Bachelor's thesis

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

Hedda Thunes Agdal

The endless fluctuation of life:

A study on autistic traits and emotion recognition in the context of gender stereotypes.

Bachelor's thesis in Psychology
Supervisor: Francesca Parisi
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Preface

Acknowledgement for the establishment and planning of the project, application for funding and ethical approvements, in addition to quantifications of data is attributed to the project's leaders and supervisors, Francesca Parisi and Gerit Pfuhl. A total of nine psychology students were contributors to this project through the bachelor programme in psychology at the Norwegian University of Science and Technology (NTNU), Trondheim. The students contributed with translations of the consent form, translations of the emotions presented in the Geneva Emotion Recognition Task short version, in addition to recruiting participants, and conducting measurements and tasks in the laboratory at Dragvoll campus, NTNU.

Working on this project has been an intriguing and valuable learning experience. The collaboration and communication between the project leaders and students, in addition to the students in-between, has been excellent. Furthermore, the experiences I have gained through my contributions to this project has exceeded my expectations. I want to thank Francesca Parisi and Gerit Pfuhl for their remarkable dedication to the project and for us bachelor students. Their assistance and guidance through this thesis, including assistance with the methodology section and analyses, has been highly beneficial and educational. I have profound appreciation for Francesca Parisi as my supervisor, and Gerit Pfuhl as secondary supervisor. Thank you for keeping my feet on the ground and maintain a sense of calm in this important period of my education.

I wish to thank my friends and family who have been assisting me with emotional support and grammatical corrections in my thesis. Lastly, thank you for the participants who volunteered to participate in this project, and to my fellow students on this project, who have been working with me throughout this semester. Without you, this project would not have been possible. Thank you for your contribution in both practical and theoretical obstacles, and the supportive space we created through this shared experience. I wish you all the best in the future.

Abstract

The Diagnostic and Statistical Manual of Mental disorders fifth edition (DMS-5) and the International Statistical Classification of Diseases and Related Health Problems 11th edition (ICD-11), both posit deficits in emotion recognition as one of the core symptoms of social impairments in autism spectrum disorder (ASD). A prominent theory for the characteristics in ASD is the Extreme Male Brain (EMB) theory, suggesting a resemblance between an extreme systematic 'male brain' and the autistic profile. The EMB theory view females as the more empathetic gender; a potential contribution to the skewness of the male-to-female ratio in ASD. The present study aims to discover if there are any differences in emotion recognition between males and females with characteristics of ASD in the general population, moreover, if they experience different levels of effort. Measures of autistic traits were performed through the Autism-Spectrum Quotient-Short (AQ), and emotion recognition through the Geneva Emotion Recognition Task short version (GERT-S). Measurements of effort were recorded through response time, brain activity through functional near-infrared spectroscopy (fNIRS) in the prefrontal corticles (PFC), and the NASA Task Load Index (N-TXL). The sample consisted of, N = 55, Norwegian participants between the ages 20 – 42, *M* = 24.6, including females, *n* = 29, and males, *n* = 26, recruited through a non-clinical convenience sample. Analyses were conducted through an independent t-test and Kendall's tau-b correlations. Results both confirm and contradict the thesis hypotheses, creating a discussion reflected upon stereotypical gender norm expectations, and the EMB theory in a psychosocial perspective.

Sammendrag

Manualene '*The Diagnostic and Statistical Manual of Mental disorders fifth edition'* (DMS-5), og '*International Statistical Classification of Diseases and Related Health Problems'* (ICD-11), beskriver begge svekkelse i emosjonsgjenkjenning som et sentralt trekk ved det sosiale aspektet i autismespekterforstyrrelse (ASF). En fratredende teori for denne beskrivelsen av ASF er '*the Extreme Male Brain*' (EMB) teorien, som foreslår en likhet mellom en sterk systematisk 'mannlig hjerne' og den autistiske profil. EMB-teorien oppfatter kvinner som det mer empatiske kjønnet; en mulig påvirkning av den ujevne kjønnsfordelingen i ASF. Formålet med denne studien er å undersøke forskjeller i emosjonsgjenkjenning mellom menn og kvinner med karakteristikker av ASF i den generelle befolkningen, samt om de opplever anstrengelse på ulike nivåer. Mål av autistiske trekk vil bli utført gjennom '*Autism-Spectrum Quotient-Short*' (AQ), og emosjonsgjenkjenning gjennom '*the Geneva Emotion Recognition Task short version*' (GERT-S). Videre vil mål av anstrengelse bli målt gjennom respons tid, hjerne aktivitet gjennom funksjonell nær-infrarød spektroskopi (fNIRS) i den prefrontale kortikallappen (PFC), og gjennom '*the NASA Task Load Index*' (N-TLX). Utvalget inkluderte, N = 55, norske deltakere i en alder mellom 20 – 42, *M* = 24.6, inkludert kvinner, *n* = 29, og menn, *n* = 26, rekruttert gjennom en ikke-klinisk bekvemmelighetsutvalg. Analysene ble utført gjennom en uavhengig t-test og Kendall's tau-b korrelasjoner. Resultatene av analysene både bekreftet og avkreftet oppgavens hypoteser, og skapte en diskusjon med drøfting over stereotypiske kjønnsnormer og forventninger, samt EMB-teorien fra et psykososialt perspektiv.

Introduction

Emotion recognition is an essential cognitive ability for our understanding of others. Deficits in this ability can, therefore, contribute to social dysfunctions and challenges within the social world. This study aims to discover if there are any differences in performance within the short version of the Geneva Emotion Recognition Task (GERT-S; Schlegel & Scherer, 2015) between males and females with a moderate to high score of autistic traits, and if they experience different levels of effort, both cognitive and subjective, during this task. To further understand the subject matter of this research, it is essential to clarify and define important background knowledge and concepts. This will be the focal point of the thesis first part.

Theoretical background

Autism spectrum disorder

The concept of 'autism' has undergone many modifications throughout history. However, the most notable definition endured in the 1940's, where Kanner (1943) and Asperger (1944) described autistic traits as "autistic disturbances of affective contact" and "autistic psychopathy" (Posserud et al., 2005), indicating an absence of affective understanding of others in the autistic individual. Hence, the origin of the outdated diagnosis of 'Asperger's syndrome'. As of the Diagnostic and Statistical Manual of Mental Disorders fifth edition (DSM-5), the categorisation of 'Asperger's syndrome' and 'Autistic disorder' are no longer considered two different diagnoses, rather different dimensions along a continuum within the disorder of autism spectrum disorder (ASD; F84.0; American Psychiatric Association, 2013).

