Bachelor's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Psychology

Ingeborg Midttun

The effect of autistic traits on adaptive emotion regulation, and the possible long-term outcomes

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Supervisor: Francesca Parisi
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Preface

This project was established to be about the effortfulness of emotional regulation strategies and was planned by the project leader. Although, the title for this project was “how effortful are emotion regulation strategies”, it was possible through student contribution to go in many different directions with the premiss of the project. The topic of this thesis came from a list of pre-proposed topics the project advisors had put together, and did not involve effort, but rather focused on emotional regulation strategies and their relationship with autistic traits. Other student contributions for this project were recruiting participants, translating questionnaires into Norwegian, pilot testing of all instruments and questionnaires used, in order to give feedback to the project advisors, adjustments were made accordingly, and testing of participants in the lab. Most students recruited 5 participants each, with some recruiting more. Instruments that could be used for this project was decided upon by the project advisors beforehand, and the specific instruments used in this thesis was chosen with guidance from the project advisors. The writing process throughout the semester was in large part independent work. However, we were provided with draft feedback twice, met for group discussions on Fridays for a little over the first month, and had the opportunity to meet with advisors’ face to face for some extra feedback regarding the data analysis.

I wish to thank all my fellow students on this project who worked hard and volunteered a lot of their time to get all lab testing done. This whole project was a great collaborative effort, were students discussed how to go about writing a bachelor thesis and helped each other. I also want to give a huge thanks to both my advisors for being very supportive, dedicated, and helpful throughout the entire process. I want to thank my boyfriend for support and technical guidance. Lastly, I want to thank my mother for looking over the English language in this article, it was much appreciated.

Abstract

This study examines the link between emotional regulation tendencies, autistic traits, and their possible impact on health outcomes. Using questionnaires that measure autistic traits (AQ-28) and emotional regulation tendencies (ERQ), the latter being divided into two subscales cognitive reappraisal (adaptive) and expressive suppression (maladaptive), and physiological measurements of heart rate variability (HRV). Since HRV can be considered a physiological measurement for emotional regulation tendencies. A significant correlation between higher autistic traits and the tendency for expressive suppression was found. This suggests that individuals with higher autistic traits may be more prone to maladaptive emotional regulation. No other analyses performed had significant results, therefore, further research with larger samples is needed to investigate the topics of this study. The study also discusses potential contributing factors to poor emotional regulation related to autistic traits, such as cognitive inflexibility and alexithymia, and explores the relationship between emotional regulation difficulties and burnout. Understanding these connections can inform interventions to support individuals with many autistic traits in managing their emotional well-being. Further research into this connection is recommended as well.

Sammendrag

Denne studien undersøker sammenhengen mellom følelsesmessige reguleringstendenser, autistiske trekk og deres mulige innvirkning på helseutfall. Ved å bruke spørreskjemaer som måler autistiske trekk (AQ-28) og emosjonelle reguleringstendenser (ERQ), sistnevnte er delt inn i to underskalaer kognitiv revurdering (adaptiv) og ekspressiv undertrykkelse (maladaptiv). Det ble også utført fysiologiske målinger av hjertefrekvensvariabilitet (HRV). Siden HRV kan betraktes som en fysiologisk måling for emosjonelle reguleringstendenser. Det ble funnet en signifikant sammenheng mellom høyere autistiske trekk og tendensen til ekspressiv undertrykkelse. Dette tyder på at individer med høyere autistiske trekk kan være mer utsatt for maladaptiv emosjonsregulering. Ingen andre utførte analyser hadde signifikante resultater, derfor er det nødvendig med ytterligere forskning med større utvalg for å undersøke temaene for denne studien. Studien diskuterer også potensielle medvirkende faktorer til dårlig emosjonsregulering knyttet til autistiske trekk, som kognitiv inflexibilitet og aleksithymi, og utforsker sammenhengen mellom emosjonelle reguleringsvansker og utbrenthet. Å forstå disse sammenhengene kan videre informere intervensjoner for å støtte individer med mange autistiske trekk i å håndtere deres følelsesmessige velvære. Videre forskning på denne sammenhengen anbefales også at blir utført.

The effect of autistic traits on adaptive emotion regulation, and the possible long-term outcomes

Emotional regulation as a field of study concerns *"how individuals influence which emotions they have, when they have them, and how they experience and express them"*(Gross, 1998, p. 271).

Two of the more researched strategies for emotional regulation are expressive suppression and cognitive reappraisal. These emotional regulation strategies are often considered to be adaptive or maladaptive depending on the long-term effects that are correlated with dominant use of one strategy over the other. Habitual use of expressive suppression has been associated with negative emotions, impaired social functioning and memory, and higher sympathetic activation. Cognitive reappraisal on the other hand is associated with more positive long-term outcomes, such as better memory, reduced negative affect, a reduction in anxiety and depression levels, and diminished cardiac reactivity. Therefore, cognitive reappraisal should be considered the more adaptive emotional regulation strategy when looking at long-term effects (Cai Ru et al., 2018, p. 963).

The use of adaptive strategies over maladaptive strategies and vice versa can be more prevalent in some groups of people than others. For example, research suggests that individuals with high autistic traits tend to use more maladaptive strategies. Autistic traits involve impairment social functioning and communication, a ridged mindset, inflexibility, and repetitive behaviours, among other patterns of behaviour. These traits exist on a continuum, and a high enough score across them might qualify for an autism spectrum disorder diagnosis, which is considered a neurodevelopmental disorder. However, a variation in scores on autistic

traits is also a part of individual differences between individuals with typical development (Nagase, 2023). The tendency for those with many autistic traits to use maladaptive emotional regulation strategies is something that should be considered in research surrounding emotional regulation in general, given the possible negative effects maladaptive regulation can have.

