smokeless tobacco)? _____ times per day.
		125. <i>In the past 6 months</i> , on how many days were you drunk? _____ days.
		126. <i>In the past 6 months</i> , on how many days did you use drugs for nonmedical purposes (including marijuana, cocaine, and other drugs, except alcohol and nicotine)? _____ days.

Appendix G

ADOS-2 Module 4

ADOS-2

Participant ID: Steven

Gender: Female Male

Date of Birth: _____

Date of Evaluation: _____

Chronological Age: 27 years

Examiner: Catherine Lord

Other Information: Consensus Coding

Fluent Speech Adolescent/Adult

Observation/Coding

1. Construction Task*
2. Telling a Story From a Book
3. Description of a Picture*
4. Conversation and Reporting
5. Current Work or School*
6. Social Difficulties and Annoyance
7. Emotions
8. Demonstration Task
9. Cartoons*
10. Break
11. Daily Living*
12. Friends, Relationships, and Marriage
13. Loneliness
14. Plans and Hopes
15. Creating a Story

**optional*

OBSERVATION**NOTES****1 Construction Task** *(optional)***Focus of Observation:**

- Does the participant indicate the need for more pieces?
 - If so, how does he or she attempt to do so?
(For example, does he or she reach over your arm?
Does he or she vocalize, gesture, or make eye contact?)

- Place the extra blocks out of reach, on the other side of your arm, so that the participant must reach over your arm to take the pieces (or ask for them).
- Show and tell the participant where the blocks are located, and initially encourage the participant to ask for more as needed.

Communication Sample:

2 Telling a Story From a Book**Focus of Observation:**

- Obtain a sample of the participant's spontaneous language and communication, as well as a sense of what captures his or her interest.
- Evaluate the participant's response to conventional humor, his or her spontaneous comments about how the characters in the story are feeling, and the degree to which he or she can convey continuity in a story.

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3 Description of a Picture *(optional)*

Focus of Observation:

- Obtain a sample of the participant's spontaneous language and communication, as well as a sense of what captures his or her interest.

4 Conversation and Reporting

Focus of Observation:

- To what extent does the participant build on your statements, elaborate on his or her own statements to provide leads for you, and take a full role in back-and-forth conversation, particularly about a topic outside of the immediate context?
- How does the participant report *routine* and *nonroutine events*, and how does he or she describe *relationships* and *emotions*?
- Observe features of the participant's communication, including his or her use of gaze, facial expression, intonation, and gesture.

5 Current Work or School *(optional)*

If the participant is in school full time or does not have a job and has never been employed (including working as a volunteer), omit the employment questions and proceed to the questions about school.

Focus of Observation:

- Is the participant employed and/or in school?
- Has he or she had to leave jobs? If so, for what reasons?
- Does the participant have a realistic understanding of the possibilities for future employment?
- What has the participant's school experience been like?
 - Does he or she have a realistic understanding of the training or experience necessary for future employment?

Interview Questions About Work

- Do you have a job?
- If so:*
 - What kind of job is it? How did you find it?
 - Have you had other jobs before?
 - Are you happy where you are or would you like to move on to something else eventually? What would it be?
 - What about your co-workers? Do they seem to be happy or are they ready to move on?
- If not:*
 - What do you do during the day?
 - Did you have a job before? Why did you leave your old job? Was it something you had planned?
 - Would you like to have a job someday?
- If yes:*
 - What would it be?
 - What will you need to do to find this type of job?
- If no:*
 - What *would* you like to do?

OR

Interview Questions About School

- Are you in school? Where?
- What courses are you taking?
- What year (grade) are you in? How is it going?
- If the participant is no longer in school and not employed:*
 - How far did you go in school? How did it go?
 - What do you plan to do next? What experience/training would you need to do that?

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6 Social Difficulties and Annoyance

Focus of Observation:

- Evaluate the participant's perception of social difficulties and his or her insight into the nature of these problems.
 - Has the participant made any attempt to change his or her own behavior in order to fit in with others more smoothly?
- Pay attention to the participant's understanding of the appropriateness and implications of his or her feelings and behaviors.

Interview Questions

- Have you ever had problems getting along with people at school or at work? How about at home? Do you ever get in trouble? Why? What for?

- Are there things that other people do that irritate or annoy you? What are they?

- What about things you do that annoy others?
 - (If no response, ask: What about your family members?)

- Have you ever been teased or bullied? Why, do you think?

- Have you ever tried to change these things? Have you ever done anything so that others wouldn't tease you? How has it worked?

- Are there other people you know who get teased or bullied?

7 Emotions

Focus of Observation:

- Identify the events or objects that elicit different emotions in the participant, particularly whether they are social in nature or not.
- Observe how the participant describes his or her emotions.
- Does the participant exhibit facial expressions or creative uses of language in the context of describing his or her emotions and others' emotions?
- Does the participant display insight into typical social relationships that may cause some of these emotions?

Interview Questions

- What do you like doing that makes you feel happy and cheerful?
- What kinds of things make you feel this way? How *do* you feel when you're happy? Can you describe it?
- What about things that you're afraid of?
- What makes you feel frightened or anxious? How does it feel? What do you do?
- What about feeling angry?
- What kinds of things make you feel that way? How do you feel "inside" when you're angry?
- Most people have times when they feel sad. What kinds of things make you feel that way?
- How *do* you feel when you're sad? What is it like when you're sad? Can you describe that?
- How about feeling relaxed or content? What kinds of things make you feel that way?

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NOTES

8 Demonstration Task**Focus of Observation:**

- Does the participant represent familiar actions in gesture?
 - If so, how does he or she do this?
 - Does the participant use his or her body to represent an object (e.g., a finger for a toothbrush) or mime the use of a pretend object?
- Evaluate the participant's report of a routine event and the pragmatics of teaching a sequence of actions.

9 Cartoons *(optional)***Focus of Observation:**

- Observe the participant's use of gesture and its coordination with speech, as well as his or her response to humor.
- Obtain an additional language sample from the participant and a sense of his or her degree of flexibility in adapting a narrative to the audience of the listener.
- Note any comments the participant makes about emotions and relationships.

10 Break**Focus of Observation:**

- How does the participant occupy himself or herself during free time?
 - How does he or she respond to your withdrawal from and return to the interaction?
- Does the participant initiate and participate in an unstructured conversation or interaction with you at the end of the break?
 - If so, how does he or she do this?

11 Daily Living *(optional)***Focus of Observation:**

- Obtain factual information about the participant's level of financial responsibility.
- Where is the participant living, and how was this arrangement made?
- To what extent is the participant realistic about plans for independence and the complexities of various living arrangements?

Interview Questions About Money

- What about money? Do you take care of your own money?
- Where does it come from? Who pays your bills?
- Have you ever saved your money to buy something or do something special? What was it?

Interview Questions About Residential Arrangements

- Where are you living now?

If living at home with parents:

- Have you ever lived away from your parents?
- What would be different about living on your own?
- Would you like it better?
- What would be difficult?

If living on his or her own:

- How did you find the place where you live now?
- Who do you live with?
- Can you tell me a little about it?

Interview Questions About Leisure Activities

- What do you like to do in your spare time at home?
- What about going out?

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12 Friends, Relationships, and Marriage

Focus of Observation:

- Evaluate how the participant understands the concepts of friendship, marriage, and other social relationships, and the nature of these relationships.
- Evaluate the participant's understanding of why a person might want to be involved in a long-term relationship and of his or her own possible role in such a relationship.

Interview Questions

- Do you have some friends? Can you tell me about them?
(Note the ages of the friends. It can be helpful to ask for names if the participant is very general about who his or her friends are. Sometimes the names provided are family members or professionals or a list of an entire class, which is useful to know in terms of interpreting the answers to the questions below.)
- What do you like doing together? How did you get to know them?
How often do you get together?
- What does being a friend mean to you?
How do you know someone is your friend?
- How is a friend different from someone whom you just work with or go to school with?
- Do you have a girlfriend or boyfriend? What is her/his name?
How old is she/he?
- When did you see her/him last?
- What is she/he like? What do you like to do together?
- How do you know she/he is your girlfriend/boyfriend?
- Where do you want to live when you get older?
What kind of place (apartment, house, condo)?
- Whom do you think you would like to live with?
Your family, a roommate(s), by yourself?
- Do you ever think about having a long-term relationship or getting married (when you are older)?
- Why do you think some people get married or live with a girlfriend or boyfriend when they grow up?
- What would be nice about it? What might be difficult about being married or living with a girlfriend or boyfriend? Or living with a roommate?