Today, ASD is defined as a complex and multidimensional neurodevelopmental disorder characterised by impairments in social interactions, in addition to restricted, repetitive stereotypic behaviour, interests and activities (Mintz, 2016). The DSM-5 diagnostic criteria for ASD, A. 1 – 3, emphasise the need for persistent deficits within social communication across multiple contexts. These criteria, along with diagnostic criteria from the International Statistical Classification of Diseases and Related Health Problems 11th edition (ICD-11; autism spectrum disorder; 6A02), include deficits within social-emotional reciprocity, understanding and maintaining relationships and social contexts, in addition to difficulty adjusting suited behaviour for the given situation. Furthermore, the criteria precise deficits in understanding feelings, emotional states, and attitude of others (American Psychiatric Association, 2013; World Health Organisation, 2024). To qualify for a diagnosis, these symptoms of social communication and relationship difficulties must be present in childhood and in early developmental period, regardless of the age the diagnosis is set. Although, full manifestation may not occur until later in life, or the history of social deficits may only be apparent in retrospect, it is an essential aspect of the diagnosis (Criteria C.; American Psychiatric Association, 2013; World Health Organisation, 2024).

Autistic traits

Definition

Autistic traits

Studies suggests the existence of ASD traits outside the clinical population, indicating a variability of autistic traits and phenotypes that is continuously distributed within both the clinical population and the general population (Abu-Akel et al., 2019; Constantino & Todd, 2003; Krahn & Fenton, 2012; Posserud et al., 2005; Ruzich et al., 2015). This subclinical spectrum of autistic traits will be the focal point in this thesis. Therefore, '*autistic traits'* will hereafter be defined as presence of autistic characteristics, e.g. characteristics of deficits within social behaviour, on a subclinical spectrum within the general population.

Dimensions of autistic traits

ASD is often viewed as a highly complex and heterogenous disorder, composed by multiple dimensions contributing to this complexity. Several studies throughout the recent years have indicated that behavioural phenotypes differentiating male and female are among these dimensions. Amidst these studies, a systematic review and meta-analysis by Moseley and colleagues (2018), showcase an international 3:1 male-to-female diagnostic ratio within diagnosed children, suggesting that for every three boys, one girl got diagnosed with ASD. However, other evidence suggests a closer male-to-female ratio to be 2:1 (Corbett et al., 2020; Kim et al., 2011). A Norwegian population study done by Posserud and Lundervold (2013), indicate a pattern of later diagnosis, or misdiagnosis in young girls, due to the assumption of disruptive behaviour and other impairments being necessary to get a diagnosis. Furthermore, the absenct portrayal of these impairments are assumed to be contributing to the skewed male-to-female ratio.

One of the most prominent theories explaining the reasoning behind the heterogeneous nature of the ASD population, distinctive to other clinical populations, in addition to the male-to-female ratio, is the extreme male brain (EMB) theory of autism proposed by Simon Baron-Cohen (2002). This theory suggests two neglected dimensions of cognitive processing of understanding the outside world, often associated with traits of a stereotypical 'male brain' and a stereotypical 'female brain': *systemising*, defined as "if *x* – then *y*" mental correlations and analyses (stereotypical 'male brain') and *empathising*, defined as identification of assumed variables, such as emotions and thoughts (stereotypical 'female brain') (Baron-Cohen, 2002). This cognitive ability to perceive and assume the mental states of others, including intentions, behaviours, and feelings, along with understanding these, are often referred to as 'mentalisation' (Ashwin et al., 2007; Kliemann & Adolphs, 2018; Lai, 2011). The EMB theory suggest an extreme version of the 'male brain' to be close to the equivalent of the classical, stereotypical autistic profile both Kanner and Asperger suggested. Moreover, indicate that the diagnostic criteria of these traits are based on this extreme version, thus, a possible contribution to the statistical difference between the male-to-female ratio within the ASD population.

Social contributions

The EMB theory indicate that females are on average better at empathising than males (hence, the representation of the stereotypical 'female brain' for this trait). This suggest a gender norm and expected gender stereotypical behaviour in society, where females are expected to be more interpersonally oriented and empathic than males (Löffler & Greitemeyer, 2021). However, it is essential to take into consideration cultural context when addressing the concept of gender stereotypes due to the diversity of a binary perspective across cultures (Vincent & Manzano, 2017). In a study completed by Löffler and Greitemeyer (2021), the female sample had a tendency of reporting stronger empathetic responses than males, despite no suggestion of female superiority in emotion recognition. This can be viewed as a contributing finding indicating gender-norm expectations for the stereotypical 'female brain' in females. However, the stereotypical profile of autistic traits is represented primarily by the stereotypical 'male brain', which may be a contributing factor to the skewness of the male-to-female clinical diagnosis ratio. Given this expectation of female empathy in society, autistic females may develop adaptive strategies, or possible mechanisms, to portray neurotypical behaviour, or stereotypical 'empathic female behaviour' to mask social deficits. In corollary of this, females with autistic traits, both clinically and subclinically, may experience more effort when maintaining these adaptive strategies and portrayal of neurotypical behaviour.

Emotion recognition and effort

Definitions

Effort

‘Effort’ is a complex and multidimensional concept that refers to the degree of engagement with demanding tasks (Westbrook & Braver, 2015). The level of effort is dependent on the level of engagement; low engagement within a demanding task decreases the level of effort. The multidimensional aspect of the concept refers to the different levels within the measure of effort: an objective measurement of effort within cognitive processes during a task, and a subjective experience and feeling of effort. It is important to note that a high level of effort does not equal a high level of difficulty within the task (Westbrook & Braver, 2015). One can experience subjective effort within a task, without measuring a high level of cognitive effort; the task can be both very difficult, yet not effortful demanding (Westbrook & Braver, 2015).

Neurological studies on emotion recognition and ASD (Ashwin et. al., 2007; Baron-Cohen, 2000; Harms et. al., 2010; Herba & Philips, 2004; Kliemann & Adolphs, 2018), indicate dysfunction in brain regions within this population, including a significantly reduced activity within the medial prefrontal cortex (mPFC), in contrast to an increased activity within the anterior cingulate cortex (ACC) during mentalising tasks compared to a non-clinical control group (Ashwin et al., 2007). These findings suggest an increase of cognitive effort in individuals with ASD during performance in tasks of social and emotional processing, compared to non-clinical control groups. The present study will implement these overall neurological findings, and further investigate how this affects individuals with a high score of autistic traits within the general population.