Theoretical background

Emotional regulation

Emotional regulation as a research topic has its origin from developmental psychology and has become a popular research topic across many psychological fields (Gross, 1998). With its popularity as a research topic, emotional regulation runs into an issue concerning definition. Considering it is a concept spanning across several fields of study, that all might use their own inclusive and exclusive criteria and theories, it can be difficult to pin down the exact definition of the concept. The definition must be seen in relation to how one defines what emotions are and do. Emotions are responses to either internal or external stimuli. They produce a change in one's subjective experiences and affect behaviour as well as one's peripheral physiology. Furthermore, emotions produce changes in both the autonomic and neuroendocrine system. Accordingly, emotions should be considered changes both in behaviour and physiology, that are triggered by some sort of stimulus. They unfold over time and can last from seconds to minutes. Emotions can be considered either useful or harmful depending on the context (Gross, 2015). Emotions can assist in organizing the body and mind to reach goals, through prioritizing adaptive behaviours, as well as assisting with communicating effectively in the intricate social systems set up by humans (McRae, 2016).

Sometimes, emotions and how they are displayed need to be modified, e.g, if they are a mismatch to the current situation in duration, type or degree (McRae, 2016). Emotional regulation is goal oriented; the trajectory of an emotion is modified to reach a goal. The emotional regulation could be both the means and the ends, for example down regulating a negative emotion for the sake of feeling better, but often it is done to achieve some larger outcome, such as social favour or personal life goals (Gross, 2015).

Adaptive and maladaptive emotion regulation

One of the more common models to organize and explain different emotional regulation strategies is the process model of emotional regulation. According to this model, different strategies are deployed during the emotion generation process. The model outlines five categories of emotional regulation strategies: attentional deployment, situation selection, situation modification, response modulation, and cognitive restructuring (Gross, 2015). The focus of this article will be on the last two categories, response modulation (expressive suppression) and cognitive restructuring (cognitive reappraisal).

When looking at expressive suppression through the process model of emotional regulation, suppression is aimed at decreasing expressive behaviour, but it does not impact one's emotional experience. Suppression is often used when a person's true expressive display of their emotions could be seen as socially unacceptable, at least from the viewpoint of the person utilizing the suppression. A multitude of experimental studies over the years have shown that manipulation of behaviour can have an impact on a person's affect. For example, studies where participants were asked to keep a fixed neutral face while consuming something meant to be humorous, such as a cartoon comic or a comedy routine, influenced their perceived amusement. However, there were little to no effect on the participants'

physiological measurements compared to control groups. This suggests that at the very least one's external display of emotion could impact the subjective experience of a situation (Gross, 2002).

Cognitive reappraisal is reframing of one's emotional situation. It involves changes in multiple steps through the emotion generation process. When using cognitive reappraisal a mindset shift will occur, the person changes their thoughts around a stimulus they are presented with rather than trying to change their behaviour as with expressive suppression. The re-interpretation of the stimulus might produce the same preferred behavioural outcome as the expressive suppression, due to how the change in one's emotional state might affect how one behaves as well (Gross, 2002).

When looking into the research on emotional regulation strategies it is apparent that cognitive reappraisal produces the most psychological and health benefits and is generally considered an adaptive strategy. Reappraisal is particularly adaptive in especially stressful situations (Troy et al., 2013). Cognitive reappraisal is mostly used to decrease negative emotions, but it can also be used to increase positive emotions (Gross, 2015). This is another reason it can be considered adaptive, since effective emotional regulation strategies that produces more positive outcomes, might depend not only on down-regulating negative emotions but also on up-regulating positive emotions (Giuliani et al., 2008). Reappraisal has in experimental studies been found to have a positive or at least neutral effect compared to no regulation at all in several areas, such as: decreased levels of negative emotion experience, no impact or decreases in sympathetic nervous system responses, lesser activation in emotion-generative brain regions like the amygdala. Furthermore, reappraisal either has no impact on memory, or has in some studies improved memory, enhancing exam performances (Gross, 2015).

The adaptiveness of cognitive reappraisal is dependent on the context it is being used. A potential key factor concerning whether reappraisal is adaptive or not is the controllability of the situation. How much control one has over the outcome of a situation should be a consideration. When a stressor is out of one's control restructuring their emotional response can be very adaptive, as it might be one of the only aspects that can be controlled. Whereas, in a situation where there is less of a need for an emotional change to achieve a desirable outcome, reappraisal might be less adaptive. For example, when potentially failing an exam, an emotional coping strategy like cognitive reappraisal could be less adaptive than problem-focused coping, where changing the situation, by reading more, is more adaptive than changing one's emotions (Troy et al., 2013).

In contrast to the mostly adaptive strategy of cognitive reappraisal, expressive suppression has been shown to be a more maladaptive strategy. Although, expressive suppression can diminish the outward expression of emotion, it does not decrease the experience of negative emotions. It can, however, decrease the experience of positive emotions (Gross, 2015). Furthermore, expressive suppression when compared to no regulation at all led to increased sympathetic nervous system responses, and more activation in emotion-generative brain regions such as the amygdala. Unlike the possible memory promoting effects of cognitive reappraisal, expressive suppression led to a worsening in memory. Lastly, experimental studies have also showed adverse social effects when using expressive suppression, as it led to lesser liking as well as a greater cardiovascular response between social interaction partners (Gross, 2015). All these findings would suggest that expressive suppression is in most cases not adaptive, considering both the possible negative effects of using it, as well as the fact that it does not influence negative emotional states, only what is outwardly expressed.

The established research, especially the work done by Gross with his process model of emotional regulation, points to one adaptive and one maladaptive emotional regulation strategy, cognitive reappraisal and expressive suppression, respectively. Although the research done by Gross and other researchers is compelling, some argue that a conclusion of universal adaptability is an incomplete one. Research into the topic has shown that a more nuanced understanding is needed, where the adaptability of several different forms of emotional regulation is dependent on factors like context and time, as well as individual differences. Different emotional coping strategies are moderated by the context, duration, and characteristics of the emotional triggering stimulus. An example of how context affects the adaptability of cognitive reappraisal is that an individual's stress level plays a key role in whether the reappraisal has an impact on depression levels or not, with higher stress levels being connected to reappraisal having a mediating effect on depression. Moreover, research suggest that a key factor concerning emotional regulation is flexibility, and that variation between individuals and contexts can lead to the use of different strategies being adaptable. (Bonanno & Burton, 2013).