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13 Loneliness

Focus of Observation:

- Does the participant understand the concept of loneliness?
How does he or she feel it pertains to him or her or to other people?

Interview Questions

- Do you ever feel lonely?
- Do you think other people your age ever feel lonely?
- Are there things that you do to help yourself feel better?
What about things other people do to help themselves feel better when they're lonely?

14 Plans and Hopes

Focus of Observation:

- What does the participant anticipate in the future?

Interview Questions

- Do you have plans or dreams for the future of things that you would like to do, or have, or see happen to you? Tell me about them.

15 Creating a Story

Focus of Observation:

- Observe and evaluate the participant's creative use of objects in telling a novel story or creating a newscast or commercial.

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CODING

- The overall ratings that you assign in this section should be made on the basis of the participant's behavior throughout the entire ADOS-2 administration.
- Ratings should include only behavior that is directly observed during the ADOS-2 administration and should not be based on behavior reported or observed in other contexts (e.g., parent report).
- If the participant's behavior changes in quality after a brief, initial adaptation period, ratings should be based on the period after the behavior stabilizes.
- Ratings should be assigned immediately after the ADOS-2 assessment.
- The ratings are organized according to five main groupings: "A. Language and Communication," "B. Reciprocal Social Interaction," "C. Imagination," "D. Stereotyped Behaviors and Restricted Interests," and "E. Other Abnormal Behaviors."

A Language and Communication

Unless stated otherwise, code in relation to chronological age expectations, not in comparison to developmental level or estimated expressive language skills.

A1. Overall Level of Non-Echoed Spoken Language

The rating for this item should reflect the majority of the participant's utterances, not merely the best ones. For the purposes of the ADOS-2, a complex sentence is defined as an utterance with two or more clauses. Examples include "I didn't go to the zoo because it rained" or "I think wasps are really scary." In contrast, "I have two sisters and one brother" would not be considered a complex sentence.

0 = Uses sentences in a largely correct fashion (must use some complex speech).

1 = Some relatively complex speech (occasional utterances with two or more clauses), but with recurrent grammatical errors not associated with use of dialect.

2 = Non-echoed speech is mostly utterances of at least three words, but without complex language as described above.

3 = Non-echoed language is mostly simple phrases.

A2. Speech Abnormalities Associated With Autism (Intonation/Volume/Rhythm/Rate)

The focus of this item is on speech abnormalities that are characteristic of autism. Because of the variability within the autism spectrum, speech patterns in intonation, volume, rhythm, or rate (not articulation) that are unusual, but not obviously characteristic of autism, should receive a rating of 1. Code this item relative to the participant's expressive language level.

0 = Appropriately varying intonation, reasonable volume, and normal rate of speech, with regular rhythm coordinated with breathing.

1 = Little variation in pitch and tone; rather flat or exaggerated intonation, but not obviously peculiar. OR slightly unusual volume, AND/OR speech that tends to be somewhat unusually slow, fast, or jerky.

2 = Speech that is clearly abnormal for ANY of the following reasons: slow and halting; inappropriately rapid; jerky and irregular in rhythm (other than ordinary stutter/stammer), such that there is some interference with intelligibility; odd intonation or inappropriate pitch and stress; markedly flat and toneless ("mechanical"); consistently abnormal volume.

7 = Stutter or stammer or other fluency disorder (if odd intonation is also present, code 1 or 2 accordingly).

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ADOS-2 MODULE 4 11

A3. Immediate Echolalia

This item pertains to the participant's immediate repetition of the last statement or series of statements made by the examiner or another person. When coding, do not include repetitions that are a lead-in to a response to the examiner or that are used as a memory device in specific tasks.

- | | |
|--|--|
| | 0 = Does not repeat others' speech. |
| | 1 = Occasional echoing. |
| | 2 = Echoing words and phrases regularly, but some spontaneous language, which can be stereotyped. |
| | 3 = Speech largely consists of immediate echolalia. |

A4. Stereotyped/Idiosyncratic Use of Words or Phrases

Coding for this item includes delayed echolalia or other highly repetitive utterances with consistent intonation patterns. These words or phrases can be intended meaningfully and can be appropriate to conversation at some level. The focus of the item is on the stereotyped or idiosyncratic quality of the phrasing, unusual use of words or formation of utterances, and/or their arbitrary association with a particular meaning. Neologisms and referring to oneself by name should be coded here, as well as clear evidence of a pronoun error *across person* (e.g., *you* or *he* or *she* to mean *I*). Code relative to the participant's expressive language level.

- | | |
|--|---|
| | 0 = Rarely or never uses stereotyped or idiosyncratic words or phrases. |
| | 1 = Use of words or phrases tends to be more repetitive or formal than that of most individuals at the same level of expressive language, but not obviously odd, OR occasional stereotyped utterances or odd use of words or phrases, with substantial spontaneous, flexible language as well. |
| | 2 = Often uses stereotyped utterances or odd words or phrases, with some other language. |
| | 3 = Frequently uses odd or stereotyped speech, and rarely uses non-stereotyped spontaneous speech. |

A5. Offers Information

The focus of this item is on the participant's spontaneous, appropriate offering of personal information, new to the examiner. It does not have to occur in context or be part of a sustained interaction. It can occur as the elaboration of responses to questions, but must include new information, not specified by the question. It can be related to the participant's interests, but should not be related solely to preoccupations. Comments about facts (e.g., "Did you know that whales are mammals?") are not coded here, but can be considered in assigning a rating under "Conversation" later in this section. Comments about relationships or possessions (e.g., "I have two brothers" or "Our family has a boat") can be coded here if they refer to an activity rather than a list of characteristics or objects. Lists of multiple characteristics (e.g., "I like to hike, sail, and fish") should be counted as one instance of offering information unless they are part of compulsive listing behavior, which does not receive credit here.

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|--|---|
| | 0 = Spontaneously offers information about his or her own thoughts, feelings, or experiences on several occasions. |
| | 1 = Occasionally offers information spontaneously about his or her own thoughts, feelings, or experiences. |
| | 2 = Rarely or never offers information spontaneously, except about circumscribed interests or preoccupations, OR offers information about facts or general knowledge, including preoccupations or circumscribed interests. |

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A6. Asks for Information

The focus of this item is on the participant's spontaneous expression of interest in the examiner's ideas, experiences, or reactions. This should not be part of a preoccupation. When assigning a rating, exclude asking for information that is not related to the examiner, or about the ADOS-2 materials, or about particular facts not specific to the examiner; instead, include these when assigning a rating under "Conversation." For this item, questions do not necessarily have to lead to a sustained conversation. Questions about relationships or possessions may be coded here if they refer to the examiner's experiences rather than filling in a list.

- | | |
|--|---|
| | <p>0 = Asks the examiner about his or her thoughts, feelings, or experiences on several occasions.</p> <hr/> <p>1 = Occasionally (at least one clear example) asks the examiner about his or her thoughts, feelings, or experiences.</p> <hr/> <p>2 = Responds appropriately to examiner's comments about his or her thoughts, feelings, or experiences, but does not spontaneously inquire about them.</p> <hr/> <p>3 = Rarely or never expresses interest in the examiner's thoughts, feelings, or experiences.</p> |
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A7. Reporting of Events

The focus of this item is on the participant's ability to select an event spontaneously or in response to the examiner's general questioning, and to describe it in a comprehensible fashion without requiring specific probes. This should involve a sequential description of an event outside the immediate environment. Code the "best" example, given the rating constraints described below with regard to preoccupations and probes.

