UNIVERSITY OF LINCOLN

A comparative investigation of face and body emotion recognition: the role of autism, individual differences, task characteristics, and actors' emotion expression ability

Candidate: Andrei Zarie

Supervisors: Assoc. Prof. Petra M. J. Pollux, Prof. Kun Guo

A thesis submitted in partial fulfilment of the requirements of the University of Lincoln for the degree of Doctor of Philosophy

School of Psychology, Sport Science, and Wellbeing,

College of Health and Science

June 2025

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Acknowledgements

I am glad to finally be able to formally express my gratitude and recognition for my main supervisor and friend, Assoc. Prof. Petra M. J. Pollux, who has put up with my shenanigans for about 9 years through a part-time MSc and PhD. I would not have even imagined embarking on this crazy ride if it wasn't for you dragging my potential out by force! Honoured to be your last student, and I hope that I haven't driven you out of supervising with my strange work ethic! My sincere gratitude to my initial second supervisor, Dr. Louise O'Hare, who has taught me some of the craziest technical skills I have acquired in my whole time in academia, and has equipped me with the know-how of creating cognitive tests. I extend my thanks to Prof. Kun Guo, who became my second supervisor mid-way through a chaotic project, and has guided me in perfecting my emotion recognition tests with his world-class expertise, all whilst renewing my passion and curiosity for the field.

Warmest thanks to my research collaborator and friend Assoc. Prof. Niko Kargas, who has mentored me as a supervisor, despite not being on the supervisory team for this PhD thesis. Niko has worked with me on more than 60% of the research involved in this thesis, introduced me to the field of autism studies, and offered me wide-reaching research opportunities inside and outside the PhD project. Special thanks to Assoc. Prof. Andrea Pavan and Dr. Frouke Hermens for showing me the ropes of programming in statistics and experiment building; your excellent teaching has led to me ultimately learning 3 programming languages to a fluent level, currently learning others, and using them in all my research, as well as tutoring others in programming skills.

The data collection involved in this thesis was a massive collaborative effort, involving many experimenters, actors, and participants. I want to extend thanks to all students that have collected data for my project as part of their dissertation theses and module assessments. I am grateful to all participants for taking interest in this project across various platforms; I hope your efforts have a long-standing impact! To all the actors that have allowed me to film their emotions, I am sorry that I can't name you for ethical reasons, but the value of your contributions is inestimable! Special thanks to Dr. Charlotte Cartledge and Dr. Lynn Pickerell for organising the Summer Scientist Weeks,

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

as well as for all parents and children who offered their valuable contributions to psychological research in these events.

I want to thank all my PhD student colleagues for their advice and help throughout the years, both the current and the future doctors: Lizzie, Heather, Kat, Greg, Charlotte, Lynn, Tibi, Patrycja, Polly, Matt, David, Lauren, Tom, Khaled, Alessandro, Claire, Jamie, Joe, and Lorena.

After all that I have learned in these past six years and a half, especially as an associate lecturer and teaching assistant, I feel that I need to thank two very important educators from my past. I would like to thank Prof. Andrei C. Miu for passing onto me the love for affective science, and his passion for research and teaching in general. I also need to thank my primary school teacher, Mrs. Ica Surulescu, a person without whom I would have never made it so far in education. She has instilled a great work ethic, discipline, and self-efficacy in an otherwise chaotic and not very conscientious pupil.

Finally, I need to thank the PhD project itself, as I believe it has a life of its own at this point. I need to thank you, dear PhD programme, for giving me the chance to meet my lovely fiancée, and soon to be mother of my children, Hannah Dempsey! Thank you, Hannah, for putting up with my long days of writing, constant delays, trips together missed due to work, and thank you for supporting me throughout the past 4 years! Hannah has also been the first actor that I filmed emotion expressions with, and has helped me with proofreading, research, and writing advice throughout the project. I could not have done this without you!

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Abstract

Most past research conducted on the ability to recognise emotional cues involved the use of facial expressions. More than 50 years of research have untangled what clinical and non-clinical traits and what demographic characteristics are associated with facial emotion recognition. Additionally, the effect of task characteristics that impact emotion recognition scores is well known for facial expressions, such as the type of test used (e.g., forced choice categorisation, matching, free labelling), the use of videos or images, the types of emotions portrayed, or the types of actors depicting the emotions. Much less is known about how people recognise bodily expressions of emotion, despite their importance being known for decades. This thesis aimed to explore if known correlates of facial expression recognition apply to recognising body expressions, as well as what task characteristics affect the two types of emotion recognition. In addition, the present thesis compared the recognition of emotions expressed by the same actors via faces and bodies, all while controlling for individual differences in both recognisers (participants) and expressers (actors).

The present PhD project contributes to emotion recognition methodology by creating two emotion expression stimulus sets: a first set containing four volunteer actors recruited via convenience sampling, and a second set composed of 16 paid actors whose autism, personality traits, and demographics have been measured. The two sets have been used in three large-sample studies to investigate face and body emotion recognition comparatively: assess relationships with autism, personality traits, age, and gender, investigate motion differences, and explore the effect of actor individual differences. The studies also measured different aspects of emotion recognition, such as accuracy, speed, confidence, and intensity.

The studies found that using videos instead of images improves emotion recognition scores, but this dynamic advantage is larger for bodies than faces. Emotion recognition was associated with cognitive and affective empathy, alexithymia, state and trait anxiety, age, gender, and autism, although correlates were different depending on modality and measure of emotion recognition. There were small differences between autistic adults that were explained by variation in alexithymia, anxiety, or empathy; for

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

accuracy, there were only differences in body expression recognition. In children, the differences in body expression accuracy were not explained by age or personality traits. Children up to the age of 11 had lower emotion recognition accuracy than young adults and older adults. There were small declines in accuracy, speed, and confidence associated with aging, but only when the emotion recognition task was more difficult. All studies uncovered a high variety of emotion recognition differences when comparing the stimuli from different actors, with differences between bodies and faces, and between all basic emotions. The final study discovered a strong association between the emotion expression ability of actors and their alexithymia, autism-like traits, and trait anxiety.

Implications for the double empathy problem, the alexithymia hypothesis of autism, the shared network hypothesis, and embodied simulation models are discussed. The thesis highlights the crucial differences between facial and bodily emotion recognition and encourages the measurement of both types in future research.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Table of contents

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Chapter 1 – General introduction

The main objective of this thesis is to investigate differences between the ability to recognise emotion expressions in faces and bodies, and explore relationships between these abilities and demographic characteristics, personality traits, and autism. This chapter will define the concept of emotion recognition and the way it is measured, discuss the importance of body expressions, and briefly outline psychological constructs related to emotion recognition. Finally, the overall aims of the thesis will be outlined. Detailed literature reviews on the relationships between face and body emotion recognition and psychological constructs of interest, along with specific research questions and hypotheses, can be found in the introductions of each study that is part of this project. The first study explores a variety of correlates of emotion recognition, whilst the second and third studies will focus more on autism research questions.