Autistic traits and emotional regulation

Autism spectrum disorder (ASD) is a neurological development disorder that according to the DSM-5 is characterized by persistent deficits in social interaction and communication, as well as restrictive and repetitive behaviour, which both must take place across multiple contexts (American Psychiatric Association, 2013). The traits that make up autism spectrum disorder are also a part of general individual differences, below the threshold of a diagnosis. There is a cognitive, behavioural, and emotional continuity between those who are autistic and those who are allistic (someone without ASD) (Monk et al., 2022), where those who are diagnosed with ASD are considered to inhabit many autistic traits, and those

who are not diagnosed inhabit few autistic traits and or below threshold for a diagnosis of ASD (Nagase, 2023).

Persons with ASD tend to use more maladaptive and less adaptive emotional regulation strategies. This tendency has been associated with several negative mental and physical health outcomes (Cai Ru et al., 2018). Higher autistic traits are associated with more emotional regulation difficulties. To investigate the impact of autistic traits in emotion regulation, Nagase etal. measured autistic traits with the AQ and emotion regulation. They found a negative relationship between autistic traits and regulation styles connected to cognitive change, such as positive reappraisal. (Nagase, 2023).

In a study on children and adolescent individuals with ASD and their use of emotional regulation strategies it was found that not only did they use less cognitive reappraisal and more suppression compared to their typically developing peers, they also had persisting trouble using cognitive reappraisal after the technique had been explained to them and they had been encouraged to use it (De Groot & Van Strien, 2017). Underlining that autistic traits seemingly have a profound impact on emotion regulation strategies that is beyond just being a pre-disposition. Furthermore, high scores on autistic traits are in general connected to poorer health outcomes, such as higher rates of depression and anxiety (Rosbrook & Whittingham, 2010). Something that should be considered to possibly be connected to these difficulties with favourable emotional regulation strategies.

HRV as a measure of emotional regulation, and HRV and autistic traits

One of the established effects of using expressive suppression was autonomic activation, a physiological response that should be given extra consideration when discussing health outcomes. Autonomic activation and its effects on emotional responses can be studied

by looking at heartrate variability (HRV). *"Heart rate variability (HRV) refers to the fluctuations between consecutive heartbeat cycles…. A healthy heart corresponds to a certain inherent variability, and the loss of this variability is a precursor to heart damage. The strict periodicity of the heart is not a sign of health but is associated with pathological conditions*" (Zhu et al., 2019, p. 3). HRV is a continuous interplay between the sympathetic and parasympathetic nervous system. Therefore, it is of importance to consider the implications of too much sympathetic nervous system activation (Zhu et al., 2019). In general, the sympathetic effects are slow, on the time scale seconds, whereas the parasympathetic effects are fast, on the time timescale of milliseconds. Because of this, only parasympathetic influences are capable of producing rapid changes in the beat to beat timing of the heart (Thayer et al., 2012). High HRV depends on parasympathetic activation.

HRV is a measurement of how well one adapts to their environment, and flexibility is a crucial part of that adaption. As stated in pervious paragraphs, emotions and emotional regulation is also a form of adaption to the environment. HRV and emotional regulation are very much interlinked, arguably to such a degree that HRV could be considered a physiological measurement for emotional regulation (Zhu et al., 2019). *"According to the Polyvagal Theory of emotions, cardiovascular control is associated with emotion regulatory capacity and in turn determines socio-communicative behaviours. Thus, researchers have suggested that HRV is a physiological indicator of the capacity to regulate emotions."* (Cai Ru et al., 2019, p. 55). It has been demonstrated that higher resting HRV or RSA are associated with better emotion regulation and more adaptive regulation strategies, while lower resting HRV was associated with use of less adaptive strategies in several empirical studies (Cai Ru et al., 2019).

Low HRV suggests dominant use of maladaptive emotional regulation strategies like expressive suppression, and that high HRV suggests dominant use of adaptive emotional

regulation strategies like cognitive reappraisal. In a meta-analysis looking at HRV in individuals with ASD the results showed that both baseline HRV and HRV reactivity under social stress were significantly lower in individual with ASD than in controls (Cheng & Huang, 2020). Although this study was done on individual diagnosed with ASD, it could be an indication of how high autistic traits might affect HRV.

A hypothesis concerning why emotional regulation difficulties and low HRV is common in the autistic population concerns the association between respiratory sinus arrhythmia (RSA, HRV when measured in the frequency of respiration to use as an indicator of parasympathetic nervous system control) and socio-emotional competence. Studies have shown that higher RSA at baseline corresponds with better emotional recognition in adults. Further, studies on children with ASD showed that a grater RSA at baseline is associated with better emotion recognition. In other words, greater RSA at baseline is associated with better social and emotional abilities, indicating higher parasympathetic control in individuals that display a higher degree of socio- emotional competence (Soker-Elimaliah et al., 2020). Socio-emotional competence is a challenge for those with ASD, and arguably those with higher scores on autistic traits, considering one measure of autistic traits is a measure of social competency. Since it is the traits that make up an ASD diagnosis that seem to have an impact on HRV and emotional regulation difficulties it should be considered of importance to investigate the impact of these traits when normally distributed in the population, as well as looking into the clinical population, which many studies already have. To define and understand the association between autistic traits and emotional regulation difficulties more thoroughly.

The present study

Alot of the research done on emotional regulation and autistic traits is done on a clinical population with diagnosed ASD, and often some or all the participants are children. This study will look at a non-clinical sample of adults (above the age of 18), where being diagnosed with a neurological disorder is a bar from entry. The goal is to add to the existing literature looking into associations between autistic traits and maladaptive emotional regulation in the general population. Hopefully, looking into how normal variations in peoples' traits might affect their emotional regulation tendencies will provide deeper insight into what effects emotional regulation, and how one's traits might make them vulnerable to the adverse health outcomes associated with maladaptive regulation strategies.

RQ: Individuals with more autistic traits have less adaptive emotional regulation strategies.

H1: A high score on autistic traits correlates positively with the use of suppression as an emotional regulation strategy.