- | | |
|--|---|
| | <p>0 = Reports a specific nonroutine event (e.g., a holiday, a vacation, a shopping trip) that is not part of any preoccupations or intense interests and seems likely to be real. Gives a reasonable account without specific probes, but may need to be asked a general question to get started.</p> <hr/> <p>1 = Gives a reasonable account of a routine event (e.g., playing a favorite game, usual routine when he or she arrives home from work or school) that is not part of a preoccupation or intense interest and seems likely to be real. Gives the account without specific probes, but initially may need to be asked to describe the event. Include accounts from the "Demonstration Task" here.</p> <hr/> <p>2 = Provides an account of routine or nonroutine events, but dependent on specific probes, OR only describes an event that seems unlikely to have been real.</p> <hr/> <p>3 = Inconsistent or insufficient responses, even to specific probes.</p> |
|--|---|

A8. Conversation

This is a summary item that focuses on the to-and-fro use of words and phrases in social conversation. Code this item relative to the participant's expressive language level. Code evidence of (or lack of) *nonverbal* reciprocity under "Amount of Reciprocal Social Communication" in section B of this protocol. This rating should consider all opportunities for conversation, not merely the best.



0 = Conversation flows, building on the examiner's dialogue. This rating requires that much of the participant's speech provide both a response to the examiner's speech and some additional talking (not necessarily a question) that builds on what has just been said and allows a response from the examiner (i.e., sequences of at least four elements: examiner opens, participant comments, examiner responds, participant responds to response).

1 = Speech includes some spontaneous elaboration of the participant's own responses for the examiner's benefit OR provides leads for the examiner to follow, but either this is less in amount than would be expected for the participant's expressive language level or it is limited in flexibility.

2 = Little reciprocal conversation sustained by the participant; may follow his or her own train of thought rather than participate in an interchange; may have some spontaneous offering of information or comments, but little sense of reciprocity.

3 = Little spontaneous communicative speech (although there may be much echoed or noncommunicative speech). This rating can be used to describe participants who make some limited, but very few, responses to conversational initiations by the examiner.

A9. Descriptive, Conventional, Instrumental, or Informational Gestures

The focus of this item is on descriptive gestures that enact or represent an object or event (such as acting out rinsing a toothbrush or showing how a roller coaster curves through the air). Gestures that are conventional (e.g., clapping for "well done"), informational, or instrumental (e.g., pointing, shrugging, head nodding, or head shaking) receive partial credit. When coding, exclude emphatic gestures (e.g., "beats" accompanying speech, which are rated in the next item); include behaviors that occur during the "Demonstration Task" and throughout the ADOS-2 evaluation. The emphasis is on how the participant uses gestures before he or she is prompted or asked to do so, or gestures that the participant adds as he or she responds to a requested description (e.g., pretending to spit after demonstrating how to use a toothbrush, as requested). Pointing is included here as an instrumental gesture, as it is not coded separately in Module 4. Grabbing and reaching are not coded here.



0 = Spontaneous use of several descriptive gestures. These gestures may be typical or idiosyncratic, but must be communicative. May also use conventional or instrumental gestures.

1 = Some spontaneous use of descriptive gestures, but exaggerated or limited in range and/or contexts (e.g., occur only during "Demonstration Task"), OR frequent use of conventional or instrumental gestures, but rare or no use of descriptive gestures.

2 = Some spontaneous use of informational, conventional, or instrumental gestures, but rare or no use of descriptive gestures.

3 = No or very limited spontaneous use of conventional, instrumental, informational, or descriptive gestures.

8 = N/A (e.g., limited by physical disability).

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A10. Emphatic or Emotional Gestures

The focus of this item is on emphatic (e.g., natural, rhythmic “beats” that often accompany speech) or emotional gestures (e.g., hand to mouth or hands up for “wow”). The rating for this item should be assigned on the basis of the timing of the gestures as they occur during speech. Other aspects of coordination of gesture, such as integration with gaze, should be coded under “Language Production and Linked Nonverbal Communication” or “Quality of Social Overtures” in section B.

	<p>0 = Variety of appropriate emphatic and/or emotional gestures that are well integrated with speech.</p> <hr/> <p>1 = Some emphatic or emotional gestures, but exaggerated, OR limited in frequency, appropriateness, integration, or style.</p> <hr/> <p>2 = Odd, excessive, or definitely awkwardly integrated emphatic or emotional gestures.</p> <hr/> <p>3 = No or very limited emphatic or emotional gestures.</p> <hr/> <p>8 = N/A (e.g., limited by physical disability).</p>
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B Reciprocal Social Interaction

Code in comparison to nonverbal mental age.

B1. Unusual Eye Contact

Coding for this item requires that clear, flexible, socially modulated, and appropriate gaze that is used for a variety of purposes be distinguished from gaze that is limited in flexibility, appropriateness, or contexts. If the participant is shy initially, and his or her gaze changes markedly and consistently as he or she becomes more comfortable, do not base the code on earlier impressions. However, if eye contact never improves, coding must be based on what is observed, even if the participant seems shy. Do not code eye contact that occurs between the participant and individuals other than the examiner who may be in the ADOS-2 assessment room.

0 = Appropriate gaze with subtle changes meshed with other communication.

2 = Uses poorly modulated eye contact to initiate, terminate, or regulate social interaction.

B2. Facial Expressions Directed to Examiner

The rating for this item should indicate whether the participant's facial expressions are directed to the examiner for the purpose of communicating affective (e.g., enjoyment, frustration) or cognitive (e.g., puzzlement, skepticism) states. Facial expressions that are directed to objects or other people in the room, or that are undirected, are not rated here. Appropriate or slightly exaggerated facial expressions should be coded even if there are also odd expressions.

0 = Directs a range of appropriate facial expressions to the examiner in order to communicate affective or cognitive states.

1 = Some direction of facial expressions to the examiner (e.g., directs only expressions indicating emotional extreme(s), or occasionally directs wider range of expressions). A participant who has a limited range of facial expressions, but who directs almost all of his or her facial expressions to the examiner, may be rated here.

2 = Does not direct appropriate facial expressions to the examiner.

B3. Language Production and Linked Nonverbal Communication

The purpose of this item is to code the degree to which, *when* the participant vocalizes, the vocalization is accompanied by subtle changes in gaze, facial expression, and gesture. This item should be coded on the basis of the vocalizations used, regardless of their frequency. Code the most typical occurrences, not merely the best ones. When assigning a rating, include vocalizations used to maintain interaction or to respond to the examiner, as well as initiations. A rating of 8 (uncodable) should be assigned by default if one or more of the following behaviors coded earlier in this protocol received a rating of 2: "Unusual Eye Contact," "Facial Expressions Directed to Examiner," or "Descriptive, Conventional, Instrumental, or Informational Gestures."

0 = Vocalization usually accompanied by subtle and socially appropriate changes in gesture, gaze, and facial expression.

1 = Vocalization accompanied by abnormal, limited, or less than usual frequency and/or range of gesture, gaze, and facial expression, OR use of one modality almost exclusively (e.g., frequent use of gaze, but limited use of gesture and facial expression).

2 = Little or no nonverbal communication linked with vocalization.

7 = Some avoidance of direct eye gaze, particularly at the beginning of the session, perhaps because of shyness, but shows some modulation and coordination of language and nonverbal behavior.

8 = N/A; no vocalization OR no or minimal use of gesture, facial expression, or socially directed gaze. This code should be assigned automatically if the absence of linking can be accounted for by the limited frequency of unusual eye contact, facial expressions, and/or gestures.

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B4. Shared Enjoyment in Interaction

Rate the participant's directed pleasure during any of the tasks or conversation. This item should not be used to indicate his or her general emotional state during the ADOS-2 evaluation. The rating applies to the participant's ability to *indicate* pleasure to the examiner, not just to interact or respond.