Emotions

The definition of emotions is a highly debatable subject among scientists within the different domains of psychology (Glasø, 2008; Cai et al., 2023; Malezieux et al., 2023). However, the majority of scientists generally agree that emotions consist of different components, including cognitive evaluations, feelings, actions, and physiological changes

(Glasø, 2008; Kalat, 2018). An important aspect of this concept is the difference between 'emotions' and 'feelings'. 'Emotions' are characterised by observable and measurable changes within the body, e.g. an increase of adrenaline, thus, changes within blood pressure and breathing when experiencing fear. However, 'feelings' are subjective experiences only available to the individual experiencing them (Kalat, 2018). Emotions can be categorised into six basic facial emotions: 'happiness', 'sadness', 'fear', 'anger', 'disgust', and 'surprise', however, the exact number of basic emotions may fluctuate between theories (Kalat, 2018; Cai et al., 2023). Moreover, the manifestations of these emotions are more complex than facial expressions alone, including linguistics, non-verbal behaviour, or physiological signals (Herba & Philips, 2004; Cai et al., 2023). Supplementing these exhibitions of emotions, further generate dimensions of more complex emotions (Cai et al., 2023), such as disgusts, amusement, irritation, pride, etc. The complex emotions employed for this thesis will be presented by the GERT-S in the methodology section of the present study.

Development of emotion recognition

The ability to recognise faces is an essential source for emotional information and indications about our peers, thus, important to our skills within social interactions. Studies indicate that infants exhibit the ability to distinguish facial expressions of emotions from an early developmental stage, primarily between expressions of happiness, sadness, and surprise, in addition to alternate their behavioural responses based on these facial expressions (Herba & Philips, 2004; Martinez, 2021). However, the development and performance of emotion recognition is under continuous improvement through childhood and adolescence (Durand et al., 2007; Herba & Philips, 2004). With increasing age, the ability to recognise emotions evolve from exclusively relying on facial expressions, to being able to decode cues and becoming more insightful into their own emotional lives, further, increasing emotional understanding of others (Herba & Philips, 2004). The older you get; the more complex emotions you manage to define and recognise. However, social orientation and experience is crucial for these developments of facial emotion recognition, meaning that a lack of these can result in deficits in this ability (Harms et al., 2010).

Emotion recognition and autistic traits

The diagnostic manuals state that one of the core characteristics of autistic traits are impairments, or deficits within social interactions and social-emotional reciprocity, which must be present through the early developmental stages in childhood (American Psychiatric Association, 2013; World Health Organisation, 2024). Although deficits within these interactions, impairments in facial recognition as a subdimension of social interactions may vary within the clinical population of ASD. Consequently, empirical findings within behavioural studies of emotion recognition within the autistic spectrum, is to this day inconsistent (Ashwin et al., 2007; Durand et. al., 2007; Harms et al., 2010; Herba & Philips, 2004; Kennedy & Adolphs, 2012). Within the subclinical population, individuals with autistic traits may not portray, nor experience, deficits in social interactions to the degree of reducing the ability of facial recognition (Harms et al., 2010). However, some suggests that these impairments might be camouflaged by potential compensatory mechanisms employed by these individuals, either consciously or subconsciously; meaning a presentation of neurotypical behaviour and skills, despite a neurological presence of autistic traits and cognitive difficulties (Livingston et al., 2020). This is theorised to be done by creating alternative neural routes and psychological strategies, e.g. using complex mental algorithms to predict other people's thoughts and feelings, in order to pass as neurotypical (Livingston et al., 2020). In other words, people with autistic traits, without a presence of social deficits, may have a conscious, or subconscious tendency to collect data from social interactions, analyse them, and create certain 'social rules' within neurotypical behaviour, e.g. the average time neurotypical people hold eye contact, which they further implement into their own social lives (Livingston et al., 2020). This can be seen as an extension of autistic traits, considering the autistic profile being characterised by analytic behaviour and the need to follow rules.

The nature of these compensatory mechanisms, in addition to the EMB theory and social expectations of gender norms, can be speculated to be implemented more by females than males. Furthermore, this may be a contributing factor to a diagnosis of ASD being more frequently under evaluated in childhood and diagnosed much later in females than the average autistic male (Surén et. al., 2019; Posserud & Lundervold, 2013; Moseley et. al., 2018; Corbett et. al., 2020). To constantly worry about 'neurotypical social rules', either consciously or subconsciously, in addition to the expectations of reliable mentalisation, can arguably be an effortful process within every social interaction throughout the day, including emotion recognition. One can argue this to be the reason behind findings, including the Löffler and Greitemeyer study (2021), where females tended to report a subjective stronger empathetic response than males, despite no objective suggestion of this. By supplementing effortfulness into this findings and theoretical background, we can contribute to further knowledge and understanding of the emotion recognition part of autistic traits, in addition to the dimension of gender differences within these traits.

Research question and hypotheses

Theories surrounding ASD and autistic traits in both clinical and nonclinical populations, are still under development. Due to the heterogenous population, potential compensatory mechanisms camouflaging symptoms, in addition to social gender-norms expectations and the history of this neurodevelopmental condition, studies within this field are currently fluctuating between different theories and hypotheses. However, some theories seem to be more prevalent than others, including the EMB theory. Despite a commonly used theory, the empirical findings on effort within emotion recognition and gender differences, is inconsistent. Thus, further research in this field is necessary.

The present study aims to contribute to research within this field, in aspiration of participating in a growing field within psychology. Furthermore, contribute to valuable knowledge, practical for individuals struggling with autistic traits. This study will emphasise on the emotion recognition part of the disorder by using the GERT-S, along with measuring subjective effort through the NASA Task Load Index (N-TLX; Hart & Staveland, 1988), and objective effort through response time and oxygenated blood in the frontal corticles (HbO / HbR) conducted by functional near-infrared spectroscopy (fNIRS). Autistic traits will be measured with the Autism Quotient 28 item version (AQ; Hoekstra et al., 2011). It is important to note that the presented study is not clinical, due to its focal point on autistic traits in the general population. Although, it is possible to achieve a high score of autistic traits within AQ scores without meeting the criteria for a clinical diagnosis, it can be an indicator of autistic traits within the subclinical group, therefore, relevant for research within this field.