H2: A high score on autistic traits correlates negatively with the use of cognitive reappraisal as an emotional regulation strategy.

H3: There is a correlation between the AQ scores and the HRV measurements (rmssd).

H4: There is a correlation between the rmssd and the two respective ERQ subscales.

H5: There is no correlation between the ERQsuppression and the ERQcognapprasial subscales.

The research question as well as H1 and H2 was pre-registered at OSF.io using a preregistration template from AsPredicted.com (https://osf.io/vq34w).

A confirmatory correlation analysis between the scores of the Autism Spectrum Quotient-28 (AQ-28) and the Emotional Regulation Questionnaire (ERQ) will be performed. As well as an exploratory correlation analysis between the scores of the AQ and HRV measurements (rmssd) acquired with a Biopac PPG, as a physiological measure of the relationship between autistic traits an emotional regulation. An exploratory correlation analysis will also be done between the rmssd the and the two respective ERQ subscales, as a further measure of the relationship between HRV and emotional regulation. Lastly, an exploratory correlation analysis will be performed between the two ERQ subscales to demonstrate that they effectively measure different things.

Method

Sample

This study used a convenience sample of 56 participants (N=56) to participate in a computer-based experiment. The inclusion criteria were being above 18 years old, being a native Norwegian speaker, having no diagnosed neurological disorders, and not taking psychotropic medication. 1 participant had all their data removed from due to not meeting the inclusion criteria, therefore, the final sample size was N=55. Moreover, 4 other participants had part of their data removed due to technical or other difficulties. The participants were native Norwegian speakers fluent in English, apart from one participant who was a native French speaker. In this sample four participants were psychology students, and the sample also consisted of a wide range of occupations, fields of study, and levels of education. The participants reported no history of neurological disorders, brain disease, or surgery, and they were not currently taking any central nervous system drugs or medication. 26 (47%) of

participants were men, and 29 (53%) of participants were women. The age of participants ranged from 20-42 years, with the mean age being 24.73 years (*SD*=4.37).

Procedure

This project involved a group of nine bachelor students who would all be using data from the same participants; each student was asked to recruit around five participants each. This took place during the months of February and March 2024. A consent form was drafted beforehand and sent to the participants that were recruited. The consent form contained information about the purpose of the experiment, which was explained as a study into the relationship between emotional regulation, recognition of one's emotions, and cognitive effort. Furthermore, the consent form included what the project would entail for those who participated, as well as information about how the participant is guaranteed anonymity, how their data is used, and how they have the right to withdraw from participation. The project was approved by NTNU's ethics committee and the Norwegian Agency for Shared Services in Education and research (SIKT.no). The project consisted of an hour-long computer-based part, where participants were given a demographic questionnaire where they were asked to fill out their age and gender, the options for genders were man, woman, and non-binary. They also filled out a two-part questionnaire through Qualtrics, measurements of the participants HRV was done with a Biopac PPG. Some other physiological measurements, as well as completing two cognitive tasks were also done. Afterwards, the participants were sent to a different lab to complete a 30-minute irony task while their pupil size was measured. Upon completion participants were thanked and received a 300kr gift card to Kiwi, as a thank you for their time and participation. Below are only the instruments used that are relevant to this bachelor's thesis described in detail, the formulation of some technical details of the instrument's descriptions were written with guidance from the project supervisor. A complete

description of the materials can be found on osf.io (https://osf.io/g9cwf/?view_only=54027d1f69f14ea09b4c7a8d9684ed19).

Instruments

In this study data from two of the questionnaires done through Qualtrics was used: The Emotional Regulation Questionnaire (ERQ)(Gross & John, 2003) and the Autism Spectrum Quotient-28 (AQ-28)(Hoekstra et al., 2011), the latter is not a diagnostic instrument. The ERQ is a 10-item scale to measure respondents' tendencies to regulate their emotions in two ways: (1) Cognitive reappraisal and (2) Expressive Suppression. Respondents answer each item on a 7-point Likert-type type scale ranging from 1 (strongly disagree) to 7 (strongly agree) (Gross & John, 2003). The items in the ERQ are formulated like statements, for example: "I keep my emotions to myself" or "When I feel positive emotions, I am careful not to express them". The respondent will rate the statement on a 7-point Likert-scale. Some items measure suppression, others cognitive reappraisal (Gross & John, 2003). The Norwegian version was received via personal communication by A. Harver on 2023-12-14 (Haver et al., 2023). The range for the cognitive reappraisal subscale score is 6 to 42, while the range of scores for the expressive suppression subscale ranges from 4 to 28. A high score is indictive of greater use of the respective subscale. The internal consistency (Cronbach's coefficient) of the original English version had an alpha = .75 for Cognitive Reappraisal and alpha = .68 for Expressive Suppression. In the current study internal consistency for the Cognitive reappraisal subscale was McDonald' omega = .842 (95% CI .778; .907), and Cronbach's alpha .836 (95% CI: .755; .895). For the suppression subscale McDonald's omega was .785 (95% CI: .691; .879) and Cronbach's alpha was .77 (95% CI: .652; .854).

The Autism Spectrum Quotient-28 is a short form version of the original Autism Spectrum Quotient, that consisted of 50 items that were divided into five empirically derived

subdomains, it was shorten from the original 50 times to 28 items. These 28 items are assigned to five factors: Social skills, Routine, Attention switching, imagination, and Numbers/Patterns. The items in the factors “Social skills”, “Attention switching”, and “imagination” are supposed to measure deficits in those areas, while the items for the factor “Routine” are supposed to measure a preference for upholding a routine, and the items for the factor “Numbers/Patterns” are supposed to measure a fascination with numbers or patterns. The AQ questionnaire comprises of descriptive statements assessing personal preferences and habits related to the 5 factors. They are measured through a 4-point Likert scale: 1= “definitely agree” to 4= “definitely disagree”. The scoring is reversed for items where an “agree” response is characteristic of autism (Hoekstra et al., 2011). The AQ-short correlates very highly with the full-scale AQ (*r* between .93 and .95) (Hoekstra et al., 2011). A high score on the AQ reflects higher levels of autistic traits, the scoring range for the AQ short is 28-112. The internal consistency (Cronbach’s coefficient) of the original English version was alpha =.77. In the current study McDonald’s omega was .735 (95% CI: .632, .839) and Cronbach’s alpha was .752 (95% CI: .634; .839).