- | | |
|--|---|
| | <p>0 = Shows definite pleasure appropriate to context during interactive participation or conversation with the examiner in more than one task or conversational topic.</p> <hr/> <p>1 = Shows some pleasure appropriate to context during interactions with the examiner, OR shows definite pleasure during one interaction.</p> <hr/> <p>2 = Shows little or no expressed pleasure during interaction with the examiner, but shows pleasure in his or her own speech or actions or in noninteractive components of the ADOS-2 materials or activities.</p> <hr/> <p>3 = Little or no expressed pleasure during the ADOS-2 evaluation.</p> |
|--|---|

B5. Communication of Own Affect

The focus here is on the participant's ability to convey a range of his or her own emotions using words and facial expression, tone of voice, vocalization, and/or gesture. The coding for this item should reflect the range of emotion and the effectiveness of the communication (rather than the presence of specific emotions). Descriptions elicited during socioemotional questions may be rated here, as well as spontaneous comments and reports.

- | | |
|--|---|
| | <p>0 = Effective communication of a range of emotions that he or she is feeling or has felt.</p> <hr/> <p>1 = Some description of experiencing several emotions, but limited effectiveness of communication, AND/OR effective communication of at least one emotion.</p> <hr/> <p>2 = Some communication about at least one emotion.</p> <hr/> <p>3 = Minimal or no communication of his or her own affect.</p> |
|--|---|

B6. Comments on Others' Emotions/Empathy

The focus of this item is on the participant's communication of his or her recognition, understanding, and/or response to the feelings of other people or characters, real or conveyed in stories or other tasks. Exclude shared enjoyment with the examiner, which is rated in a preceding item.

- | | |
|--|---|
| | <p>0 = Spontaneously communicates clear understanding or labeling of and/or appropriate response to several different emotions in other people/characters. Labeling several emotions in others is sufficient but not necessary if there are other clear indications of understanding and/or appropriate response.</p> <hr/> <p>1 = Communicates some understanding, labeling, or response to an emotion in others (e.g., spontaneously and correctly identifies at least <i>one</i> emotion in another person/character).</p> <hr/> <p>2 = No or minimal identification/communication of understanding of emotion in others.</p> |
|--|---|

B7. Insight Into Typical Social Situations and Relationships

The focus of this item is on the participant's ability to provide spontaneous examples of insight into the nature of social relationships. These can include ongoing relationships, such as friendships or marriage, or interactive situations, such as getting along with other students or co-workers, that may be discussed in conversation or in response to the socioemotional questions. Two separate aspects of relationships are coded: (a) the nature of specific relationships (e.g., what is friendship), and (b) the participant's role in these relationships.

- | | |
|--|--|
| | <p>0 = Shows examples of insight into the nature of several typical social relationships (without evidence of lack of insight into those same relationships), including his or her own role in at least one. May show no more than one example of inaccurate understanding of other social relationships.</p> <hr/> <p>1 = Shows examples of insight into several typical social relationships, but not into his or her own role, OR into only one relationship including his or her own role.</p> <hr/> <p>2 = Shows some insight into one typical social relationship, though not necessarily about his or her own role in it.</p> <hr/> <p>3 = Shows no or limited insight into typical social relationships.</p> |
|--|--|

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ADOS-2 MODULE 4 17

B8. Responsibility

This item focuses on the participant's references to and descriptions of being responsible for his or her own actions in typical daily living situations, in responding to normal social mores and expectations (from getting a haircut to finding a job) in an active, independent way.

0 = Describes himself or herself as responsible for his or her own actions in several contexts, including dealing with minor problems in daily living.

1 = Provides at least one clear indication of being responsible for his or her own actions, but not consistent across contexts or consistently less straightforward than what is described above for a rating of 0. May show no more than one clear example of a lack of responsibility.

2 = Shows limited indication of a sense of responsibility for his or her own actions or shows more than one clear example of lack of responsibility that would be appropriate for his or her chronological age, taking into account developmental level.

B9. Quality of Social Overtures

This is a summary item that focuses on the *quality* of the participant's attempts to initiate social interaction with the examiner, not on the frequency of such attempts. Special attention should be given to the form of the overture and its appropriateness to the social context. The rating should reflect the majority of social overtures to the examiner, not merely the best ones.

0 = Effectively uses nonverbal and verbal/vocal means to make clear social overtures to the examiner. The overtures must be appropriate to immediate contexts.

1 = Slightly unusual quality of some social overtures. Overtures may be restricted to personal demands or related to the participant's own interests, but with some attempt to involve the examiner in those interests.

2 = Inappropriate overtures; many overtures lack integration into context AND/OR social quality. This includes the participant's bringing up preoccupations with little attempt to involve the examiner in them.

3 = No social overtures of any kind.

B10. Amount of Social Overtures/Maintenance of Attention

The focus of this item is on the *number* of the participant's attempts to get, maintain, or direct the examiner's attention, AND/OR to direct the examiner's attention to objects, actions, or topics of interest to the participant. The rating for this item may include verbal or nonverbal behaviors if they are neither related to preoccupations nor aimed at getting objects, but seem to function primarily as a method of social contact. *Do not include requests when rating this item except for a code of 3.*

0 = Frequent attempts to get or maintain the examiner's attention AND/OR to direct the examiner's attention to objects, actions, or topics of interest to the participant.

1 = Some attempts at getting, maintaining, or directing the examiner's attention as described above for a rating of 0, but reduced in frequency or the number of different activities in which they are used.

2 = Makes occasional attempts to get, maintain, or direct the examiner's attention, including overtures solely related to preoccupations.

3 = Shows relatively little concern as to whether the examiner is paying attention to him or her unless he or she needs help (e.g., initiates social contact only when requesting).

7 = Unusually frequent, intense, or excessive demands for attention.

B11. Quality of Social Response

This is a summary item that focuses on the participant's social responses throughout the ADOS-2 evaluation.

0 = Shows a range of appropriate responses that are varied according to immediate social situations and presses.

1 = Shows responsiveness to most social contexts, but somewhat limited, socially awkward, inappropriate, inconsistent, or consistently negative.

2 = Odd, stereotyped responses, or responses that are restricted in range or inappropriate to the context.

3 = Minimal or no response to the examiner's attempts to engage the participant.

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B12. Amount of Reciprocal Social Communication

The focus of this item is on the frequency with which reciprocal interchanges occur during the course of the ADOS-2 evaluation, using any mode of communication. *Frequency* here is defined both by absolute number of occurrences and distribution across a range of contexts. The rating for this summary item should describe aspects of nonverbal and verbal/vocal behavior that need not be coordinated but must result in at least brief reciprocal interchanges with the examiner (not others who may be present in the ADOS-2 assessment room).

- 0** = Extensive use of verbal or nonverbal behaviors (at whatever level attained) for social interchange (i.e., chat, comments, remarks, or nonverbal behaviors that appear to have reciprocal intent).
- 1** = Some reciprocal social communication (as described above for a rating of 0), but reduced in frequency or amount, or in the number of contexts in which such behaviors occur (regardless of the amount of nonsocial talk).
- 2** = Most communication is either object-oriented (i.e., to ask for things), OR response to questions, OR echolalic, OR concerned with particular preoccupations; little or no social chat or give-and-take.
- 3** = Little or no communication with the examiner.

B13. Overall Quality of Rapport

The code for this item is a summary rating that reflects the examiner's overall judgment of the rapport established with the participant during the ADOS-2 evaluation. The rating should particularly take into account the degree to which the examiner had to modify his or her own behavior to maintain the interaction successfully.

- 0** = Comfortable interaction between the participant and examiner that is appropriate to the context of the ADOS-2 assessment.
- 1** = Interaction sometimes comfortable, but not sustained (e.g., sometimes feels awkward or stilted, or the participant's behavior seems mechanical or slightly inappropriate).
- 2** = One-sided or unusual interaction resulting in a consistently mildly uncomfortable session or a session that would have been difficult if the examiner had not continuously modified the structure of the situation beyond the standard activities in the ADOS-2 evaluation.
- 3** = The participant shows minimal regard for the examiner, OR the session is markedly uncomfortable for a significant proportion of the time.

C Imagination

Code this item in comparison to expressive language skills.

C1. Imagination/Creativity

This item should be assigned a rating that reflects the degree to which any of several forms of creativity/inventiveness are exhibited by the participant throughout the ADOS-2 evaluation, either in his or her use of objects or through verbal descriptions.