The intention of the present study is to discover if performance differs in the emotion recognition task GERT-S in individuals with a moderate to high score of autistic traits, in addition to differences in males and females along the autistic continuum. Furthermore, investigate if they experience different levels of effort, both subjective and cognitive, while performing the GERT-S. Thus, the research question is as follows: *Do females and males with many autistic traits perform differently in an emotion recognition task, moreover, experience different levels of effort?*

Within this question, there are two main hypotheses, both pre-registered through The Open Science Framework (OSF; AsPredicted): (H1) There is a negative association between autistic traits (AQ) and performance in the GERT-S. (H2) The more autistic traits, the more effort the participant spends on the GERT-S. To further analyse this hypothesis, three sub-hypotheses are needed: (H2a) The more autistic traits, the longer the response time, (H2b) the more autistic traits, the more oxygenated blood in the frontal corticles, (H2c) the more autistic traits, the more subjective effort through the N-TLX. Findings for these hypotheses would contribute to the cognitive literature surrounding autistic traits and emotion recognition.

Methodology

The present study consisted of several self-report questionnaires, tests, and physiological measurements, conducted at a laboratory within the institute of psychology at the Norwegian University of Science and Technology (NTNU), thus, characterised as a laboratory study. Overview of the project, including time and language, in addition to all tasks and measurements employed in the study can be found on OSF (MethodsBA3; Parisi et. al., 2024). The present study is part of a Doctor of Philosophy (PhD) project; hence, more measurements and tasks in the overview than presented in this study. This part of the thesis will present the relevant tasks and measurements for the present study.

Participants

Sample

Participants for the present study were recruited through a convenience sample by the project's bachelor's students' friends, peers, and acquaintances. Altogether, the total sample size consists of 55 participants, N = 55, inclusive 29 females, n = 29, and 26 males, n = 26, within the ages 20 – 42, thus, a mean age of 24.6, M = 24.6. Descriptive statistics are included in Table 1.

Inclusion and exclusions

Inclusions

Criteria for participation were as follows: The participant had to be a native Norwegian speaker, in addition to fluent in English, between the ages of 18 and 50. Furthermore, a history of neurological disorders, including severe depression, epilepsy, or Parkinson's had to be absent. Additionally, an absence of brain diseases, tumours, or surgery were necessary for participation. Lastly, the participant had to have no current use of central nervous system medication, or drugs, and was urged not to consume caffeine at least two hours before testing.

Exclusions

Two participants did not meet the inclusion criteria. Additionally, one data was excluded from the GERT-S, due to the absence of Norwegian translation of the 14 emotions. Furthermore, 11 participants for brain activity within the frontal cortex were excluded, due to missing, or problematic data. For the project, one NIRScap was provided, thus, not suitable for all participants, resulting in a few exclusions of the cap during the testing, in addition to removing it after placement for participants experiencing pain, or discomfort. Furthermore, two cases of problematic data were reported, thus, excluded. One problematic data provided too poor signal for inclusion in the study, whereas the second had the NIRScap not placed correctly on the participant.

Table 1

Descriptive statistics

Variable	*N*	*M*	*SD*	*Skewness*
Age	55	24.72	4.37	2.08
AQ score	53	2.19	0.31	– 0.02
GERT score	54	26.96	4.43	– 0.14
GERT response time	54	5.36	1.78	1.00
Brain activity	44	4.60	2.30	0.91
Mental demand	54	52.28	20.75	– 0.25
Effort	54	52.23	22.23	– 0.38

Note. N = 55.

Exclusions in all the variables except age, due to messy, or problematic data.

Ethical considerations

The project was approved by the ethics committee at NTNU and registered by the knowledge sector's service provider (SIKT). Approvement from the Regional Committees for Medical and Health Research Ethics (REK), were not required for the present project, given that no sensitive medical, or health information was collected.

Before testing began, all participants were informed and aware of the possibility of exhaustion from the included tests before consenting to participation. Additionally, information about their right to withdraw from the study at any point were given, and anonymity was granted. Information was provided through both verbal communication and written documentation, and the participants confirmed their understanding of the testing verbally, prior to signing the consent form. All participants were given time to read the consent form before signing, prior testing.

Methods of measurements

This section will describe the methods of measurements within the present thesis. Descriptions have been formulated in collaboration with the bachelor students and supervisors on the project. Full description on measurements within the whole project can be found on OSF (MethodsBA3; Parisi et. al., 2024).

Autism-Spectrum Quotient-Short

The measure of autistic traits was calculated through a Norwegian translated version of the 28-item version of the AQ. The task requires the participants to report on 28 items divided into five factors of 'social skills', 'routine', 'switching' / 'attention, 'imagination', and 'numbers' / 'patterns'. Possible answers were given on a 4-point Likert-scale from 1 = "Definitely agree" to 4 = "Definitely disagree". 15 items were reverse scored, thus, 1 = "Definitely disagree" to 4 = "Definitely agree". Lowest possible score = 28, whereas highest possible score = 112, indicating levels of autistic traits; the higher score, the higher levels of autistic traits. Cronbach's alpha within the internal consistency of the original English version was, $\alpha = .77$. In the current study, $\alpha = .75$, $\omega = .74$. Although, clinically used, the AQ has not undergone psychometric evaluation for diagnostic screening, thus, a high score of autistic traits does not equal a clinical diagnosis (Ruzich et al., 2015).

Geneva emotion recognition task short version

The participants completed the English version of the GERT-S on Qualtrics (Qualtrics, Provo, UT), assessing emotion recognition ability, with a Norwegian translation of the 14 emotions on a physical piece of paper. The task incorporates the different domains of emotion information, linguistically, auditive, non-verbal and visual cues through body postures and facial expressions, through 42 brief video clips, each lasting between 1 to 3 seconds (Herba & Philips, 2004). The videos feature five male and female actors portraying 14 different emotions through facial expressions, gestures, and voice tone, depicted from their upper torso and face. In the videos, no words were spoken, however, the sounds made by the actors convey emotional nuances. The participants wore headphones to ensure clear, direct audio of the actors' noises. The 14 emotions are as follows: pride, anger, joy, irritation, amusement, disgust, pleasure, sadness, relief, despair, interest, fear, surprise, and anxiety. To watch the video clips of the actors, the participant had to press within the video frame, and could watch the clip only once, with exception of the practice trial videos, before selecting an emotional label from an emotion when presented on Qualtrics (Figure 1), with a physical copy of Norwegian translations on the desk (Figure 2). There was no time limit for responding, however, response times were recorded, and participants received feedback on the percentage of correct answers after completion of the whole task. Participants completed two practice trials before starting the recorded task. The point system consists of each correctly identified emotion = 1 point, while incorrect emotion = 0 points. The 42 videos of emotions to identify create a score range of 0 –

42, where higher scores indicate better ability in emotion recognition. In addition to measuring of total score and response time, activity in the prefrontal cortex (PFC) of the participants was recorded through fNIRS, resulting in the ability to measure cognitive effort during this task. Cronbach's alpha within the internal consistency of the original version of the GERT-S was, α = .80, α = .83 (Schlegel & Scherer, 2016).