1.1 Emotion recognition ability

The ability to perceive and accurately recognise emotions in non-verbal expressions is a core part of human social functioning. Emotion recognition (ER) is related to a wide variety of psychosocial wellbeing outcomes and traits (Bänziger, 2016). ER is associated with good general social functioning (Morningstar et al., 2018). More specifically, ER plays a role in relationship well-being (Carton et al., 1999), intercultural adjustment (Yoo et al., 2006), and marital satisfaction (Blonder et al., 2012). In children, ER is associated with popularity (Boyatzis & Satyaprasad, 1994) and social competence (Philippot & Feldman, 1990; Maxim & Nowicki, 2003). ER is also important for psychological well-being. For example, it is positively associated with self-esteem in both healthy (Rey, Extremera, & Pena, 2011) and clinical populations (Wells et al., 2020), and negatively associated with anti-social behaviour (Marsh & Blair, 2008), depression (Dalili et al., 2015), and state anxiety (Attwood et al., 2017). ER can also be related to workplace outcomes, with some studies finding indirect relationships with annual income (Momm et al., 2015), and partial relationships with job performance

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

(Doucet et al., 2016), albeit mostly in professions where interpersonal skills are essential (Elfenbein et al., 2007).

ER is broadly defined as the process of identifying what emotion another organism is feeling. In the psychological literature, ER takes a more specific definition, referring to the social-cognitive process of identifying another organism's emotional state based on their non-verbal behaviour (Ferretti & Papaleo, 2019). ER is considered to be an automatic, fast (<1s), and innate process (Pizzagalli, Regard, & Lehmann, 1999). Analogously, emotion expressions (EEs) are defined as nonverbal, often automatic and unconscious movements executed with the purpose of conveying an emotional state to another social actor (Ekman & Cordaro, 2011). ERA is distinct from the concept of Theory of Mind (Buitelaar et al., 1999; Schlinger, 2009), despite some studies using the terms interchangeably (see Oakley et al., 2016 for an example of an ER test that has been interpreted as a ToM test).

There are two prominent theoretical models (and methodological paradigms) of EEs and ER: the basic emotions theory and dimensional models of emotion. The basic emotions theory (BET) contours the existence of basic emotions: fundamental affective states that are innate, evolutionarily fundamental, neurally hardcoded, universal across human cultures, and each having a distinct EE (Ekman, 1992). Most of the proposed basic emotions have also been noted in many non-human animals both historically (Darwin, 1872) and more recently (Bradshaw & Cameron-Beaumont, 2000; Brosnan & de Waal, 2003; Range et al., 2009; Kaminski et al., 2017). The classical set of basic emotions proposed by Ekman (1992) is: anger, disgust, fear, joy (happiness), sadness and surprise. Dimensional models of emotion describe emotions, as well as emotion expressions, using various combinations of continuua, ranging from 2D models (valence – arousal; Russell, 1980) to 5D models (novelty – intrinsic pleasantness – goal significance – coping potential – norm compatibility; Scherer, 2009). Whilst the BET and dimensional models are not necessarily in contradiction (basic emotions can be described using various dimensions (e.g., anger has negative valence and high arousal), they have distinct assumptions about how emotions arise and, most importantly for the present thesis, how they are expressed. BET posits that EE are distinct categories that are hardwired, whereas dimensional models consider EE to also be on a spectrum

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

defined by different dimensions, and emphasise the varied intensity of EE (e.g., frustration frown vs. enraged shouting, both expressions of anger). Modern research tends to accept both paradigms, integrating them for a more nuanced understanding of emotion (Eerola & Vuoskoski, 2011; Hamann, 2012). In line with such integrative efforts, the present project, despite focusing on measuring the recognition of the classic six basic emotions, makes the effort of taking into consideration some aspects of dimensional models, such as intensity (arousal) and allowing subjective variation of basic emotions on other dimensions. Specific details will be outlined in later chapters.

Although ER and emotion perception are sometimes used interchangeably (e.g., Neal & Chartrand, 2011), they are distinct constructs. Emotion perception refers to the detection of emotion cues and the discrimination of them from non-emotional cues (Schirmer & Adolphs, 2017). Typical emotion perception research involves the presentation of emotional stimuli and the measurement of brain activity (i.e., neuroimaging and electrophysiology) or subjective experience (e.g., asking participants to indicate when they see an emotion). ER is a more complex process of differentiating the qualities of emotional signals by labelling and/or categorising them into various types or different degrees of affect (e.g., discriminating between rage and irritation; Bänziger, 2014). ER will be the main focus of this thesis.

ER is a latent construct with various operationalisations. It is usually referred to as a skill – emotion recognition ability (ERA), but can also be measured with self-report methods measuring beliefs about one's self-efficacy in ER (Kirk et al., 2008). This project aims to investigate mainly ERA as a social-cognitive skill. There are two main measures of ERA typically investigated in the literature: accuracy and speed. Emotion recognition speed (ERS) is operationalised as the time it takes a participant to make an emotion categorisation after viewing a trial, often referred to as response time. Speed is a less valid measure of ERA, as differences in response times could be due to lower ERA, or other factors, such as attentional capacity, task characteristics or task strategies (Georgopoulos et al., 2022). In computerised experiments, speed can also be impacted by hardware variations (Plant et al., 2003; Reimers & Stewart, 2015). For the purposes of this project, ER accuracy (i.e., number/percentage of correct categorisations; Bänziger, 2016) will be referred to as ERA, but ERS will also be

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

investigated as it can be a relevant ER construct, especially when accuracy – response time trade-offs are computed (Kliemann et al., 2013). Emotion recognition confidence (ERC) will also be measured throughout the project. ERC, in contrast to ER self-efficacy, represents a self-rating of confidence after making an ER choice. It is distinct from ERA as a measure of ER-related metacognition (Begue et al., 2019), but people's confidence tends to match their accuracy (Sinvani & Fogel-Grinvald, 2024). Finally, emotion recognition intensity (ERI) will also be investigated in some parts of the project. ERI simply represents a self-report rating after each emotion stimulus, asking participants how intense they thought the depicted emotion was. Although it could be constrained as an emotion perception concept, it can be related to ERA (e.g., Barsnikov et al., 2021). In summary, this project focuses on ERA (operationalised as accuracy), but will also investigate ERS, ERC, and ERI as secondary objectives.

There are three modalities by which emotions can be expressed non-verbally: facial expressions, vocal expressions, and body expressions. Facial expressions refer to activation of facial muscles to form various meaningful discrete configurations. They have been studied extensively using pictures of human faces (Ekman, 1976). Vocal expressions are defined as the prosody of speech and non-speech vocalisations. They are most commonly studied using nonsense words and sentences in order to observe the differences in emotional vocal perception, without the interference of meaning that can introduce unsystematic variance (Bachorowski & Owren, 2008). Body expressions consist of body posture, general postural changes, and relevant specific body movements executed together to convey emotion (i.e., gestures). Body expression stimuli consist of images or videos that show an entire human body (De Gelder & Hadjikhani, 2006). Some research has used a special type of body expression stimuli – point-light displays (PLDs; Atkinson et al., 2004), which are composed of points (moving or static) organised in patterns similar to a human doing a certain action or expression. There is a distinction between body expressions where the face is blurred or masked in order to remove facial expression information, and body expressions that also contain the face – bimodal expressions. Throughout this thesis, the former will be referred to as "body expressions", and the latter as "face-body expressions". Researchers have also attempted to measure emotion recognition in a multimodal fashion, by using stimuli

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

containing information from all three modalities (Bänziger, Grandjean, & Scherer, 2009). The present thesis focuses on visual ER: face emotion recognition (fER) and body emotion recognition (bER), but research on vocal emotion recognition (vER) will also be reviewed for a more nuanced picture of the field.