- 0** = Several different spontaneous, inventive, creative activities or comments in conversation.
- 1** = Some creative or make-believe actions, but limited in range or occurring only in response to one structured situation (e.g., creating a story).
- 2** = Little spontaneous creative or make-believe actions, OR only actions that are repetitive OR stereotyped in quality.
- 3** = No creative or inventive actions (not even stereotyped or repetitive).

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ADOS-2 MODULE 4 19

D Stereotyped Behaviors and Restricted Interests

Code in relation to chronological age expectations.

D1. Unusual Sensory Interest in Play Material/Person

Rate the participant's interest in or unusual behaviors associated with sensory aspects of toys or surroundings (e.g., sniffing, repetitive feeling of texture, licking, mouthing, or biting, unusually strong interest in the repetition of certain sounds, unusual or prolonged visual examination).

If the participant has a preoccupation that is based on a sensory interest, this may be coded here as *one* unusual sensory interest. For example, if he or she shows an interest in radiators or plumbing, that is coded later in this section of the protocol under "D4. Excessive Interest in or References to Unusual or Highly Specific Topics or Objects or Repetitive Behaviors." If the participant is interested in the radiator in the room because he or she likes to look at it, as shown by peering at it while tilting his or her head, rocking from side to side, and jiggling his or her hands, this should be coded under "D2. Hand and Finger and Other Complex Mannerisms," but it may also be coded here because of the sensory component involved. If the participant likes to look out of the corner of his or her eye at the radiator, the corners of the room, the doors on the cabinets, and the slats of the window blinds, but does not become overly preoccupied with any of these objects and does not move in unusual ways as he or she does so, he or she should be coded here for unusual sensory interests but not under "Hand and Finger and Other Complex Mannerisms" or under item "D4. Excessive Interest..."

If the ADOS-2 assessment occurs in a room with a one-way mirror, looking into the mirror is not coded as an unusual sensory interest. Do not code here for touching the pin art. Sensory aversions are also not coded here.

0 = No unusual sensory interests or sensory-seeking behaviors.

1 = Several possible sensory interests not as clear as specified below for a rating of 2 AND/OR only one clear occurrence of an unusual sensory interest or a sensory-seeking behavior. One "possible" sensory interest should be coded 0.

2 = Definite interest in sensory elements of objects or of play materials, OR sensory examination of himself or herself or others; two or more clear occurrences must be observed. May be observed during the same activity.

3 = Definite unusual sensory-seeking behaviors occur frequently, during at least two different tasks or activities, and may interfere with the ADOS-2 assessment.

Specify:

D2. Hand and Finger and Other Complex Mannerisms

Rate unusual and/or repetitive movements or posturing of the hands and fingers, arms, or body. Repetitive clapping may be coded here. Do not include body rocking unless it involves more than the torso. Finger tapping, nail biting, hair twisting, and thumb sucking are also not coded here. The participant does not have to watch the movements of his or her fingers or hands for the movements to be coded here.

0 = None.

1 = Unusual and/or repetitive hand and finger mannerisms or complex mannerisms not as clear as specified below for a rating of 2.

2 = Definite finger flicking or twisting, AND/OR hand or finger or complex mannerisms, stereotypes, or posturing. May be brief and/or rare if clear.

3 = Mannerisms, as described above, occur frequently, during at least two different tasks or activities, and/or may interfere with the ADOS-2 assessment.

Specify:

D3. Self-Injurious Behavior

Rate behaviors that involve any kind of aggressive act to self, even if not clearly harmful.

0 = No attempts to harm self.

1 = Dubious or possible self-injury, and/or rare but clear self-injury (e.g., one clear example of biting at own hand or arm, pulling own hair, slapping own face, or banging own head).

2 = More than one clear example of self-injury, such as head banging, face slapping, hair pulling, or self-biting.

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D4. Excessive Interest in or References to Unusual or Highly Specific Topics or Objects or Repetitive Behaviors

Because circumscribed interests, preoccupations, or unusual behaviors are often difficult to judge during a brief observation, the focus of this item is on any references that (a) are unexpectedly high in frequency, (b) pertain to an unusual or odd topic, (c) are not well integrated into the conversation, or any behaviors that (d) pertain to use of an object in a manner highly specific to the participant, or (e) pertain to use of the participant's own body in a highly specific manner not clearly associated with behaviors coded under items D1 (Sensory Interests) or D2 (Hand/Finger Mannerisms); for example, putting his or her hands over and/or fingers in his or her ears should be considered here. Persistent aversive reactions that are unusual in form and/or intensity to sensory stimuli (e.g., the feel of the laminated picture, the sound of the examiner clearing his or her throat) can be coded here as 1, 2, or 3, as appropriate. Topics that are developmentally or age appropriate should not be coded here (e.g., a participant with a mental age of 8 years who repeatedly talks about a recent vacation in general terms would not be coded here; if he or she repeatedly talks about staying in hotel room 465, that behavior would be considered here).

The focus of this item is on the *topic* of references and/or unusual forms of behavior. Use of unusual terms (e.g., stereotyped phrases) and/or lack of conversational flexibility are coded elsewhere. Behaviors may be coded in two ways if they represent separate instances of each domain. For instance, if the participant repeatedly says "Do they need room service in room 465?", uses the same phrase in several other contexts ("No more room service!", "Room service now!"), and makes other statements about hotel room numbers, this would be coded both here and under "A4. Stereotyped/Idiosyncratic Use of Words or Phrases" earlier in this protocol. Repetitive behaviors involving objects that have a clear sequence (e.g., touching objects in a particular order) should be coded under the following item, "Compulsions or Rituals."

0 = No excessive interest in or references to unusual or highly specific or restricted topics or objects or repetitive behaviors.

1 = Occasional references to unusual or highly specific topics or patterns of interest, occurring to an unusual degree, or occasional repetitive behaviors.

2 = Definite, stereotyped, or unusual patterns of interest that may or may not intrude and/or interfere with social communication and/or definite repetitive behaviors.

3 = Definite preoccupation(s) and/or repetitive behaviors to a degree that interferes with the ADOS-2 assessment.

D5. Compulsions or Rituals

The emphasis for compulsions or rituals in this context is on the participant's determination to carry out an activity that involves a predictable sequence, endpoint, or manner that is not required as part of an ADOS-2 task (e.g., checking if a wallet is in a purse; insistence on completing the book used for the storytelling task; careful placement of materials as they were initially presented; reciting a list of classmates as friends). Provision of lists should be rated here.

0 = No obvious activities or verbal routines that must be completed in full or according to a sequence that is not part of the task.

1 = Unusually routinized in speech or activities (includes insistence on finishing the book or providing a list that is not relevant to the conversation), but no behavior that appears clearly compulsive in quality.

2 = One or more activities or verbal routines that the participant has to perform or say in a special way. The participant appears under pressure or becomes anxious if an activity is disrupted (i.e., compulsive quality is present). Include the recitation of lists that must be completed or that the examiner is asked to record (e.g., friends, favorite foods) or insistence that the examiner respond in a specific way.

Specify:

E Other Abnormal Behaviors

Unless stated otherwise, code these items without reference to developmental level or estimated expressive language skills.

E1. Overactivity/Agitation

This item describes excessive movement or physical agitation.

- | | |
|--|---|
| | <p>0 = Sits still appropriately throughout the ADOS-2 assessment.</p> <hr/> <p>1 = Sits, but often fidgets or moves about in the chair. Difficulties in the ADOS-2 assessment are not principally due to overactivity or agitation.</p> <hr/> <p>2 = Difficulty sitting; moves either in or out of the chair or handles or manipulates objects in a way that is mildly disruptive.</p> <hr/> <p>3 = Overactive behaviors are difficult to interrupt. The level of activity disrupts the ADOS-2 assessment.</p> <hr/> <p>7 = Underactive.</p> |
|--|---|

E2. Tantrums, Aggression, Negative or Disruptive Behavior

This item includes any form of anger or disruption beyond communication of mild frustration or whining.