Figure 1. Emotions presented in the GERT-S (English version).

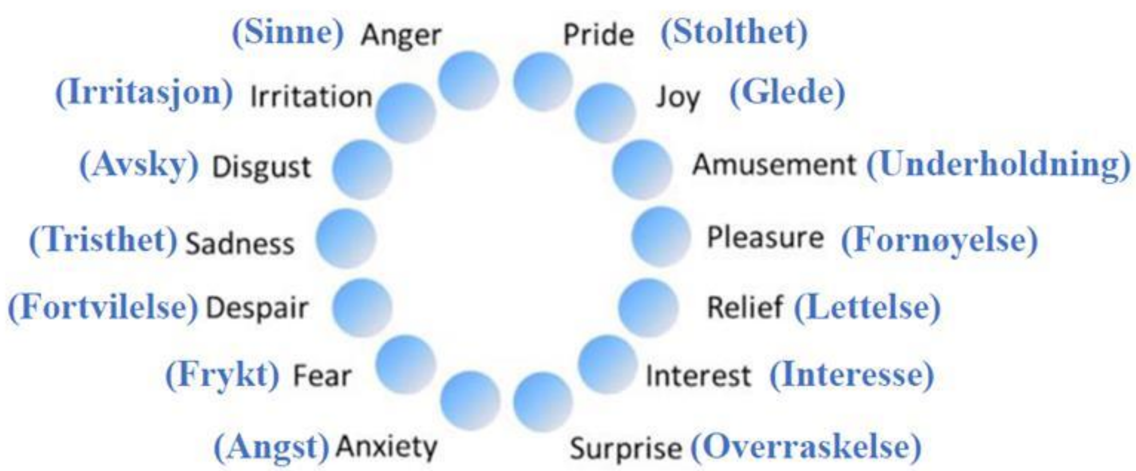

Figure 2. Emotions presented in the GERT-S (Norwegian translations).

NASA task load index

The participants were requested to fill a Norwegian translation of the N-TLX digitally, to report perceived workload of the GERT-S. The N-TLX was completed after the GERT-S on the Qualtrics (Qualtrics, Provo, UT). Six items were measured: mental demand, physical demand, temporal demand, effort, perceived performance, and frustration in relation to the task. The participant reported on six visual horizontal scales for each item, scoring from "very low" on the left end, to "very high" on the right end, with the ability to score freely between the two extremes. The present study and analyses will include two of these items: mental demand and effort. Mental demand indicates how much mental and perceptual activity, e.g. how much thinking, deciding, remembering, etc., was required by the participant during the task. A high score within the mental demand item indicates a subjective experience and feeling of mental effort. The item measuring effort within the N-TLX indicate how hard the participant had to work, both mentally and physically, to accomplish a satisfied performance. Within this, clarification for inclusion is required. Although, the item measuring effort are measures of physical effort, in addition to mental, the GERT-S is not considered a physical task. Thus, including this item of effort will in the present study act as an extension of the first item measuring mental demand. The subjective measures of effort within these variables will, therefore, measure mental and perceptual activity, in addition to how much effort the participant experienced to accomplish a satisfied performance. Higher scores within these items indicate a higher workload.

Functional near-infrared spectroscopy

The measure of objective effort was performed through fNIRS; a non-invasive neuroimaging technique that measure changes in blood oxygenation levels in the brain through near-infrared light, specifically concentration changes of oxygenated hemoglobin (HbO) and deoxygenated hemoglobin (HbR) in the blood vessels of the brain cortex. The present study measured PFC. Furthermore, the concentration changed of Hbo and HbR are used as an indirect estimations and indicators of neural activity (Rahman et al., 2020). The more activity, the more oxygen supplement within the active brain regions.

Prior to recording, the NIRScap was connected to a NIRSPort2/2.10 (NIRx, Orlando, United States), composed of 15 Short Distance Detector Probes covering the Prefrontal area. The NIRScap was placed on the participant following the instructions outlined in the NIRx manual. When correctly placed, signal optimisation routine was executed. Recording was manually enabled before starting the trial tasks within the GERT-S, and manually stopped after the participants had completed the task. No automatic triggers were included in this recording.

Analyses

An independent samples t-test was performed to investigate gender differences within the variables AQ score, GERTS-S score, mental demand, effort, brain activity and response time (Table 2). The results indicated no statistic significant difference between AQ score, GERT-S score, and gender, therefore, subsequent confirmatory analyses included AQ scores, GERT-S scored, response time during the GERT-S, max power in brain activity, mental demand through the N-TLX, and effort through the N-TLX (Table 3). The confirmatory analyses were performed through Kendall's Tau correlations, due to statistical significance within the Shapiro Wilk test. No mediation analysis was executed, due to the results from the t-test. The statistical analyses for the present study were executed through the computer software JASP, version 0.18.3 (Apple Silicon), provided by the JASP team (2024) at the University of Amsterdam.

Table 2

Individual samples t-test of the variable 'gender'

Variable	*t*	*df*	*p*	*Cohen's d*	*SE Cohen's d*
AQ score	0.93	51	.35	.26	.28
GERT score	0.31	52	.76	.08	.27
Mental demand	2.06	52	.05	.56	.28
Effort	2.78	52	.01	.76	.29
Brain activity	– 0.93	42	.36	– .28	.30
Response time	– 0.40	52	.69	– .11	.27

Note. N = 55.

Student's t-test.

Table 3

Kendall's Tau Correlations

Variable	1	2	3	4	5	6	7
1. Gender	—						
2. AQ score	– .12	—					
3. GERT score	– .02	– .20*	—				
4. GERT response time	.05	.02	.02	—			
5. Brain activity	.12	– .12	.10	.15	—		
6. Mental demand	– .23*	.16	– .04	.02	– .08	—	
7. Effort	– .32**	.14	– .07	.07	– .10	.60***	—

*$p < .05$

**$p < .01$

***$p < .001$

Note. N = 55.

95% Cl., Kendall's Tau B (correlation coefficient).

Results

To investigate the gender aspect of the thesis research question, an independent two-tailed student's t-test was executed as an exploratory analysis. Firstly, the difference in autistic traits score, n = 53, between females, n = 27, and males, n = 26, was investigated. The results showed no statistical significant difference between scored of autistic traits, $t(51) = 0.93$, p = .36. However, the analysis revealed that females, M = 2.23, SD = 0.30, scored on average higher than males M = 2.15, SD = 0.31. Although, a small difference with low effect size, d = .26, it contradicts expectations prior to the analysis, expecting males to score notably higher than females.