1.2 Body expressions of emotion

Historically, most research conducted on ERA, as well as most of the tests developed, used facial expression stimuli. This paradigm stemmed from the cornerstone research by Ekman and collaborators on universal expressions (Ekman & Friesen, 1969; Ekman & Friesen, 1971) and has spurred much interest in the study of emotion recognition in the past 50 years, with hundreds of studies conducted on the topic (De Gelder, 2009). Vocal expressions of emotion have been receiving increased attention, and there is now a significant body of research on the topic, especially bimodal studies with facial and vocal expressions (Bachorowski & Owren, 2008). The ability to recognise body expressions (bERA) is the least studied ERA in the triad, with studies starting to examine the specifics of body expression perception mostly in the last two decades (De Gelder, 2009). Although body EE stimuli have been developed around the same time as facial EEs (Rosenthal et al., 1979), there has not been much bERA research conducted until more recently, starting with the work of Atkinson et al. (2004) and De Gelder and colleagues (Meeren et al., 2005; De Gelder, 2006). In this subchapter, research on body expression perception and bER will be reviewed, and discussed in contrast to fER.

Most of the research, especially in the early stages of body expression research at the beginning of the century, has focused on the perception of bodies, rather than the ability to accurately recognise body expressions and the implications of this ability. fMRI and ERP studies have determined that body expressions are perceptible and have a clear neural basis that is similar to facial expressions, with some significant differences (for reviews of neuroscientific findings, see Tamietto & De Gelder, 2010; De Gelder et al., 2015). In order to maintain the focus on ERA rather than on perception, this literature review will focus on studies where behavioural measures of ability have been employed: measures of accuracy and/or speed. However, there are a number of ERP

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

studies where a bER task has been employed with the purpose of studying both perception and recognition neural mechanisms (e.g., Li, 2021). Since perception is necessary for recognition (De Gelder et al., 2015), emotion recognition tasks provide a good orthogonal activity for participants whose perception is being measured instead. In the case of such studies, only the behavioural performance on the ER task will be reviewed.

Early evidence found that body EEs can be recognised above chance in both static and dynamic stimuli, and in both point-light and full-light displays (Atkinson et al., 2004; Bänziger & Scherer, 2007, September; De Gelder & Van den Stock, 2011). Additionally, there is evidence that body expressions, when added to facial or vocal expressions, can increase recognition accuracy, or even impair it when the different modalities display incongruent emotions, such as a fearful face on a body expressing joy (Meeren et al., 2005; Van den Stock et al., 2007). Facial EE can be recognised from partial facial information, with different face areas (eyebrows, eyes, mouth) being more informative for different emotions (Wegrzyn et al., 2017; Grundmann et al., 2021; Zhang et al., 2021). An analogous trend has been found for body EE, with recent studies demonstrating that humans can accurately recognise emotion when hand and arm cues are edited out from stimuli (Ross & Flack, 2020) as well as when only isolated parts of body expressions are presented, such as just the hands, arms, head, or torso (Blythe et al., 2023).

Direct comparisons between bERA and fERA have not been investigated until recently (Lott et al., 2022). Most studies that measured both fERA and bERA did not aim to compare the two abilities. For example, an ERP study that focused on uncovering the perception of congruent vs. incongruent bimodal face and body expressions, used control stimuli to assess face and body expressions in a unimodal fashion and discovered that fear is more accurately recognised in bodies than faces (Zhang et al., 2015). One other study found body expressions more informative than facial expressions when depicting intense emotions from spontaneous, ecological expressions (winning or losing, Aviezer et al., 2012). Other studies found the opposite, that fERA is higher than bERA in tasks involving EEs of anger, fear, and joy (Kret et al., 2013; Pavlova et al., 2022), as well as in a task containing all basic emotions (Li, 2021).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

In the latter study, participants were also faster in recognising facial EE overall. Recently, better fERA has also been found in preschool children even when facial expressions (anger, joy and, neutral) were blurred to increase the difficulty (Ren et al., 2023). Actis-Grosso et al. (2015) found specific differences between the recognition of static facial pictures and dynamic body PLDs: participants were more accurate in recognising fear from body expressions and sadness from facial expressions. These findings need to be considered cautiously, as there were no static body expressions or dynamic facial expressions for a complete comparison; there were also no facial PLDs or body pictures. Lott et al. (2022) have created a new tool aimed at assessing both ERAs comparatively. In the initial validation study, bERA and fERA were roughly equal; however, it was the intention of the authors to obtain tasks that produce roughly the same accuracy score between faces and bodies by selecting stimuli that were of similar recognisability for both modalities. Other studies have compared fERA and fbERA, finding that using bimodal expressions improves accuracy and speed in both static and dynamic recognition (Gunes & Piccardi, 2007; Pollux et al., 2019). None of the aforementioned studies have investigated all basic emotions, with most only focusing on two emotions, one positive and one negative. Moreover, all studies that compared fER and bER have used stimuli from two different sets for each modality, some even using stimuli of different formats, such as face FLDs with body PLDs (Actis-Grosso et al., 2015; Lott et al., 2022). All of the studies that have used FLDs have only used static stimuli, with the difference between face and body dynamic FLDs being completely unknown. The main objective of the present thesis is to address these gaps by exploring differences between fER and bER for all basic emotions, using face and body EEs from the same actors. Moreover, the bERA vs. fERA comparison will be conducted in different populations and in relation to other relevant personality constructs and demographics.

1.3 Static vs. dynamic expressions

Static expressions refer to still pictures of expressions, whereas dynamic expressions refer to a sequence of photographs: a video. Most of fER research has been conducted using static stimuli, but dynamic stimuli have been used in research for a comparable amount of time (for an example of some of the earliest research, see

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Bassili, 1978). With the development of modern digital technology, a new type of emotion recognition stimulus has been employed in research – facial expression morphs. These stimuli involve modifying pictures of faces digitally by choosing a start expression and an end expression, then morphing the start expression into the end expression using specialised software (Calder et al., 1996). Morphs are useful for either creating animations from pictures, such as animating a neutral face to a happy face, or for obtaining images of an exact intensity (e.g., 50% intensity joy) between two emotions. Due to the versatility of morphs, they can be used as both static and dynamic stimuli; however, they represent a special category of dynamic stimuli, as they are a computer algorithm generated animation, not a naturalistic movement. Indeed, fER research comparing morphs to stills and videos has found that they produce different accuracy results, with small or no correlations between the three measures on specific emotions and moderate correlations between the total ER accuracy (Khosdelazad et al., 2020). Dynamic stimuli tend to have an advantage in recognisability in both fER (Krumhuber et al, 2013) and bER (Atkinson et al., 2004; Pollux et al., 2019), but studies have never examined the two abilities in parallel in order to see if they are impacted differentially by the presence of motion. Study 1 will investigate the interaction of modality and motion as a main objective. The literature on static vs. dynamic EEs and the mechanisms behind the dynamic advantage is discussed in the introduction of Study 1. Study 3 will explore if static and dynamic stimuli are recognised differently by autistic vs. non-autistic people.