A physiological measurement was also used in this study. The Participants’ heart rate variability (HRV) was measured at the beginning of their respective sessions using a Biopac systems Photoplethysmography (PPG) (Park et al., 2022). This is a non-invasive measurement using light source and a photodetector to measure volumetric changes in blood circulation. The PPG signals can capture variations in blood volume that can be analysed to evaluate heart rate activity (Park et al., 2022). Participants wore the Biopac PPG sensor on the index finger of their left hand, as all were right-handed, and avoiding too much movement was of importance, participants were instructed to move their hand as little as possible. The PPG was measured for a 5-minute period during resting, and the recording was performed on AcqKnowledge 5.0. For data processing, R-wave times of heartbeats were automatically

detected, followed by visual inspection. Any actual peaks missed by the automatic detection were added, noise was removed, and misidentified peaks were deleted. Missing data estimation was not performed to make sure the analysis was based solely on actual R-wave times, avoiding any potential effects introduced by estimated data. The HRV is expressed as root mean square for successive differences between normal heartbeats (RMSSD).

Data analysis

The data in this study was analysed using the statistics programme JASP 0.18.3.0 version. The confirmatory analysis was done through a Kendall's tau-b correlation analysis between the average AQ score (sum score divided by the number of items a participant answered, three participants did not answer one or two items) and the ERQ suppression subscale score, and a Kendall's tau-b correlation analysis between the average AQ score and the ERQ cognitive reappraisal subscale score. Since HRV can be considered another measurement for emotional regulation, an exploratory analysis was done through a Kendall's tau-b correlation analysis between the AQ and the HRV measurements of the participants (rmssd).

An a priori power analysis was also performed in the early recruitment stage of this study. The power analysis revealed a statistical power of .95, based on an alpha level of .05 (α=.05) and an effect size of .03. The obtained statistical power suggested a sample size of 111 participants. The suggested number of participants were not met due to financial and time restraints, the results of the analysis should be understood in conjunction with this statistical weakness.

Results

There were 53 participants with valid AQ data. The score ranged from 1.4 to 3. With an average score of 2.19, and a standard deviation of 0.3. The data was normally distributed. There were 54 participants with valid ERQ suppression subscale data. The score ranged from 4 to 21. With an average of 13, and a standard deviation of 4.5. The data was normally distributed. There were 54 participants with valid ERQ suppression subscale data. The score ranged from 6 to 47. With an average of 26.6, and a standard deviation of 6.4. The data was not normally distributed, as the Shapiro-Wilk assumption test was significant. There were 48 participants with valid rmssd data. The score ranged from 0.01 to 0.15, with an average score of 0.06, and a standard deviation of 0.03. The data was not normally distributed, as the Shapiro-Wilk assumption test was significant. A Kendall's tau-b correlation analysis was chosen for all correlations, as it is a nonparametric and robust test, and can therefore still be used when the data is not normally distributed.

Confirmatory analysis

A Kendall's tau-b one-tailed correlation analysis was performed to investigate the relationship between the AQ and the ERQsuppression subscale, with the expectation being a positive relationship between the variables. A Kendall's tau-b one-tailed correlation analysis was also performed to investigate the relationship between the AQ and the ERQcognapprasial subscale. Table 1 shows descriptive statistics and the reported relationship (tau) between the variables, the predicted direction of the two analyses is reflected in the tables contents as well.

The results showed a significant positive relationship between the AQ and the ERQsuppression subscale, *tau*(53) =.20 (95% CI [0.04, 1.0]) , ρ= .02. The results of the correlation analysis between the AQ and the ERQcognapprasial subscale were not significant, the null hypothesis could not be rejected, *tau*(53)= -.09 (95% CI [-1.0, 0.09]), ρ=*.19.* The

results did go in the predicted direction showing a negative correlation between the AQ and the ERQcognapprasial subscale.

Exploratory analysis

A Kendall's tau-b two-tailed correlation analysis between the AQ and the rmssd was performed to investigate the relationship between AQ and the HRV measurements (rmssd). Table 1 shows the descriptive statistics and the reported relationship (tau) between the variables.

The results of the correlation analysis between the AQ and the rmssd were not significant, the null hypothesis could not be rejected, *tau*(55)= -.004 (95% CI [-0.22, 0.21]), ρ=*.971*.

A Kendall's tau-b two-tailed correlation analysis between the rmssd and the ERQ subscales was performed to investigate the relationship between rmssd and the two subscales. Table 1 shows the descriptive statistics and the reported relationship (tau) between the variables.

The results of the correlation analysis between the rmssd and the ERQcognapprasial were not significant, the null hypothesis could not be rejected, *tau*(47)= -.016 (95% CI [-0.201, 0.169]), ρ=.876. The results of the correlation analysis between the rmssd and the ERQsuppression were not significant, the null hypothesis could not be rejected, *tau*(47)= -.153 (95% CI [-0.361, 0.055]), ρ=.138.

A Kendall's tau-b two-tailed correlation analysis between the ERQsuppression and the ERQcognapprasial subscale was performed to investigate the relationship between the two

subscales and whether they measure two distinct things. Table 1 shows the descriptive statistics and the reported relationship (tau) between the variables.

The results of the correlation analysis between the ERQsuppression subscale and the ERQcognapprasial subscale were not significant, the null hypothesis could not be rejected, *tau*(54)= .022 (95% CI [-0.177, 0.221]), ρ=.822.

Table 1.