- | | |
|--|--|
| | <p>0 = Not disruptive, destructive, negative, or aggressive during the ADOS-2 assessment.</p> <hr/> <p>1 = Displays an example of mild disruption, anger, or aggression or negative behavior to the examiner (includes verbal threats, swearing, or a deliberately loud voice).</p> <hr/> <p>2 = More than one intentionally disruptive or negative incident. Loud talking or repeated swearing is coded here.</p> <hr/> <p>3 = Shows marked or repeated temper tantrums or significant aggression (e.g., throwing things, hitting or biting others). Screaming or yelling is included here.</p> |
|--|--|

E3. Anxiety

Anxiety includes initial wariness or self-consciousness, as well as more obvious signs of worry, upset, or concern.

- | | |
|--|---|
| | <p>0 = No obvious anxiety (e.g., trembling or jumpiness).</p> <hr/> <p>1 = Mild signs of anxiety or self-consciousness, especially at the beginning of the ADOS-2 session or in response to specific activities.</p> <hr/> <p>2 = Marked anxiety throughout the ADOS-2 assessment (may be intermittent or continuous).</p> |
|--|---|

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Converting the Communication Total, Social Interaction Total, and Communication + Social Interaction Total to the ADOS-2 Classification

Compare the Communication Total, Social Interaction Total, and Communication + Social Interaction Total to the cutoff scores below for Module 4:

	COMMUNICATION	SOCIAL INTERACTION	COMMUNICATION + SOCIAL INTERACTION
autism	3	6	10
autism spectrum	2	4	7

Assign the ADOS-2 Classification:

autism	<p>All three totals (Communication Total, Social Interaction Total, combined Communication + Social Interaction Total) are equal to or greater than the three separate corresponding <i>autism</i> cutoffs:</p> <ul style="list-style-type: none"> ▪ All of the following are true: Communication Total is 3 or higher AND Social Interaction Total is 6 or higher AND Communication + Social Interaction Total is 10 or higher
autism spectrum	<p>All three totals (Communication Total, Social Interaction Total, combined Communication + Social Interaction Total) are equal to or greater than the three separate corresponding <i>autism spectrum</i> cutoffs, but at least one is less than its corresponding <i>autism</i> cutoff:</p> <ul style="list-style-type: none"> ▪ All of the following are true: Communication Total is 2 or higher AND Social Interaction Total is 4 or higher AND Communication + Social Interaction Total is 7 or higher AND ▪ At least one of the following is also true: Communication Total is 2; Social Interaction Total is 4 or 5; Communication + Social Interaction Total is 7 to 9
non-spectrum	<p>Any one of the three totals (Communication Total, Social Interaction Total, combined Communication + Social Interaction Total) is less than the <i>autism spectrum</i> cutoff:</p> <ul style="list-style-type: none"> ▪ At least one of the following is true: Communication Total is 1 or lower; Social Interaction Total is 3 or lower; Communication + Social Interaction Total is 6 or lower

Record the ADOS-2 Classification on the front of this form in the space marked *ADOS-2 Classification*.

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Child ID: _____ Date of Birth: _____
 Gender: _____ Date of Evaluation: _____
 Examiner: _____ Chronological Age: _____

ADOS-2 Module 4

ADOS-2 Algorithm for DSM 5 ASD Diagnosis	
<small>(Convert scores of 3 on the protocol to 2, and treat all scores other than 0–3 as 0.)</small>	
Language and Communication	
Conversation	(A-8) _____
Emphatic or Emotional Gestures	(A-10) _____
Reciprocal Social Interaction	
Unusual Eye Contact <i>(Convert scores of 1 or 2 on protocol to 2 here)</i>	(B-1) _____
Facial Expressions Directed to Others	(B-2) _____
Communication of Own Affect	(B-5) _____
Insight	(B-7) _____
Quality of Social Overtures	(B-9) _____
Quality of Social Response	(B-11) _____
Amount of Reciprocal Social Communication	(B-12) _____
Overall Quality of Rapport	(B-13) _____
Social Affect Total	_____

Restricted and Repetitive Behaviors	
Speech Abnormalities Associated with Autism	(A-2) _____
Stereotyped/Idiosyncratic Use of Words or Phrases	(A-4) _____
Unusual Sensory Interest in Play Material/Person	(D-1) _____
Hand and Finger and Other Complex Mannerisms	(D-2) _____
Excessive Interest in or References to Highly Specific Topics	(D-4) _____
Restricted and Repetitive Behavior Total	_____

Social Affect and Restricted and Repetitive Behavior Total _____

CSS _____

(Autism Spectrum cut-off = 8)


Diagnosis

ADOS Classification: _____

Overall Diagnosis: _____

Appendix H

WASI-II



WASI-II

WECHSLER ABSTRACTS SCALE OF INTELLIGENCE—SECOND EDITION

Record Form

Calculation of Examinee's Age		
Year	Month	Day
Test Date		
Birth Date		
Test Age		

Examinee Name: _____ ID: _____

Sex: F M Handedness: R L

Address/School/Testing Site: _____

Highest Education/Grade: _____

Examiner Name: _____

Total Raw Score to T Score Conversion

Subtest	Raw Score	T Scores			
		Verbal Comp.	Perc. Rang.	Full Scale-4	Full Scale-2
Block Design					
Vocabulary					
Matrix Reasoning					
Similarities					
Sum of T Scores					

Examinee Visual/Hearing Aids During Testing

Check type of aid examinee needed:	Used	Not Used
<input type="checkbox"/> Glasses		
<input type="checkbox"/> Prescription Lenses		
<input type="checkbox"/> Assisted Listening Device		
<input type="checkbox"/> Other:		

Sum of T Scores to Composite Score Conversion

Scale	Sum of T Scores	Composite Score	Percentile Rank	Confidence Interval 90% or 95%
Verbal Comp.		VCI		
Perc. Rang.		PRI		
Full Scale-4		FSIQ-4		
Full Scale-2		FSIQ 2		

Subtest T Score Profile


Score	Verbal Comprehension		Perceptual Reasoning	
	VC	SI	BD	MR
80-				
75-				
70-				
65-				
60-				
55-				
50-				
45-				
40-				
35-				
30-				
25-				
20-				

Composite Score Profile


Score	VCI	PRI	FSIQ
160-			
150-			
140-			
130-			
120-			
110-			
100-			
90-			
80-			
70-			
60-			
50-			
40-			

Ranges of Expected Scores

Scores	Confidence Level	
	90%	66%
FSIQ-4		
WISC-IV FSIQ		
WAIS-IV FSIQ		



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Product Number 01156961596

9 10 11 12 B C D E 202568-3 854

1. Block Design

(Time limit: See item)

Start
Ages 6-8:
Item 1
Ages 9-90:
Item 3

Reverse
Ages 9-90: Does not obtain a perfect score on either item 3 or item 4, administer the preceding items in reverse order until two consecutive perfect scores are obtained.

Discontinue
After 2 consecutive scores of 0.

STOP
Ages 6-8:
After item 11.

Record & Score
Items 1-4:
Score 0, 1, or 2 points.
Items 5-13:
Score 0, 4, 5, 6, or 7 points.

Item	Design	Presentation Method	Time Limit	Completion Time		Constructed Design		Score				
				Trial 1	Trial 2	Trial 1	Trial 2	0	1	2		
6-8	1. Examiner	Model and Picture	30"	Trial 1	Trial 2	Trial 1	Trial 2	0	1	2		
	2.	Model and Picture	30"	Trial 1	Trial 2	Trial 1	Trial 2	0	1	2		
9-90	3.	Model and Picture	45"	Trial 1	Trial 2	Trial 1	Trial 2	0	1	2		
	4.	Model and Picture	45"	Trial 1	Trial 2	Trial 1	Trial 2	0	1	2		
	5.	Picture	60"					0	4	5	6	7
									21-60	16-20	11-15	1-10
	6.	Picture	60"					0	4	5	6	7
									21-60	16-20	11-15	1-10
	7.	Picture	60"					0	4	5	6	7
									21-60	16-20	11-15	1-10
	8.	Picture	60"					0	4	5	6	7
									21-60	16-20	11-15	1-10
	9.	Picture	120"					0	4	5	6	7
									71-120	46-70	31-45	1-30
	10.	Picture	120"					0	4	5	6	7
									61-120	46-60	36-45	1-35
6-8 STOP	11.	Picture	120"					0	4	5	6	7
	12.	Picture	120"					0	4	5	6	7
									61-120	46-60	36-45	1-35
	13.	Picture	120"					0	4	5	6	7
									101-120	81-100	56-80	1-55

Maximum Raw Score
Ages 6-8: 57
Ages 9-90: 71

Block Design
Total Raw Score

2. Vocabulary



Start
Ages 6–90:
Item 4



Reverse
Ages 6–90: Does not obtain a perfect score on either Item 4 or Item 5, administer the preceding items in **reverse** order until two consecutive perfect scores are obtained.