1.4 Individual differences and emotion recognition

ER, as any human ability, varies between individuals depending on a number of demographic characteristics and personality traits. This subchapter aims to describe some known correlates of ER – gender, age, anxiety, empathy, alexithymia. A summary of the extensive fERA literature focusing on the under researched relationships with bERA will be undertaken in Chapter 3. The theme of taking correlates of fERA and exploring whether they also relate to bERA is present throughout each study as a main objective. Study 1 will focus on bER and fER relationships with gender, age and the aforementioned personality traits. Study 2 will investigate the same relationships, but

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

comparatively in four samples: autistic and non-autistic adults and children. Study 3 will also compare autistic and non-autistic people, but focuses only on alexithymia and using a larger set of actors that are also autistic and non-autistic.

Empathy is commonly understood as a process by which an observer feels and/or understands the perceived affective state of an observed organism. Historically, there has been much debate over the definition of empathy, with many disagreements still existing in the literature (see Preston & de Waal, 2002). The theoretical distinction between cognitive and affective empathy will be adopted: cognitive empathy represents the understanding of another's affective state via cognitive processes such as perspective taking, whereas affective empathy refers to matching another's affective state by feeling what they feel (Davis, 1983). As a process, ER is believed to precede empathy – in order to understand or feel another's emotions, one needs to know what they are feeling in the first place (Decetey & Jackson, 2004). Due to this close link between the two constructs, ER has often been conflated with empathy or considered to be a part of empathy (e.g., empathic accuracy; Ickes, 1993). Concerning the present thesis, ER will be referred to as a separate construct from empathy, and empathy will be operationalised as a trait, or a personality construct, measured in a self-report style, not an ability that can be tested. The trait approach is the traditional approach to empathy and constitutes most of the research conducted on it in the psychological literature (for a review, see Preston & de Waal, 2002). Considering that one of the main purposes of this thesis is to extend fERA findings to bERA, it is necessary to operationalise empathy as a trait in the same way as most of the literature on empathy and fERA (e.g., Besel & Yuille, 2010). The present thesis aims to explore the relationship between cognitive and affective empathy and ER using face and body static and dynamic EEs. Both Study 1 and 2 will explore the relationships between fER, bER and empathy. Details on the relationship between empathy and ER will be discussed in the introduction of Study 1.

Anxiety is well known to affect emotion perception and recognition via attentional biases towards threatening stimuli (Cisler & Koster, 2010). In the context of emotion expressions, individuals with higher trait anxiety are thought to have their attention drawn to anger and fear stimuli more than to non-threatening stimuli, such as

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

neutral, joy or sadness EEs (for a meta-analysis, see Bar-Haim et al., 2007). A distinction can be made between three aspects of anxiety: state, trait, and clinical anxiety. State anxiety refers to the level of anxiety that an individual is feeling at a specific point in time, usually when completing a certain task such as an ER test, whereas trait anxiety represents how anxious an individual is on a regular basis in their daily life (Endler & Kocovski, 2001). Both are usually measured via retrospective self-report, but state anxiety is sometimes operationalised in conjunction with physiological measures (e.g., heart rate, skin conductance; Hyde et al., 2019). Clinical anxiety describes individuals with a clinical diagnosis of some form of anxiety disorder (e.g., social anxiety disorder, PTSD, or panic disorder), but the degree of (clinical) anxiety can also be measured by standardised clinical inventories (Sarkar, 2020). Although it is believed that the attention of individuals who are more anxious is biased to threat-related EEs (Bar-Haim et al., 2007), the relationship between fERA and anxiety is unclear due to mixed findings (Dyer et al., 2022), and the relationship between bERA and anxiety is under-researched (Kret et al., 2013). The present thesis will explore such relationships in both Study 1 and Study 2, in the latter exploring ER – anxiety relationships in children and adults.

Alexithymia is a subclinical personality trait defined by difficulties being aware of and identifying one's feelings, describing one's feelings, and externally oriented thinking (Hogeveen & Grafman, 2021). Alexithymia has historically also been characterised by poor fantasizing ability, but this component has been removed in more recent models (Preece et al., 2017). Externally oriented thinking is a dimension of alexithymia that refers to a cognitive style in which individuals focus predominantly on the details of the external environment (empirical events and facts, objective information) instead of reflecting on their subjective internal experiences (Timoney et al., 2013). It is measured using self-report questionnaires that quantify the degree of alexithymia, with cut-off points being used to describe individuals as alexithymic or non-alexithymic (Preece et al., 2017). Alexithymia is a fairly common trait, with 10% of the general population scoring above the cut-off point for being alexithymic (Bagby et al., 1994). Males are more alexithymic than females, and the degree of alexithymia is positively related to age, and negatively to education level and socioeconomic status (Salminen et al., 1999). It has been noted to be highly prevalent in psychosomatic disorders (Sifneos, 1973), and associated with mood disorders (Honkalampi et al., 2000), eating disorders (Brewer et al., 2015), personality disorders (Ritzl et al., 2018), substance misuse (Lyvers et al., 2018), PTSD (Frewen et al., 2008), and autism-spectrum disorders (Kinnaird et al., 2019). Such associations make alexithymia one of the most important personality traits in psychology, thus receiving a great deal of attention from researchers. The present thesis aims to explore whether fERA relationships with alexithymia (Di Tella et al., 2024) are replicated in static and dynamic displays, and whether they also apply to bERA, using larger samples, and all basic emotions.

Gender difference studies in fER tend to reveal an advantage for women (Hall et al., 2025), but findings are more mixed in bER research (Pavlova, 2017). Some studies have found cross-gender advantages (Krüger et al., 2013), but the findings were difficult to replicate (He et al., 2018; Isernia et al., 2020; Pavlova et al., 2022). The present thesis aims to explore gender differences in all component studies, as well as the cross-gender effect in studies 1 and 3. The studies will use improved ER methodology (described in Chapter 2) and explore possible confounding variables, including the personality traits discussed above.

1.5 Ontogeny of emotion recognition

One of the reasons for emotion recognition being considered an innate ability is its early ontogenetic development. Newborns can discriminate between joy, sadness, and surprise, and they also imitate the expressions to a certain extent (Field et al., 1982). There is more clear-cut evidence of bimodal face and vocal ER in 3- to 4-month olds (Flom & Bahrick, 2007), as well as some gender differences with boys looking at EEs longer than girls (Barrera & Maurer, 1981). Concerning unimodal recognition, Flom & Bahrick (2007) have observed vER at 5 months and fER at 7 months. ERP findings support this age for fER, showing that 7-month olds process fear differently than joy or neutral (higher amplitude P400 ERP), parallel with more fixation on fearful faces (Leppänen et al., 2007). Although fewer studies have investigated body expressions, they tend to find similar developmental patterns (Heck et al., 2018). By the time they are two years old, toddlers understand emotion labels and use them actively in their

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

communication (Wellman et al., 1995). As they get older, children use more labels, using the full set of basic emotion labels effectively at around 4 – 5 years (Widen & Russel, 2003). ER continues to develop during preschool and school ages (Vicari et al., 2000), and tends to reach peak ability in adolescence and young adulthood (Ross et al., 2012; Pollux, 2021). Following a path similar to other cognitive abilities, ER tends to decline in late adulthood (Mill et al., 2009), with the decline being attributed largely to neuropsychological ageing (Hayes et al., 2020). Study 2 will attempt to address some gaps in age and ER research by exploring fER and bER comparatively between children, young adults, and older adults, with the literature discussed further in its introduction.