Furthermore, an investigation of difference in performance in the GERT-S, n = 54, between females, n = 28, and males, n = 26, was completed from the same independent two-tailed student's t-test. Results showed no statistical significant difference with low effect size, $t(52) = 0.31$, p = .08, d = .08. However, females had on average a higher score within emotion recognition, M = 27.14, SD = 4.22, than males M = 26.77, SD = 4.72.

Differences in objective effort in females and males were investigated through an independent two-tailed student's t-test. Results showed no statistical significant difference in response time, n = 52, between females, n = 28, M = 5.27, SD = 1.80, and males, n = 26, M = 5.46, SD = 1.79, with low effect size, $t(52) = -0.40$, p = .69, d =-.11. Furthermore, no statistical significant difference in brain activity, n = 44, between females, n = 22, M = 4.18, SD = 2.88, and males, n = 22, M = 5.01, SD = 3.10, $t(42) = -0.93$, p = .36, d = -.28.

Lastly, an investigation of differences within females, n = 28, and males, n = 26, in subjective experience of effort, n = 54, when completing an emotion recognition task, was completed with an independent two-tailed student's t-test. A statistical significant difference was observed in report of mental demand, $t(52) = 2.06$, $p < .05$, indicating a subjective experience of mental demand being more prominent in females, M = 57.71, SD = 20.38, than in males *M* = 46.42, *SD* = 3.90. Cohen's d indicates a moderate effect size, *d* = .56, therefore, a noticeable difference. Furthermore, a statistical significant difference between the subjective feeling of effort between males and females was observed, $t(52) = 2.78$, $p < .01$, indicating a subjective feeling of effort being more prominent in females, *M* = 59.93, *SD* = 22.25, than in males, *M* = 44.07, *SD* = 19.44. Cohen's d indicates a large effect size, *d* = .78, indicating a statistically significant difference between males and females, and subjective feeling of effort.

For the correlation analyses, a Kendall's tau-b correlation analysis was performed, investigating the relationship between autistic traits and performance in the GERT-S, *n* = 54, a statistically significant negative correlation was observed, $\tau_b = -.20$, $p < .05$. This observation indicates that the higher the score of autistic traits, the poorer performance in the GERT-S, confirming the first hypothesis of the thesis.

A new Kendall's tau-b correlation analysis with a sample size of 54, *n* = 54, was executed, investigating the relationship between autistic traits and response time in the GERT-S. Results were not statistically significant, $\tau_b = .02$, $p = .85$, thus, contradicting the hypothesis, H2a, of a positive correlation between higher autistic traits and longer response time.

To further investigate the second hypothesis, H2, regarding higher autistic traits are associated with more effort, a Kendall's tau-b correlation analysis was executed with a sample size of 44, *n* = 44. In this analysis, the relationship between autistic traits and brain activity, specifically, the prefrontal cortex, was investigated. The results were not statistically significant, $\tau_b = .12$, $p = .26$, displaying no indication of higher brain activity within individuals with a high score of autistic traits.

An investigation of the relationship between subjective effort and autistic traits was investigated through a Kendall's tau-b correlation analysis with a sample size of 52, *n* = 52. No statistically significant result was observed in the correlation between mental demand and autistic traits, $\tau\_b = .16$, $p = .10$. Furthermore, no significant result was observed in the correlation between effort and autistic traits, $\tau\_b = .14$, $p = .14$.

The results both confirm and contradict the hypotheses presented within the thesis. The first analysis confirms the hypothesis that individuals with a high score of autistic traits perform poorer in the GERT-S. However, no statistically significant difference in effort between individuals with a high score of autistic traits, and individuals with a low score, contradicting the second hypothesis.

Discussion

Assessment of the results

The first hypothesis of the present study stated that there is a negative association between autistic traits and performance in the emotion recognition task, indicating that a high score in autistic traits reduce the performance in the GERT-S. The results from the performed Kendall's tau-b correlation analysis confirmed this hypothesis, indicating that participants with a high score of autistic traits perform below average in the ability to recognise emotions, further, indicating deficits within this ability. It is important to note that the results only suggest an association between the two variables, not a causation. Different factors may have been a contribution to these findings.

The second hypothesis stated that the more autistic traits, the more effort the participant spends on the GERT-S. Here, three sub-hypotheses were presented to include all three measurable aspects of effort within this study: response time, oxygenated blood in the frontal corticles, and subjective feeling of effort. The analyses of these hypotheses were all performed by employing Kendall's tau-b correlations; however, no statistically significant result was observed, contradicting the second hypothesis.

Results from these analyses indicate that, although a high score of autistic traits is negatively associated with the ability to recognise emotions, no substantial effort in the participants with a high score of autistic traits, compared to participants with an average score, was recorded. The exploratory analysis of differences in males and females, executed through an independent samples t-test, displayed a statistically significant difference in self-report of subjective effort. The analysis revealed a statistical insignificance in difference in score of autistic traits, yet revealed females to score on average higher than males in the AQ. Although not statistically significant, it contradicts earlier expectations of males scoring higher than females, due to the stereotypical ‘male brain’ being closer to the autistic profile than the stereotypical ‘female brain’, according to the EMB theory (Baron-Cohen, 2002).

In conclusion, the results indicate a negative association between autistic traits and emotion recognition, without require of substantial cognitive effort. However, females report statistically significantly higher on subjective effort when performing the emotion recognition task compared to males, although, no objective reports of this in addition to no difference in total scores in the GERT-S. Additionally, there were no statistically significant difference in autistic traits between the genders, however, females had a slightly higher average score. Regardless of the statistical insignificance in the average scores in the AQ, the results are noteworthy and appealing for further exploration in the discussion.

In consideration of earlier literature

The DSM-5 and ICD-11 both include deficits in social abilities, including emotion recognition, as one of the core characteristics and diagnostic criteria for ASD (American Psychiatric Association, 2013; World Health Organisation, 2024). Despite a non-clinical population within the present study, the confirmation of a negative association between autistic traits and performance in the emotion recognition task, are compatible with these characteristics. However, these presumed deficits did not contribute to substantial cognitive effort when completing the GERT-S, contributing to the inconsistent empirical findings of autistic traits and effort in emotion recognition. The moderate score of autistic traits in the sample may have been a contributing factor to the statistically insignificant findings in this aspect of the presented study. With a sample consisting of clinically diagnosed individuals, or individuals with a high score of autistic traits on a subclinical level, results may have been different. Nevertheless, studies showcase an inconsistency in this field, both clinically and subclinically (Ashwin et al., 2007; Durand et. al., 2007; Harms et al., 2010; Herba & Philips, 2004; Kennedy & Adolphs, 2012).