Discontinue
After 3 consecutive scores of 0.



Stop
Age 6:
After Item 22.
Ages 7–11:
After Item 25.
Ages 12–14:
After Item 28.



Record & Score
Items 1–3: Score 0 or 1 point.
Items 4–5: Score 0 or 2 points.
Items 6–31: Score 0, 1, or 2 points.
See the Manual for sample responses.

Item	Response	Score
1. Fish		0 1
2. Shovel		0 1
3. Shell		0 1
4. Shirt		0 2
5. Car		0 2
6. Lamp		0 1 2
7. Bird		0 1 2
8. Tongue		0 1 2
9. Pet		0 1 2
10. Lunch		0 1 2
11. Bell		0 1 2
12. Calendar		0 1 2
13. Alligator		0 1 2
14. Dance		0 1 2

6–90

If the examinee provides a 2-point response that requires feedback or gives an incorrect (0 point) response, provide corrective feedback as instructed in the Manual.

continue

2. Vocabulary (continued)

Discontinue after 3 consecutive scores of 0.

	Item	Response	Score
	15. Summer		0 1 2
	16. Reveal		0 1 2
	17. Decade		0 1 2
	18. Entertain		0 1 2
	19. Tradition		0 1 2
	20. Enthusiastic		0 1 2
	21. Improvise		0 1 2
	22. Haste		0 1 2
6	STOP 23. Trend		0 1 2
	24. Impulse		0 1 2
	25. Ruminare		0 1 2
7-11	STOP 26. Mollify		0 1 2
	27. Extirpate		0 1 2
	28. Panacea		0 1 2
12-14	STOP		0 1 2


 continue

2. Vocabulary (continued)

Discontinue after 3 consecutive scores of 0.

Item	Response	Score
29. Perfunctory		0 1 2
30. Insipid		0 1 2
31. Pavid		0 1 2

Maximum Raw Score
 Age 6: 41
 Ages 7-11: 47
 Ages 12-14: 53
 Ages 15-90: 59

Vocabulary
 Total Raw Score

3. Matrix Reasoning

Start
 Ages 6-8: Sample Items A & B, then Item 1.
 Ages 9-90: Sample Items A & B, then Item 9.

Reverse
 Ages 9-90: Does not obtain a perfect score on either Item 4 or Item 5, administer the preceding items in reverse order until two consecutive perfect scores are obtained.

Discontinue
 After 3 consecutive scores of 0.

STOP
 Stop Ages 6-8: After Item 24.

Record & Score
 Score 0 or 1 point. Correct responses are in color.

	Item	Response	Score		Item	Response	Score
6-90	SA.	1 2 3 4 5			15.	1 2 3 4 5	0 1
	SB.	1 2 3 4 5			16.	1 2 3 4 5	0 1
6-8	1.	1 2 3 4 5	0 1		17.	1 2 3 4 5	0 1
	2.	1 2 3 4 5	0 1		18.	1 2 3 4 5	0 1
	3.	1 2 3 4 5	0 1		19.	1 2 3 4 5	0 1
9-90	4.	1 2 3 4 5	0 1		20.	1 2 3 4 5	0 1
	5.	1 2 3 4 5	0 1		21.	1 2 3 4 5	0 1
	6.	1 2 3 4 5	0 1		22.	1 2 3 4 5	0 1
	7.	1 2 3 4 5	0 1		23.	1 2 3 4 5	0 1
	8.	1 2 3 4 5	0 1		24.	1 2 3 4 5	0 1
	9.	1 2 3 4 5	0 1	6-8 STOP	25.	1 2 3 4 5	0 1
	10.	1 2 3 4 5	0 1		26.	1 2 3 4 5	0 1
	11.	1 2 3 4 5	0 1		27.	1 2 3 4 5	0 1
	12.	1 2 3 4 5	0 1		28.	1 2 3 4 5	0 1
	13.	1 2 3 4 5	0 1		29.	1 2 3 4 5	0 1
	14.	1 2 3 4 5	0 1		30.	1 2 3 4 5	0 1

Maximum Raw Score
 Ages 6-8: 24
 Ages 9-90: 30

Matrix Reasoning
 Total Raw Score

4. Similarities



Start
Ages 6–8:
Item 1
Ages 9–90:
Item 4



Reverse
Ages 9–90: Does not obtain a perfect score on *either* Item 4 or Item 5, administer the preceding items in **reverse** order until two consecutive perfect scores are obtained.



Discontinue
After 3 consecutive scores of 0.



Stop
Ages 6–8:
After Item 22.



Record & Score
Items 1–3: Score 0 or 1 point. Correct responses are in color.
Items 4–5: Score 0 or 2 points.
Items 6–24: Score 0, 1, or 2 points. See Manual for sample responses.

	Picture Item	Response				Score			Picture Item	Response				Score			Picture Item	Response				Score	
6–8	†1.	1	2	3	4	0	1	2.	1	2	3	4	0	1	3.	1	2	3	4	0	1		

	Verbal Items	Response				Score	
9–90	§† 4. Green–Blue					0	2
	§† 5. Square–Triangle					0	2
	6. Cow–Bear					0	2
	7. Shirt–Jacket					0	2
	8. Pen–Crayon					0	2
	9. Hat–Umbrella					0	2
	10. Airplane–Bus					0	2
	11. Door–Window					0	2
	12. Child–Adult					0	2

§If the examinee provides a response that suggests he or she does not understand the task, provide the specified prompt in the Manual.
†If the examinee provides a 2-point response that requires feedback or provides an incorrect (0 point) response, provide corrective feedback as instructed in the Manual.

continue →

4. Similarities (continued)

Discontinue after 3 consecutive scores of 0.

Verbal Items	Response	Score
13. Shoulder-Ankle		0 1 2
14. Love-Hate		0 1 2
15. Smooth-Rough		0 1 2
16. Hand-Flag		0 1 2
17. Wall-Line		0 1 2
18. Heat-Wind		0 1 2
19. More-Less		0 1 2
20. Shadow-Echo		0 1 2
21. Tradition-Habit		0 1 2
22. Peace-War		0 1 2
6-8 STOP 23. Time-Progress		0 1 2
24. Memory-Practice		0 1 2

Maximum Raw Score
 Ages 6-8: 41
 Ages 9-90: 45

Similarities
 Total Raw Score



Examinee Name: _____ Age: _____

Parent/Guardian Name: _____

Examiner Name: _____

Record Form

Behavioral Observations

Referral source/Reason for referral/Presenting complaint(s)

Physical appearance

Language (e.g., first/native language, other language, English fluency, expressive and receptive language ability, articulation)

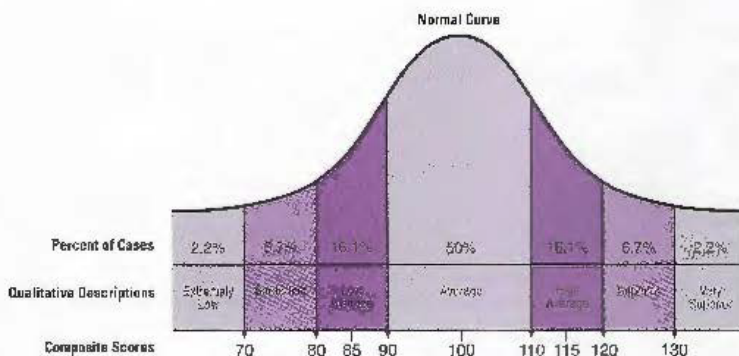
Attention and concentration

Attitude toward testing (e.g., rapport, eager to speak, working habits, interest, motivation, reaction to success/failure)