1.6 Autism and emotion recognition

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is defined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) by "persistent deficits in social communication", among a few other criteria (American Psychiatric Association, 2022). Although ASD was first described more than 80 years ago (Kanner, 1943; Asperger, 1944), it was introduced in the DSM more than 30 years later (DSM-III, 1980). The understanding of autism has evolved drastically over the years. Around the time when ASD was introduced in the DSM, its prevalence was 1 in 2,500 children, with adult diagnoses almost non-existent (Baron-Cohen et al., 1985). Today, 1 in 36 children have an ASD diagnosis in the United States (Centers for Disease Control and Prevention, 2023). Population estimates place the prevalence of ASD diagnoses in adults at 1% (Brugha et al., 2011). Understanding autism and its implications has become increasingly important.

Autism will be operationalised in three distinct ways: autism diagnosis, autism-like traits (ALTs), and autism self-diagnosis. An autism diagnosis is a medical diagnosis established by a clinician. Sub-criterion A2 of the DSM definition of ASD mentions "Deficits in nonverbal communicative behaviours used for social interaction, … deficits in understanding and use of gestures" (DSM-5-TR), but ERA testing is not part of diagnosing autism. Similarly to the distinction between an anxiety diagnosis and trait anxiety discussed above, ALTs refer to "trait autism" (Baron-Cohen et al., 2001) and are measured in self-report style (e.g., Allison et al., 2012). ALTs can have an impact on an

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

individual's wellbeing despite not meeting the criteria for a diagnosis (Wing, 1988). Finally, there is a new concept in autism research that is receiving a great deal of attention recently – autism self-diagnosis. A "self-diagnosed autistic" describes individuals who believe that they are autistic and hold an identity of autism (Lewis, 2016), often seeing themselves as part of a large autistic community (Sarrett, 2016). This identity allows people more choice in how they describe themselves as adults, given that autism is often diagnosed in childhood. This is of particular importance to individuals who are diagnosed but do not identify with autism but also to individuals who are not diagnosed but consider themselves autistic, and do not want to go through the (often very time-consuming) process of seeking a medical diagnosis (Friedman et al., 2024). It also helps adults who may have experienced difficulties commonly associated with autism – but who have never been referred for a diagnosis or informed about autism – gain a better understanding of themselves and their experiences (McDonald, 2020).

The scientific community accepts that autistic people have impaired ER (Kapp et al., 2013), with entire subfields developing around testing and teaching autistic people ER skills. Moreover, the autistic community is likely to accept the purported lower ERA as part of the neurodiversity perspective, reconceptualising lower ERA, alongside broader socio-emotional difficulties, as a difference instead of a deficit (Kapp et al., 2013). Adding to this perspective, the double empathy hypothesis (discussed in more detail in Study 3) accepts that autistic people have lower ERA by putting forward the idea that autistic people misunderstand neurotypical EEs, citing evidence that neurotypicals also misunderstand autistic EEs (Milton, 2012). Swept by a self-advocacy political movement, ER stereotypes get accepted along with ER teaching/training practices designed to enhance autistic children's learning of social cues (Kapp, 2019). Despite the overwhelming acceptance that autistic people, especially children, struggle with reading social cues, research zooming in on ER brings this stereotype into question via consistently inconsistent findings in both the fER (Harms et al., 2010; Yeung, 2022) and bER literature (Prior et al., 1990; Doody & Bull, 2013; Peterson et al., 2015).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Study 2 will focus on exploring differences in fER and bER in autistic and non-autistic adults and children, with Study 3 constituting a further exploration of ER in autistic adults in a larger sample. The complex ER – autism literature and its knowledge gaps are reviewed in the introduction of Study 2. Additionally, Study 2 and Study 3 will examine the specific emotion of disgust in autistic populations. Recent neuroimaging research found that disgust is processed in markedly different ways by autistic people, along with self-reported higher disgust proneness in autistic individuals (Jayashankar et al., 2024). Indeed, past ER research consistently finds reduced ERA and/or ERS on disgust EEs in autistic populations (Jayashankar & Aziz-Zadeh, 2023), even when expressions are at full intensity (Smith et al., 2010). The present work will add to this line of research by exploring the ER of body disgust expressions.

1.7 Individual differences in EE actors and emotion expression ability

Emotion expression ability (EEA) represents the ability of an individual to express recognisable emotions. The research investigating EEA, especially using performance-based measures, is much more sparse than research on ERA. Individuals self-report varied degrees of emotion expressivity on the emotional expressivity scale (Kring et al., 1994), and self-reported EEA is associated with positive socio-emotional outcomes (Burgin et al., 2012). Sometimes referred to as emotion encoding ability, EEA measurement involves filming participants expressing emotions and then having a sample of “judges” attempt to recognise their emotions, usually in a categorisation task (e.g., Coats & Feldman, 1996). This process is very similar to the process of creating and validating an emotion recognition test (e.g., Rosenthal et al., 1979; De Gelder & Van den Stock, 2011), which makes the procedure of EEA studies more resource-heavy than ERA studies using existing tests or stimuli. However, self-reported measures of EEA are only somewhat related to performance measures (Kring et al., 1994), demonstrating some erroneous self-beliefs about EEA. This also suggests that performance measures should form the gold standard for measuring EEA. For the remainder of this work, only performance measures will be referred to as EEA, denoted by an individual’s average recognition scores obtained for their expressions from a sample of recognisers.

Although the literature is limited in comparison to ERA, research has found individual differences in EEA as well. Some studies found females having higher EEA than males (Zuckerman et al., 1975; Kring & Gordon, 1998), whilst others found no sex differences (Inoue & Ishii, 1990). Coats & Feldman (1996) found differential patterns, with males better at expressing anger, and females better at expressing joy, and no differences on sadness. Age interacts with gender, showing qualitative differences in EEs between children and adolescents, boys and girls (Chaplin et al., 2013). Other studies have found personality traits to be related to EEA (Inoue & Ishii, 1990; Friedman & Riggio, 1999). Also, studies tend to find an association between EEA and ERA in both children (Boyatzis & Satyaprasad, 1994) and adults (Zuckerman et al., 1975). It is unknown whether the traits described in Chapter 1.4 (i.e., empathy, alexithymia and anxiety) are related to EEA, but reduced EEA has been noted in some clinical populations. For example, reduced EEA can be observed in schizophrenia (Gottheil et al., 1970; Gottheil et al., 1976; Winkelmayer et al., 1978), PTSD (Litz et al., 2002), Parkinson's Disease (Argaud et al., 2018) and ASD (Volker et al., 2009). Studies found that autistic children have less expressivity (use fewer action units when expressing; Yirmiya et al., 1989), and lower EEA (Macdonald et al., 1989; Loveland et al., 1994; Volker et al., 2009). A meta-analysis looking at a variety of ages found that autistic people express less often and for shorter durations, but not less intensely (Trevisan et al., 2018). However, the meta-analysis did not investigate EEA studies per se, just studies exploring the observed quality of autistic expressions. Whilst little is known about EEA specifically, it is clear that there are individual differences in how people express emotions, and how capable they are at producing recognisable expressions. Little to nothing is known about EEA of body expressions. Study 1 attempts to investigate own-gender or other-gender preferences by measuring if males and females are better at recognising male or female actors. Study 3 investigated whether autistic people have an own-neurotype preference (i.e., recognise expressions of autistic actor better than those of non-autistic actors). Additionally, this recogniser-actor relationships will be explored in alexithymia as well, verifying if high alexithymia people have a preference for actors with high alexithymia in terms of recognition accuracy.