Descriptive statistics and correlation analysis for AQ, ERQsuppression, ERQcognapprasial, rmssd

Kendall's Tau Correlations

		n	Kendall's tau B	p	Lower 95% CI	Upper 95% CI
AQave	ERQcognapprasial	53	-0.085	*0.192*	-1	0.091
AQave	ERQsuppression	53	0.202*	*0.02*	0.035	1
AQave	rmssd	47	-0.004	*0.971*	-0.222	0.214
ERQcognapprasial	ERQsuppression	54	0.022	*0.822*	-0.177	0.221
ERQcognapprasial	rmssd	47	-0.016	*0.876*	-0.201	0.169
ERQsuppression	rmssd	47	-0.153	*0.138*	-0.361	0.055

Note * p < .05, ** p < .01, *** p < .001

[a] AQave Autism Spectrum Quotient average

[b] ERQcognapprasial Emotional Regulation Questionnaire Cognitive reappraisal subscale

[c] ERQsuppression Emotional Regulation Questionnaire Expressive suppression subscale

[d] RMSSD The heart rate variability expressed as a root mean square for successive differences between normal heartbeats

Discussion

The purpose of this study was to investigate how autistic traits in a non-clinical population relates to the use of adaptive or maladaptive emotional regulation strategies, using both self-reported and physiological measurements. The confirmatory correlation analysis testing **H1**, found a moderate positive correlation between the average AQ scores and the ERQ suppression subscale scores. This aligned well with the scientific literature and was expected. Considering that autistic traits have consistently been associated with use of expressive suppression (Cai Ru et al., 2018). The other confirmatory correlation analysis testing **H2** was however not significant, but it did go in the expected direction showing a small negative correlation between the average AQ scores the ERQcognapprasial subscale. Although it was somewhat expected that these results would be significant and that the correlation would be at a moderate level, the results were unsurprising considering the results of the a priori power analysis. Many other studies looking at the same association found there to be a negative relationship between the two (Nagase, 2023), researchers also found that individuals with ASD had trouble using cognitive reappraisal as a strategy, even after being coached on how to do so, and encouraged to use it (De Groot & Van Strien, 2017). It is likely that the results were affected by the low statistical power that arose from a too small sample size.

The results of the exploratory analysis were all also likely affected by the low statistical power, as none of them were significant, and some had results that were incongruent with the established scientific literature. The first exploratory analysis **H3** looking at the relationship between the average AQ scores and the HRV measurements (rmssd) had the most surprising results, not only were the results not significant, but the negative correlation found was so small it was negligible. This does not align well with the

scientific literature where HRV is proposed as a well-established physiological measurement for adaptive or maladaptive emotional regulation (Cai Ru et al., 2019), and further where it is established that autistic traits are associated with poor emotion regulation (Nagase, 2023). It was expected that the two variables would have a larger negative correlation. Further, the exploratory analysis **H4** exploring the relationship between the HRV measurements (rmssd) and the two ERQ subscales. The results for both subscales were also not significant, and both showed a small negative correlation. Something that is also not consistent with the scientific literature. Considering that the literature proposes that HRV can be considered a physiological measure of the two emotional regulation strategies, the rmssd should be positively correlated with the cognitive reappraisal subscale and negatively correlated with the expressive suppression subscale (Cai Ru et al., 2019). However, since the results were not significant one cannot infer anything from them or view them as an opposing statistic for the scientific consensus in this article in general.

Lastly, the results of the exploratory correlation analysis **H5** exploring the relationship between the two ERQ subscales to establish that the two scales measure different concepts were also not significant, but did show a very small correlation, which could be a good indication that the scales are not related to each other in a meaningful way. Although little can be drawn from the results of this study considering the lack of significant values, besides the results of the **H1** correlation analysis, the reasoning for choosing and potential implications of the topics examined should still be given further consideration.

Autistic traits seem to be associated with poor emotional regulation, something that has been further demonstrated in this study with the significant positive correlation between the AQ and the ERQ suppression subscale. A consideration for why this is the case is the general inflexibility of autistic traits. People with high autistic traits tend to engage in

repetitive behaviour, fixed mindsets, and are less able to switch between tasks or viewpoints. Moreover, they tend to rigidly follow rules, and are resistant to change, as well as new social situations. When looking at these factors, at least in individuals with ASD, they constitute executive dysfunction (Albein-Urios et al., 2018). "*Executive functions are a set of cognitive control processes underpinned by frontal-striatal circuits. They allow us to direct behaviour toward a goal by planning, inhibiting prepotent responses, and switching between mental sets to adapt to new situations"* (Albein-Urios et al., 2018, p. 2506). Considering that emotional regulation is goal oriented (Gross, 2015) and that the nature of cognitive reappraisal is a restructuring of one's mentality, it stands to reason that an individual with impaired executive functions might have more difficulty with certain emotional regulation strategies, like cognitive reappraisal. This, however, could not be substantiated by the results of this study considering the lack of significant results when looking at the relationship between the AQ and the ERQ cognitive reappraisal subscale.

Besides flexibility there is another trait that goes along with high levels of autistic traits that should be of interest, especially when looking at the connection between HRV and emotion regulation, and that is alexithymia. Alexithymia is *"a personality construct characterized by impairments in sensing, identifying, and describing one's own emotions"*(Soker-Elimaliah et al., 2020, p. 119). Something studies have shown that is more common in individuals with ASD. In a study examining cardiac autonomic measures, awareness of one's cardiac responses, and emotion processing, as they related to each other and to variability in autistic traits in a sample of college students by Soker-Elimaliah, et al. The results showed that when looking at autistic traits as a continuous variable, autistic traits interact with alexithymic traits to predict heartrate change to negative stimulus, as well having a negative correlation with introspective accuracy, which is the process of accurately sensing and tracking internal traits and bodily sensations. The study thereby supported the well-

established theory that those with ASD have more difficulty with emotional regulation, and that a likely contributing factor is how autistic traits interact with alexithymia (Soker-Elimaliah et al., 2020). Although, the current study could not support the connection between HRV and emotional regulation, it has a considerable amount of scientific support outside of this article, and this study's results does not challenge that status quo.

In light of the consistent connection between autistic traits and maladaptive emotional regulation, as well as the connection between maladaptive emotional regulation and adverse long-term health outcomes, it could also be of interest to investigate the possible connection between these factors and burnout. *"Burnout is a psychological syndrome that appears as a response to chronic interpersonal stressors at work and is characterized by three factors: (1) emotional exhaustion (the inability to respond in an emotionally appropriate way due to fatigue); (2) depersonalization (responding to subjects of work coldly or in a detached way); (3) a decreased sense of personal accomplishment (a reduced sense of accomplishment as a professional)"*(Watanabe & Akechi, 2023, p. 2).