Affect/Mood

Unusual behaviors/Verbalizations (e.g., perseverations, stereotypic movements, bizarre and atypical verbalizations)

Other notes



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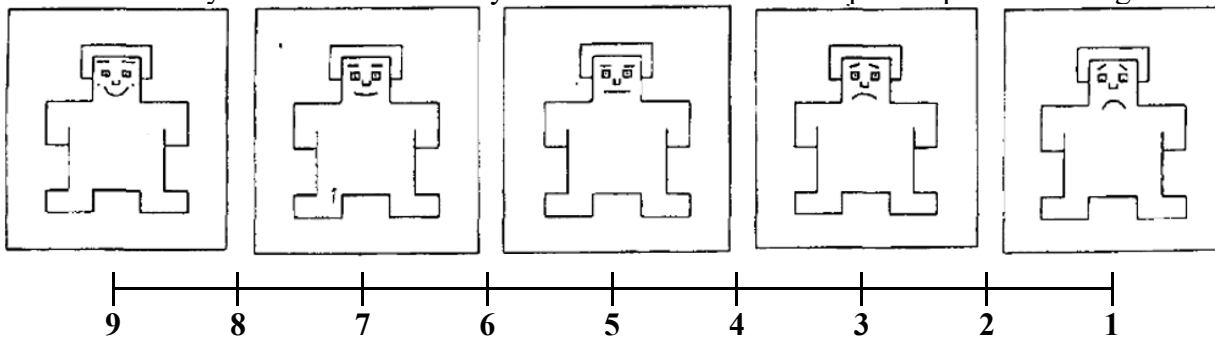
Appendix I

Post-Film Clip Self-Report Ratings

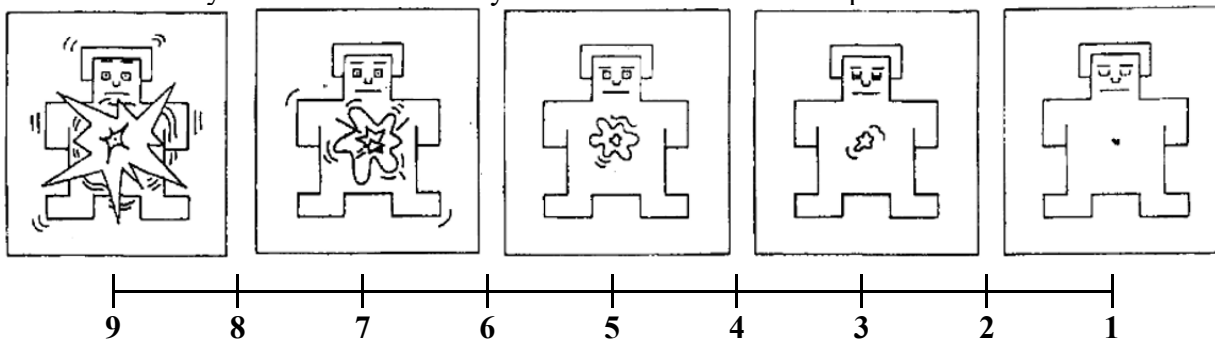
1. Have you seen this film clip before?

- Yes
- No

2. Select which you believe describes your reaction to this film clip from positive to negative.

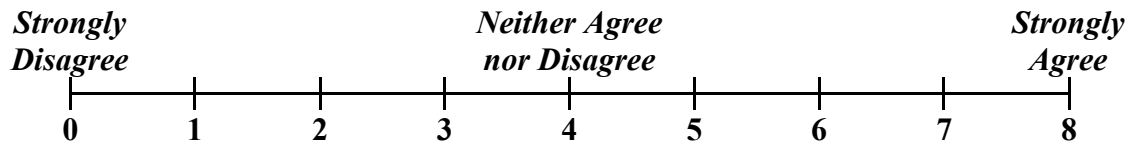


3. Select which you believe describes your reaction to this film clip from excited to calm.



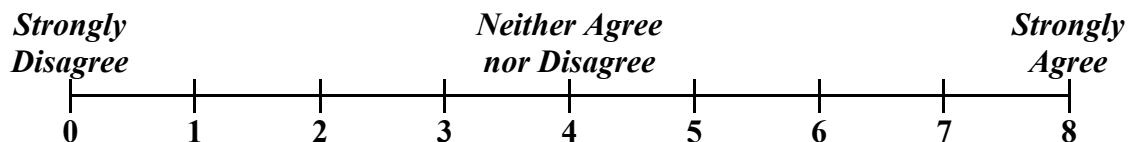
For the Reappraisal Condition only

4. During the film, I tried not to feel anything at all.



For the Suppression Condition only

4. During the film, I felt emotions but tried to hide them.



Appendix J

Selected Neutral and Negative Film Clips from Samson et al. (2016)

Neutral Film Clips

Name	Description
neu_byciclerushhour2	People cycle on the street
neu_centralstationNY	View over Grand Central Station in NY
neu_diving	Three people diving in a pool
neu_eatingwithchopsticks	Mother explaining to her children how to use chopsticks
neu_grout	Man explaining how to clean grout
neu_inthekitchen	Preparing a meal
neu_mall	People sitting in some restaurants in a mall
neu_origami4	Woman makes origami
neu_pillow	Woman explaining how to make a pillowcase
neu_walkthroughdusseldorf	Walking through the streets at night

Negative Film Clips

Name	Description
neg_ambientfromskateboard	Young man skateboarding down stairs breaks his arm
neg_backfliphittinghead	Boy does back flip off vending machine and hits machine and hits face on concrete
neg_bikefalloffcliff	Mountain biker slips and falls down a cliff
neg_bikeintowall	Young man on BMX crashes into the wall
neg_bmxfaceplant	Young man hits his face after BMX crashes into the wall
neg_boybreakswristbiking	Boy riding bike does not make jump and flies forward to ground-lays in fetal position in pain
neg_boyfaceplants	Boy rides skateboard off cabinet onto lower surface lands wrong onto head and flips over
neg_boyfallsontrafficepole	Boy is trying to balance from one to the next pole, slips, and hits it with his hips
neg_breakdancerkickingkid	Man break dancing for a crowd accidently kicks a small child who walked up to him during performance
neg_brokenlegskating	Boy falls off skateboard and lands on leg - yells in pain
neg_bullattacksroad	Man riding bull falls off and gets trampled
neg_bullhurtsman	Man on bull gets thrown around - flops like a rag doll
neg_bullthrowandtrample	Bull throws and tramples torero
neg_bullwrongtarget	Bull tramples spectator

neg_carhitsskater	Boy on roller skates makes big jump down
neg_crocbiteman	Man demonstrating daredevil trick front of crowd sticks arm in crocodile's mouth and gets bitten— runs off with bleeding arm
neg_fatboyrollercoaster	Boy on roller coaster begins slipping from roller coaster constraints screaming while his mother laughs
neg_guygetshitinfacewithabaseball	Pitcher gets hit in face with a baseball at baseball game
neg_guyridesbikedownstairs	Young man riding bike down stairs falls over
neg_gymnasticshitshead	Gymnast lands on his neck after jumping off single bar
neg_horribleskiaccident	Skier loses control at ski race
neg_horseattacksman	Horse jumping on and biting man in street while other people try to stop it, throw rocks at it. Man takes off running
neg_horsekicksface	Man whipping horse gets kicked in the face and thrown backwards
neg_kidbikesofftruck	Young boy bikes off truck and falls down
neg_manbreakslegfighting	Boxer breaks his leg in fight
neg_motorcyclejumpfinishesshort	Motorcyclist falls off his motorcycle after jumping on a ramp
neg_parcouraccident	Young man falls on bar after jump from a playground house
neg_postwalkfall	Boy trying to jump from one to the next pole, slips, and hits his head
neg_skaterfallsbreakswrist	Skater breaks his arm after skateboard stunt on a rail
neg_tablebackflip	Young man smashes his face on the table when he is doing a backflip