1.8 General research objectives

This project aims to expand the knowledge of how humans recognise basic EEs from faces and bodies, how individual differences (of recogniser and of expresser) shape this process, and how autism influences fER and bER. It also investigates if the use of static or dynamic stimuli interacts with other task characteristics and individual differences to impact ER. Research on emotion recognition has predominantly focused on facial expressions, with less emphasis placed on body expressions (De Gelder, 2009). The present research aims to verify if past findings about the effect of individual differences and autism on fER extend to bER. The thesis aims to achieve these goals via the development for two novel stimulus sets and three empirical studies using these stimuli.

Chapter 2 introduces a novel approach to the development of ER stimuli, culminating in the creation of a new stimulus set featuring both face and body EEs. The chapter summarises how existing stimulus sets do not meet the requirements brought forward by the research objectives of this thesis (Bänziger & Scherer, 2010; De Gelder & Van den Stock, 2011; O'Reilly et al., 2016). To aid the filming of EE, a new method is employed that involves showing guide videos of body expressions based on spontaneous EE videos. The chapter describes a study aimed to select the best guide videos before the filming sessions. Finally, the stimulus filming set-up and procedure, as well as the processing of videos and the selection of images from videos are described.

Chapter 3 presents Study 1, which examines ER differences between face and body stimuli, interactions with static vs. dynamic stimuli, and the role of individual differences in a non-autistic adult sample. Past research falls short of exploring the combination of modality and motion, with many studies ignoring one of the factors or investigating unmatched stimuli: static faces – dynamic bodies (Actis-Grosso et al., 2015), FLD faces – PLD bodies (Lott et al., 2022), only static stimuli (Kret et al., 2013; Zhang et al., 2015; Ren et al., 2023), or only dynamic stimuli (Pavlova et al., 2022). Study 1 addresses these limitations by investigating the recognition of static and dynamic body and faces from the same actors, using the stimuli created in Chapter 2. Chapter 3

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

investigates the relationship between bER and individual differences: gender (Hall et al., 2025), state and trait anxiety (Attwood et al., 2017), alexithymia (Di Tella et al., 2024), empathy (Olderbak & Wilhelm, 2017), and whether these relationships are similar to those observed for fER. As a novel endeavour, the study models the effect on ER of all aforementioned individual differences together, including age and ALTs.

Chapter 4 contains Study 2, an investigation into ER differences between autistic and non-autistic adults and children. The study is composed of three parts: Part 1 – autism in adults, Part 2 – autism in children, and Part 3 – age differences. Autistic people are believed to have difficulties with ER, but recent meta-analytic evidence shows mixed findings with small effects overall (Yeung, 2022). Fewer studies have investigated bER differences in autism, and have found similar mixed effects (Peterson et al., 2015; Mazzoni et al., 2020). Very few studies have compared fER and bER, and those that did, used incomparable face and body stimuli, such as: bodies with situational context – faces without (Fridenson-Hayo et al., 2016), static FLDs of faces – dynamic PLDs of bodies (Actis-Grosso et al., 2015), or stimuli from difference actors (Philip et al., 2010). In Part 1, the study aimed to address these gaps by investigating the bER and fER of autistic and non-autistic adults using comparable stimuli from the same actors. In Part 2, the study expanded this design to a sample of children, given that no comparisons of fER vs bER have been conducted in school children, only preschool children (Ren et al. 2023). The ER task used in this study was almost identical between the adult and the child sample, allowing for a comparison of the two. Finally, in Part 3, fER and bER were compared between children, young adults and older adults.

Chapter 5 describes Study 3, which aims to explore the double empathy hypothesis of autism (in the domains of fER and bER), verify if there is a dynamic stimulus advantage or disadvantage in autistic vs non-autistic individuals, and explore if actor individual differences are related to their EE performance. The double empathy problem (Milton, 2012) posits that autistic people communicate better with other autistic individuals, and struggle to communicate with non-autistic, with a vice-versa effect for non-autistic people. Evidence for (Cheang et al., 2024) and against (Brewer et al., 2016) the double empathy hypothesis in fER has been found, but no studies have looked at the effect in bER. Studies on the perception of static vs. dynamic stimuli have

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

found no interactions with autism in face EEs (Kashlak, 2014; Jelili et al., 2021) and body EEs (Mazzoni et al. 2022) separately, but no study has examined both abilities using stimuli from the same actors in a comparative fER vs. bER analysis. The effect of actor individual differences on the recognisability of their EEs is largely unknown, despite evidence of variability between actors within stimulus sets (De Gelder & Van den Stock, 2011) or actors posing for an EEA study (Le Mau et al., 2021). Study 3 aims to address these gaps by creating a new stimulus set based on the methodology developed in Chapter 2. The new stimulus set contains autistic and non-autistic actors, differing in gender and age. Personality measures that have been investigated in Study 1 (alexithymia, anxiety, empathy and ALTs) are measured in actors in Study 3, and the relationship between individual differences and actor performance (EEA) is investigated. As in Chapter 2, the new stimulus set contains images and videos, allowing for static vs. dynamic comparisons.