In a study by Watanabe and Akechi looking at the association between autistic traits and each factor of burnout or depression among medical students, they found that autistic traits were significantly associated with lower personal accomplishment, which is a factor for burnout, as well as higher depression (Watanabe & Akechi, 2023). This suggests that high levels of autistic traits might be a vulnerability factor for burnout. Something that is further supported by the phenomena of autistic burnout. As of right now the topic has not been thoroughly researched, but it seemingly shares many of the characteristics experienced from work related burnout, and is believed in part to be caused by consistent attempts to conceal ones autistic traits by those with ASD (Arnold et al., 2023). Taken together it is clear that autistic traits might lead to a depletion in cognitive resources over time that could aid in developing symptoms of burnout.

There are also other factors associated with high levels of autistic traits related to burnout. Alexithymia has been suggested as a risk factor for workplace burnout, and as established in previous paragraphs, is a trait associated with autistic traits, emotional regulation difficulties, and interoception difficulties. Moreover, research suggests that alexithymia is a vulnerability factor for developing autistic burnout as well (Mantzalas et al., 2022). In a systemic review looking at the association between emotional regulation and burnout in doctors by Jackson-koku and Grime they found that emotional regulation predicts and correlates with burnout, and that using self-regulatory and taught emotion regulation skills was associated with a reduction in burnout. The review also found that so called surface acting was strongly and positively several burnout factors, such as depersonalisation, emotional exhaustion, and psychological strain (Jackson-Koku & Grime, 2019). Surface acting involves displaying emotions that are incongruent with what is felt by the individual and could arguably be considered a form of expressive suppression.

Individuals with high levels of autistic traits should be considered at risk for burnout, and that risk should be considered of particular importance considering that the systemic review by Jackson-Koku and Grime suggests that self-regulatory measures seem to be mediating the risks for burnout. Since self-regulation and implementation of adaptive emotional regulation strategies are considerably more difficult for those with many autistic traits. Both due to the aforementioned inflexibility associated with autistic traits leading to executive disfunction, as self-regulation is a part of executive functioning (Albein-Urios et al., 2018). But also considering the finding that those with ASD might have trouble using cognitive reappraisal, even when instructed on how to do so (De Groot & Van Strien, 2017). Therefore, burnout should be of concern when looking at the effects of autistic traits on emotional regulation, when autistic traits and their association with poor emotional regulation

seem to be a potential risk factor for burnout, and how autistic traits also seem to negatively impact strategies that are protective against burnout.

Strengths and limitations

This article consists of several strengths, one being the reliability of the questionnaires used. Both the AQ-28 (Hoekstra et al., 2011) and the ERQ (Gross & John, 2003) are reliable and standardized questionnaires, and have been used in a plethora of similar research. It is therefore safe to assume that what was intended to be measured in this study was in fact measured. Furthermore, the reader will have a large pool of scientific literature to compare from. Another strength in this study is the high ethical standard of the process. All participants were well informed before participating on both the goal of our research, as well as their rights, such as their right to anonymity, access to their data, and the right to withdraw. The sample in this study was in part also a strength, given the fact that it was a convenience sample, where participants were recruited by psychology students, the participants were quite diverse. With an arguably large age range, a very good split between genders (nearly 50/50), and a good range of occupations, fields of study, and levels of education. When a sample can reflect the diversity of real life it is more likely that the findings in a given study might apply to the general population (Langdridge, 2021, pp. 46-47).

A further strength of this study was the hypotheses created to ensure that quality measurements were done, like **H4** and **H5**. The former looking into the relationship between the HRV measurements and the two ERQ subscales to further ensure that HRV can in fact be considered a physiological measurement of the two emotional regulation strategies, and to lend more support to the already existing literature. And the latter looking into whether there is a substantial relationship between the two ERQ subscales, which there should not be

between two scales measuring categorically different things. The addition of these hypotheses could potentially give the study more statistical weight and should be evaluated as a sign of quality.

The study was not without its limitations, and two of the strengths in this study can arguably also be considered weaknesses as well. One being, as alluded to in earlier paragraphs, the sample size. As mentioned, an a priori power analysis was performed prior to recruitment, and the results suggest a sample size of 111 participants. Recruiting and testing that number of participants was not feasible given the time and resources available. Therefore, the study was done with around half the recommended participants (N=56). A too small sample size does diminish the statistical power of an analysis and might be part of the reason why this study yielded very few significant results (Langdridge, 2021, p. 50).

The other being the AQ, although it is a reliable measurement and has been utilized in a great deal of scientific literature, some of which have been cited in this article, it has also been subject to some valid criticism as well. One being that the AQ is based on Baron-Choen's theory on the extreme male brain. Where Baron-Choen suggests that autism could be understood as an extreme of what he labelled the normal male brain profile, only taking into consideration the typical autistic traits of autism in men (Baron-Cohen, 2002). This makes the AQ less applicable to women, which should be considered a weakness when studying traits in the general population. Another considerable weakness of the AQ, is how variety in the autistic trait continuum sometimes affects how well the AQ can pick up on traits, sometimes leading to for example individuals with diagnosed ASD scoring low on the AQ (Abu-Akel et al., 2019). However, the issues related to gendered differences in autistic traits have been suggested to mostly pose an issue in considerably large samples, and all though it cannot always effectively pick up on autistic traits, the AQ is still considered a reliable measure of autistic traits (Abu-Akel et al., 2019).

The last limitation that will be mentioned for this study involves the material used for the theory part of this article. Although, the literature was convincing and met a high scientific standard, much of the research utilized was done on clinical samples. A demographic this study purposefully did not wish to look into. This might pose an issue if assumptions were made based of off research on a clinical sample that cannot as easily as presumed be applied to the general population. The choice of scientific literature was made due to difficulties in finding relevant articles looking at autistic traits rather than individuals with ASD, although, an effort was made to find a variety of articles looking both at autistic traits and ASD. Even if this should be taken into consideration by the reader, the argument made throughout this article, that ASD can be viewed as having enough autistic traits to qualify for a diagnosis, on a continuum of traits that is also normally distributed in the general population as well. Articles on ASD could, therefore, also reflect the effects of high scores on autistic traits as they are understood and studied in this project.