The difference in autistic scores between males and females in the present study are statistically insignificant. However, the average score in both the genders were revealed to be above '2', indicating a moderate score of autistic traits in the sample. The EMB theory assert that the defining characteristics of autistic traits align with the features of an exaggerated version of the stereotypical 'male brain'. This approach suggest that autistic traits share similarities with the typical description of the average male, contrary to the stereotypical 'female brain'; thus, the average female who is associated with higher levels of empathy and mentalisation (Baron-Cohen, 2002). According to this, a moderate score of autistic traits indicates analytic behaviour in the sample, i.e. an indication of a higher frequency of the stereotypical 'male brain' in both males and females in the sample of the present study. The statistically insignificant difference in the GERT-S scores support this indication and, furthermore, acknowledges the statistically insignificant difference in the scores of autistic traits. An observation of both males and females in the sample exhibiting analytical behaviour prior to empathic behaviour, was unexpected in corollary to the EMB theory. However, it logically explains the statistic insignificance in the GERT-S score.

Studies suggest a potential for compensatory mechanisms camouflaging specific deficits, including social deficits, in individuals with autistic traits on the clinical- and subclinical spectrum (Livingston et al., 2020). Deficits in emotion recognition, moreover, potential compensatory mechanisms, can arguably contribute to more effort within social interactions for these individuals. The results from the present study showcase no statistical significance in objective effort, response time, and brain activity, countering this hypothesis. Considering the EMB theory and the expectancy of greater skill in emotion recognition in females, one could argue that females with autistic traits may experience a substantial amount of effort, more than males, to exhibit characteristics of a neurotypical female. The t-test results contradict this hypothesis, showcasing no difference in recorded objective effort between males and females, with, or without a moderate to high score of autistic traits. Moreover, results indicate a higher experience of cognitive effort in males than females. Although a statistically insignificant observation, it creates an interesting discussion point upon reflection of the EMB theory and other results from the analyses. Despite statistically insignificant results in difference in objective effort, there was a statistical significance between males and females in reports of subjective feeling of mental demand and effort in the GERT-S, with females reporting more than males. These results are comparable with earlier findings, specifically the study performed by Löffler and Greitemeyer (2021) who reported similar results in a non-clinical population, measuring empathy. The reports suggested no objective difference in empathic skills between males and females. However, females self-reported stronger empathetic responses than men.

Stereotypes and social expectations: A psychosocial perspective

The theoretical background in this thesis has primarily been emphasising on neurological explanations for autistic traits, in corollary to the neurodevelopmental categorisation of the disorder itself. However, the sample in the present study is not on the clinical spectrum. Furthermore, the results indicate no neurological explanations as contributing factors for the findings in this study. Although, the correlation analysis revealed a statistically significant negative association between autistic traits and performance in the GERT-S, the neurological investigations showed no statistical significance. Despite the absence of objective evidence of substantial effort, females reported higher subjective feeling of mental demand and effort. This indicates a potential of additional factors that might contribute to these subjective reports. Therefore, potential contributing factors should be considered.

A psychosocial perspective may be a more prominent explanation to the findings in the present study. The results indicate moderate autistic traits with no neurological explanations within the sample, regardless of gender, yet difference in experience of mental demand and effort in the GERT-S. The EMB theory argue these findings to be a result of systematic and analytic neurological routes, which is not a prominent characteristic in females, therefore, a difference in subjective feeling of effort. However, this does not explain the differences in observed objective effort. Perceiving this theory from a psychosocial perspective, rather than the neurodevelopmental perspective it is meant to represent, the EMB theory itself, and its contribution to stereotypical gender-norm expectations, can arguably be seen as a contributing factor to the statistically significant difference in subjective feeling of effort. Therefore, upon reflection of the reported results, in addition to the EMB theory, critically evaluating the EMB theory and its validity may be beneficial and necessary for future research.

Studies indicate pattern of later diagnosis in young girls, furthermore, misdiagnosis, due to the absence of behavioural indications of autistic traits in correspondence to the stereotypical autistic profile and the ‘male brain’: analytic behaviour prior to empathetic understanding of others, strict rule following, strong interests, etc. (Posserud & Lundervold, 2013). However, studies further suggest different autistic phenotypes, that is, different presentations of autistic traits (Lai, 2011, Moseley et al., 2018). The diagnostic manuals preside a criterion of symptoms in developmental years. Without meeting this criterion, a diagnosis cannot be made. Therefore, young girls do experience these autistic traits, however, they may portray them differently than boys. The potential of different portrayal of autistic traits may be the reason most girls are diagnosed in late adolescent years, or adulthood, by seeing their social deficits and other autistic traits in retrospect, rather than in the present of childhood.

The sample in the present study are closer to the subclinical spectrum in the general population, however, the suggestion of different autistic phenotypes is still a relevant proposition, due to the nature of these phenotypes. The EMB theory explain it vastly accurately: females are *supposed* to be empathetic and understanding of other people's feelings, and males are *supposed* to be analytical and see the world through rules. Gender, and the stereotypes surrounding gender, is one of the most salient, socially constructed concepts throughout all social communities, and the awareness surrounding these develops early in childhood (King et al., 2021). Children learn from an early age what is acceptable behaviour for their assigned gender, moreover, what characteristics are expected from them. However, as children mature, they begin to understand that the concept of gender, in addition to their associated characteristics and stereotypes, are fluid concepts; a spectrum to fluctuate within. Complementary to the continuous improvement in the ability to recognise and understand more complex emotions through childhood and adolescence (Durand et al., 2007; Herba & Philips, 2004). However, it is important to emphasise cultural context when discussing the experience of gender binary, diversity and expected stereotypical gender norms due to the diversity of this across cultures (Vincent & Manzano, 2017). Nevertheless, the EMB theory is precise in a gender binary perspective when defining the characteristics of autistic traits. One of these autistic traits is an obligation to follow rules, which may lead to a polarised view of right and wrong. The neurotypical development from a binary perspective to a perspective emphasising nuances and diverse interpretation can, therefore, arguably be difficult for these individuals. In a clinical population, such challenges might be detectable through neurological investigations. However, individuals on the subclinical spectrum in the general population might display these difficulties primarily on a subconscious level, contributing to a substantial feeling of subjective effort within social deficits.