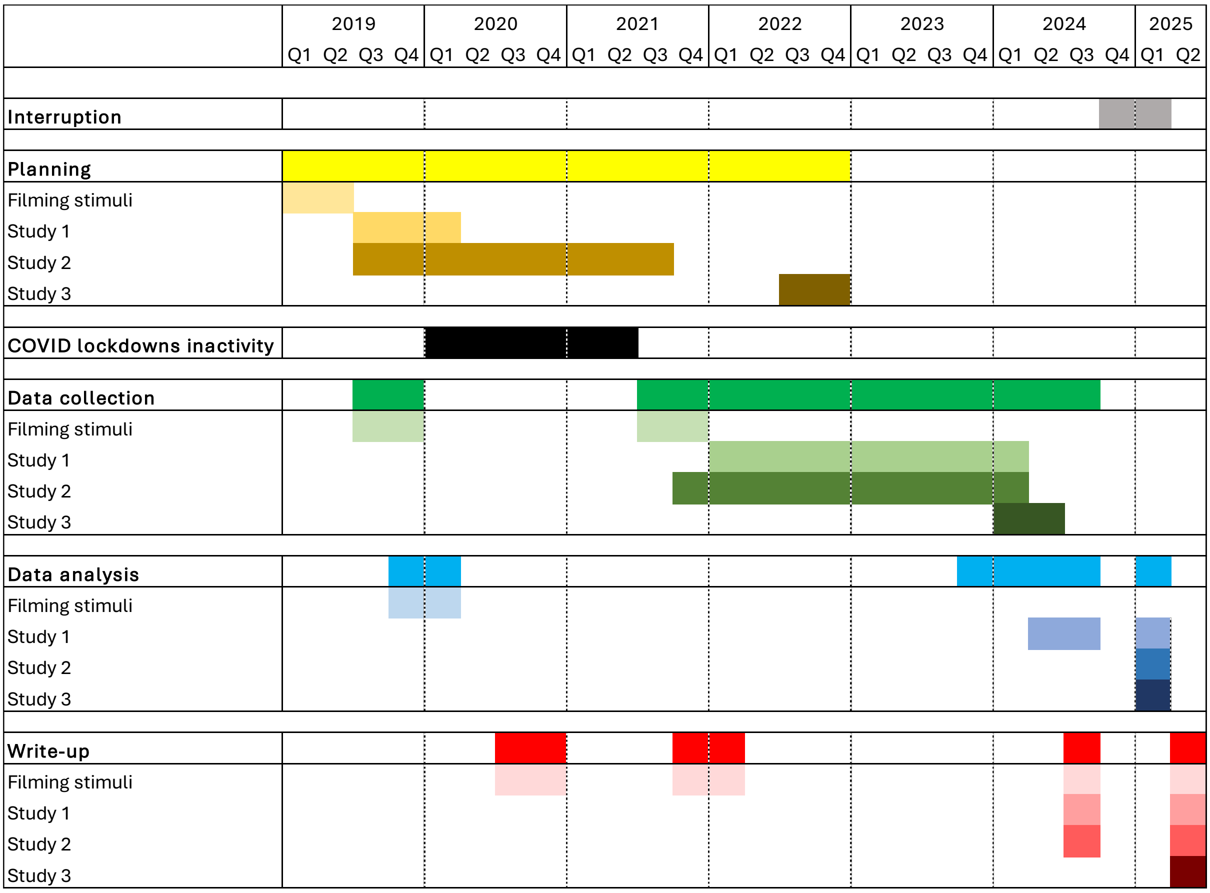
1.9 COVID-19 impact statement

The COVID-19 pandemic, particularly the lockdowns in the United Kingdom taking place in 2020 and the first half of 2021 have impacted the timeline and the design of the present project (See Figure 1). At the beginning of 2020, all the materials required for filming the stimuli were prepared, and the procedure piloted (described in Chapter 2). As actor recruitment was undergoing, the lockdowns had been issued, making any filming impossible. For the following 18 months, there were very few opportunities to film with actors. In the fourth quarter of 2020, there was a small window of opportunity where the stimuli from two actors (one male, one female) were filmed. Towards the easing of lockdowns in the second quarter of 2021, the filming sessions with the other two actors occurred. Before lockdowns, almost all studies that were part of this project were planned to be in-lab studies. Seeing the recurring return of lockdowns in that 18 month period, the main author and the supervisory team decided to change to online instead of in-person data collection. After the end of the pandemic, in-person testing was partially reintroduced (Chapter 4, Part B; Chapter 5, stimulus creation), but most studies remained online.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Figure 1

GANTT chart showing the timeline of the PhD project



Note. Q = quarter

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Chapter 2 – Emotion expression stimuli

The present chapter will discuss existing emotion expression stimuli at the beginning of this PhD project (2019-2020), explain the decision to create a new stimulus set, and describe the process of filming and editing the new stimuli. Stimuli need to meet certain characteristics in order to investigate the objective of the present thesis: to examine direct differences between bER and fER as well as relationships between the two types of ER and personality traits, using all basic emotions (including neutral), and using stimuli from the same actors. In addition, two of the studies in this thesis require static and dynamic stimuli from the same actors to assess the differential impact of motion on ER for each modality. If a stimulus set contained dynamic stimuli, static stimuli could be extracted from it. As a reminder, body EEs are considered to be EEs where the body can be seen, but the face is not visible. Since the objective is to assess the differences in bER and fER directly, the stimuli are required to be devoid of context to avoid unsystematic variance added by deductive inferences based on non-emotional cues. Additionally, although much of body expression research has used PLDs (e.g., Atkinson et al., 2004), this present thesis aims to address gaps in research by focusing on FLDs.

2.1 Overview of available body and face expression stimuli

To address the research objectives contoured in the previous chapter, emotion expression stimuli are needed in order to build ER tests. At the beginning of this PhD project (Jan 2019), there were no emotion recognition stand-alone tests that included body expressions. Stand-alone tests are “plug-and-play” emotion recognition tasks that can be downloaded/purchased and deployed in studies with existing normative data and often with automatic scoring. Examples of such tests are the DANVA (Nowicki & Duke, 1994) or the CANTAB ERT (Clark et al., 2006). Since then, Lott et al. (2022) have developed an ER test that is comprised of both body and face EEs. However, their EmBody/EmFace test would not have been suitable for the current project due to the

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

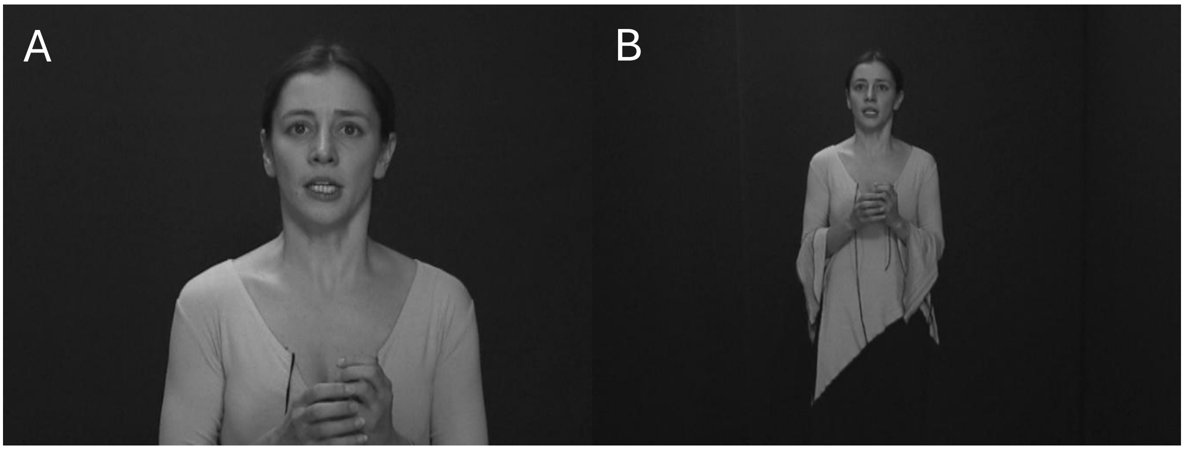
use of facial FLDs and body PLDs, and due to it containing expressions from only two emotions plus neutral.