Implications and future research

This study found a link between high scores on autistic traits and expressive suppression, further research should investigate the other hypotheses that did not have significant results in this study with a more appropriate sample size. Since the connection between HRV and autistic traits gives a more thorough look into the physiological aspects and outcomes related to emotional regulation tendencies, and how those relate to autistic traits. It should also be considered of importance to investigate the relationship between cognitive reappraisal and autistic traits in further research, not only to further establish a negative correlation between the two, but also to investigate possible reasons as to why this strategy of emotional regulation is seemingly difficult for those with many autistic traits. Especially considering the possible importance of adaptive emotional regulation as a preventative

measure for burnout. Additionally, further research should be conducted into the topic of autistic burnout, and if the same vulnerability factors that have been underlined in this article regarding work related burnout applies to autistic burnout. It could also be of interest to establish if and to what degree the two forms of burnout are related to one another.

Conclusion

This study found a significant moderate correlation between the average scores of the AQ and the expressive suppression subscale of the ERQ. An outcome that aligns with earlier research papers and serves to strengthen the conclusions of those papers. No other hypothesis made, confirmatory or exploratory, produced significant results. Therefore, no conclusions can be drawn from other analyses performed in this study. The aim, however, was to look at the relationship between the AQ and the cognitive reappraisal subscale of the ERQ, the relationship between HRV measurements and the AQ, the relationship between HRV and the two ERQ subscales, and the relationship between the two ERQ subscales themselves. The connection between autistic traits and maladaptive emotional regulation is a fairly well researched topic, with substantial evidence suggesting there is an association between the two. However, further research should be done into possible reasons for this association, such as alexithymia or other traits common in those with many autistic traits. Moreover, further research should look at the possible consequences that poor emotional regulation and many autistic traits might bring about, such as being at risk for burnout.

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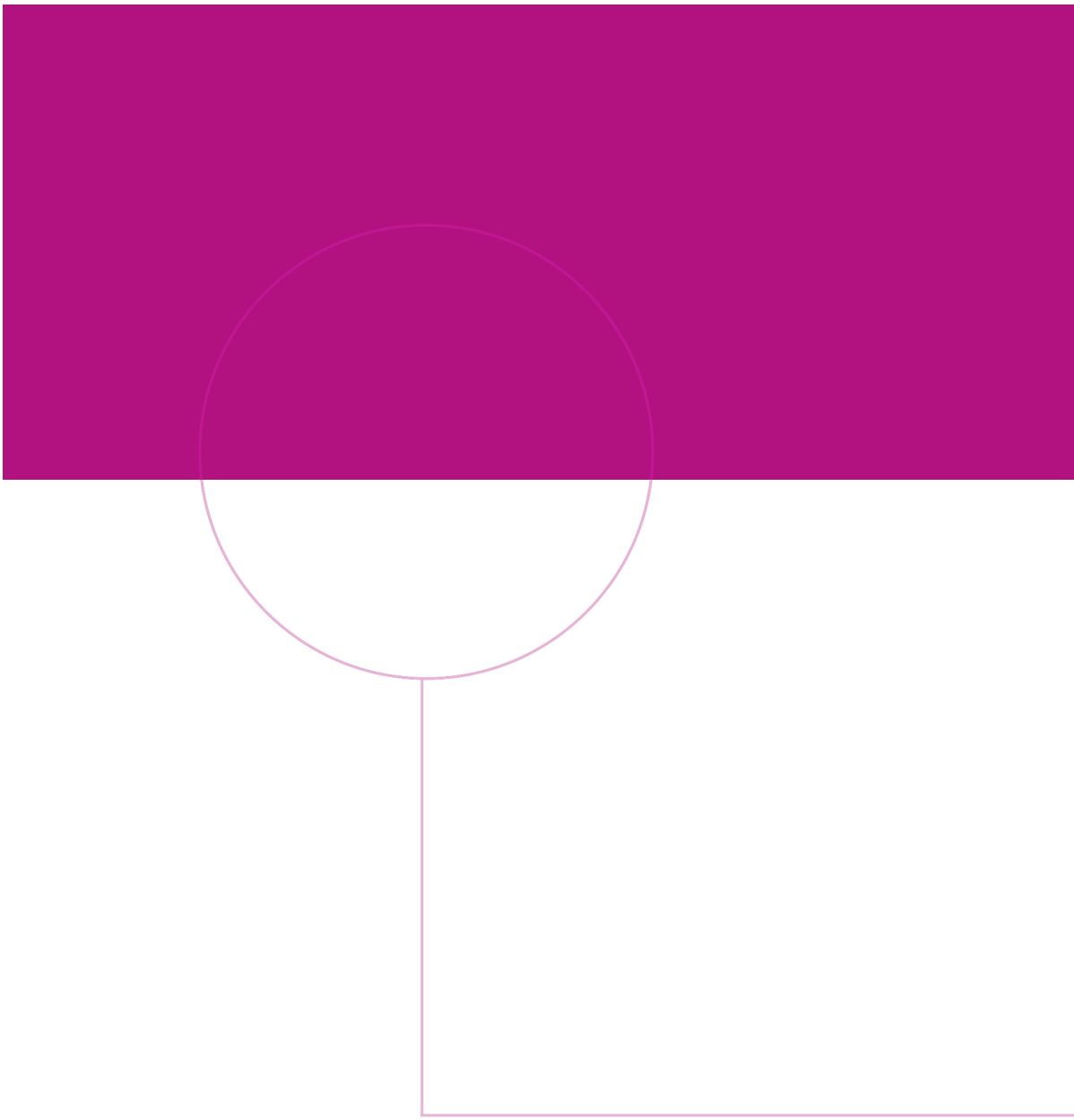

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