Females are often expected to excel in emotion recognition, and demonstrate greater emotional understanding, in addition to greater mentalisation skills. Consequently, females with autistic traits may subconsciously internalise emotional or behavioural problems to portray neurotypical, which may contribute to misdiagnosis or diagnosis in later life (Calderoni, 2022; Posserud & Lundervold, 2013). Theories like the EMB theory by Baron-Cohen reinforce stereotypical gender norms, further, incorporate these into diagnostic criteria. Consequently, the EMB theory can arguably be perceived as a prominent contribution to the skewness in the male-to-female ratio within the autistic spectrum, promoting a gender-biased interpretation of ASD and autistic traits (Krahn & Fenton, 2012). Therefore, further research on different phenotypes of autistic traits, primarily autistic traits in females, may be crucial for our understanding of ASD and autistic traits in both the clinical- and subclinical population. Moreover, it is essential for the well-being of neurodivergent females.

In summary, a negative association between autistic traits and emotion recognition is expected, due to the clinical characteristics of social deficits. However, females reporting subjective feelings of mental demand and effort, more than males, can arguably be a consequence of the expectations for prestation from society; stereotypical gender-norms. Children learn from a young age what is expected from them, subconsciously integrating social expectations in most of their performance. Consequently, females may experience a subjective feeling of mental demand and effort more than males. Moreover, females with autistic traits may experience these subconscious expectations more than females without, due to deficits within the ability to read nuances in everyday life. Gender-norms and social expectations are unwritten rules learned from an early age, rules that females with autistic traits feel an obligation to follow, therefore, report a substantial feeling of mental demand and effort more than males, despite no objective indications of this, nor statistically significant differences in emotion recognition score.

Strengths and limitations

The present study aimed to discover differences in emotion recognition in individuals with autistic traits, further contribute to this scientific field within psychology. The study was performed in a controlled environment, creating consistency in the performance of the study, particularly, creating consistency in the sound and view of the GERT-S for all participants. Furthermore, participants were placed in a private room without significant disturbances while performing the tasks and questionnaires, whereas two bachelor students were always present in the adjacent room. Although participants were recruited by the students in the project, the bachelor students were instructed to avoid administering tests to participants of close personal relationships. The participants were informed about the study before agreeing to participate and given a consent form to review and sign prior to testing. Additionally, the participants were informed about their right to withdraw from the study at any point. Participation in the study was voluntary, and the confidentiality and anonymity of the participants were granted. The tests and measurements did not collect sensitive health information about the participants. However, certain limitations within the measurements, contributing to exclusions and potentially unreliable data, should be addressed.

Firstly, the sample consist of individuals from the general population. Therefore, despite autistic relevance, the results give limited disclosure to the clinical population. Autistic traits were measured by the AQ-short (Hoekstra et al., 2011), and although, good internal consistency, the questionnaire was designed to be descriptive, rather than diagnostic (Ruzich et al., 2015). Furthermore, the description of autistic traits in the AQ is more related to the male phenotype of autistic traits, and the stereotypical 'male brain', rather than the female phenotype. However, this did not affect the results in the present study as expected.

Nevertheless, there is a potential limitation for the measure of autistic traits. Further research within this field should consider a different and more neutral method of measurement to the phenotypes on the autistic spectrum. Moreover, the AQ is considered a self-report, due to the participants reporting subjectively to the presented questions. Therefore, the reliability of the questionnaire may be impaired due the potential of response bias; thus, misrepresentation of autistic traits in the participants. This could be accomplished through either dishonesty or by presenting a more favourable image of themselves while preforming in the AQ. The potential of deficits within reliability is a relevant limitation in all self-report measurements in the study, thus, including the AQ and N-TLX.

Secondly, the sample was initiated by a convenience sampling, primarily friends and acquaintances of the project's bachelor students. Therefore, results may not be an accurate representation of the general population. However, the variety of the sample, in addition to the inclusion criteria, can arguably be seen as a compensation for this. Regardless of a convenience sample of friends and acquaintances, the results are coherent to earlier theories and research in the subclinical- and clinical field, indicating a relevance and representation to the general population.

The last limitation of the present study is the use of fNIRS. Although, a valuable and affective measuring technique for blood oxygenation levels in the brain, the technology of near-infrared light has its limitations and potential biases. One notable limitation of the method is differences in signal optimisation and performance affected by skin pigmentations and hair texture. The accuracy of the fNIRS may be affected by this due to better signal in individuals with lighter skin and thinner hair than individuals with dark pigmented skin and thicker hair. In addition, the provided NIRScap used in the current study came in a single size, creating discomfort for participants with lager head sizes. These limitations created potential exclusions for the data, resulting in an exclusion of 11 participants from the total sample.

Implications for practical use and further research

The results from this thesis contribute to the previous indications of a subclinical population with autistic traits, in addition to previous suggestions of different autistic phenotypes. Moreover, the results are coherent with the inconsistency in this field, suggesting changes within measurements or procedure are necessary. Further research in this field should consider different measurements, primarily in measuring autistic traits. Presenting a study with a focal point on gender-norm expectations and how these expectations are experienced by females with autistic traits, whether they experience this consciously, or subconsciously, in an emotion recognition task, can contribute to a better understanding of the female autistic phenotype. This is important to emphasise due to the skewness of the male-to-female ratio among children diagnosed with ASD (Corbett et al., 2020; Kim et al., 2011; Moseley et al., 2018; Posserud & Lundervold, 2013).

Conclusion

The aim for the present study was to investigate differences in emotion recognition in males and females with autistic traits on a subclinical level, moreover, differences in objective and subjective feeling of effort. Some of the results were unexpected in light of the EMB theory. There was no statistical significance in differences between male and females in the ability to recognise emotions, in addition to no difference between objective effort. However, females reported a subjective feeling of mental demand and effort statistically significant more than males. Reflection upon the results, in addition to the presented theoretical background of the thesis, created a discussion emphasising on stereotypical gender norms and social expectations in both a clinical and non-clinical perspective, contributing to these results. This was further discussed to be a potential contribution to the skewness of the male-to-female ratio on the autistic spectrum, in coherence with similar critics in this field (Calderoni, 2022; Krahn & Fenton, 2012; Posserud & Lundervold, 2013). Although, the present study is not a clinical study, the results' indications can contribute to succeeding research within this field, particularly as a critical perspective of the EMB theory. Further investigation of the studies hypotheses would, therefore, be intriguing in a clinical population, moreover, how gender-norm expectations and expectations of stereotypical behaviour affect the well-being of females diagnosed with ASD.

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