Most bER research has used either validated stimuli from a stimulus set or custom stimuli created for the purpose of a specific study. The **Bodily Expressive Action Stimulus Set** (BEAST; De Gelder & Van den Stock, 2011) is a popular stimulus set that has been used in a number of studies even before its validation (e.g., Van den Stock et al., 2007) and contains body expression from numerous actors expressing almost all basic emotions. The BEAST could not be used for this project given that there are no facial expression equivalents from the same actors, and the stimulus set is entirely comprised of static stimuli. Another stimulus set that constituted a good candidate for this project is the **EU-emotion** stimulus set (O'Reilly et al., 2016). The stimulus set contains body and face EEs of all emotions in video format, with actors of various ethnicities and ages. Unfortunately, all body expressions contain contextual cues, such as a person being angry upon discovering a broken disc in a case. The most suitable stimuli set for the present thesis was the **Geneva Multimodal Emotion Portrayals** (GEMEP; Bänziger & Scherer, 2010). The GEMEP is a large corpus of dynamic EEs, containing face and body expressions (as well as vocal expressions) from multiple actors. The corpus contains displays of basic and complex emotions. However, it has several issues that render it incompatible with the project: (1) the emotions available for each actor are unbalanced, with some actors containing disgust but not surprise, and others containing surprise but not disgust; (2) the corpus does not contain body expressions with covered faces; they are essentially bimodal expressions; (3) the facial expressions are cuts of the body expressions, but still retain much of the postural information (such as shoulders), and sometimes gesture information (hands visible; see Figure 2.1.A); (4) almost all body expressions have non-visible legs (see Figure 2.1.B); (5) there are no neutral expressions.

Figure 2.1

Example of face and body EEs from the GEMEP

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display



Note. A = facial expression; B = body expression.

Given that none of the existing stimulus sets met the criteria required for this project, it was decided that a new stimulus set should be created for use in this thesis.

2.2 A new method of generating emotion expressions

The main methodological hurdle in creating body expressions of emotion is the acting method. As discussed in Chapter 1.7, when creating facial expressions, authors can use prototypical action units as instructions for actors based on prototypical facial expressions (Young et al., 2002; Van Der Schalk et al., 2011). For body expressions, there is no agreement on prototypical expressions (Dael et al., 2012), although there is disagreement even when discussing the prototypicality of facial expressions (Le Mau et al., 2021; Binetti et al., 2022). As mentioned above, for the purposes of this project, FLDs are desirable. The contrasting characteristics of FLDs compared to PLDs lie in ecological validity: PLDs capture only biological motion, FLDs are designed to approximate visual information akin to real-life EEs. The stimuli created for use in this project will have ecological validity as a goal. The highest level of ecological validity is the use of spontaneous, realistic emotion expressions captured in quotidian situations. An example of such stimuli is the expressions used by Aviezer et al. (2012), where the EEs were pictures of tennis players' expressions when winning or losing. Unfortunately, such expressions are very difficult to obtain, as filming unaware people in daily encounters poses obvious ethical issues and would require an unknown amount of

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

takes, time, and resources to achieve. Moreover, a degree of control needs to be retained on how emotion expressions appear, especially with regards to distance to the viewer, visibility of the body, orientation, etc. This means that emotion expressions need to be filmed in a studio, where such technical characteristics of expression can be easily controlled. However, this method of creating EEs results in acted, not spontaneous portrayals. Posed EEs can be affected by a number of factors that do not pertain to how an actor would express emotions in an ecological environment. In the BEAST (De Gelder & Van den Stock, 2011), actors were closely instructed by researchers on how to enact emotions, offering some examples of daily scenarios where the emotions would be felt. This method adds subjectivity to the EEs, stemming from the prototypes of EEs that the creators of the instructions hold. In the GEMEP (Bänziger & Scherer, 2010), actors were provided vignettes ahead of filming along with theoretically grounded definitions of the emotions they would be portraying (theoretically grounded in the theory developed by the researchers). The actors were asked to improvise interactions with the director when expressing emotions, and they prepared these interactions ahead of time with the director. Whilst the method allows some actor freedom, the director has a large degree of sway over how the emotions are expressed, making the EEs heavily based on the prototype of the director. The EU-emotion stimulus set (O'Reilly et al., 2016) was not reported to have had a strong director interference, instead just using detailed vignettes of real-life scenarios. However, emotional vignettes are meant to represent a scenario in which a given emotion would be felt. As different emotions would be expressed differently in some scenarios compared to others, the selection/writing of vignettes by the authors introduces the subjective influence of researchers on when and what emotions should be felt, likely affecting how they would be expressed in the studio. Vignettes are almost never subjected to validation by a general population sample, leaving the scenario choice almost entirely to the decision of researchers. An alternative to the control by a director or specific vignettes/instructions is to allow actors to freely express their own prototype of an emotion, based on their life experience. In the absence of known emotion stereotypes, especially for body EEs, this is the most objective approach. However, if an emotion stimulus set contains EEs from a small number of actors, the collection of emotion prototypes is subject to unsystematic error akin to any psychological measurement undertaken on a small sample of participants.

In an attempt to reduce the issues described above, the stimuli that were used in this project were designed to reduce researcher subjectivity as much as possible, whilst still filming in a studio, instead of trying to film spontaneous EEs. In addition, the method was intended to add the prototypes of a substantial sample of people to how the body expressions were portrayed by actors.

Instead of using vignettes, the author decided to use guide videos when filming body EEs with actors. This entailed showing actors short video clips of body expressions to aid their portrayals. The prototypes of facial expression are fairly well understood; therefore, using previously validated stimuli as guides was decided. The actors were still allowed full freedom, but were primed with videos of real-life situations where body expressions were captured (and images for faces). In order to create the guide videos, the author selected 7 to 10 video clips for each emotion as candidate guide videos. The uneven number of videos was due to some emotions being more difficult to find full body EEs for in a spontaneous context. The videos were obtained via unsystematic searches on youtube.com. Types of video titles from which clips were extracted from are shown in Table 2.1.

Table 2.1

Examples of video titles from which the guide videos were clipped for each emotion

Emotion	Video titles
Anger	Angry moments in sports; Top road rage moments caught on camera; Top 20 Angry Outbursts Caught on Live TV; Top 5 angry customers compilation
Disgust	Best of Disgusting Pranks | Just For Laughs Compilation; The Most Disgusting Food Ever on Gordon Ramsay's Kitchen Nightmares; Stinky Funny Fart Prank
Fear	Best Scary Fails; Best Scarecam Pranks Reactions; Scary Elevator Pranks
Joy	Happy Moments Video Compilation; Random Acts Of Kindness; Greatest Sports Moments; Best Comeback In Olympic History; Most Beautiful and Respect Moments in Sports

Sadness	Most emotional moments in football; The Saddest Moments in NFL history; Favourite Team Losing Reaction
Surprise	Heartwarming puppy surprise moments; Best Gift Reactions, Best SURPRISE Reactions That'll Make Your Heart Burst; 50 Most shocking moments in World Cup history; Surprising my parents with their first grandchild

This is one of four stages in the stimulus creation process where the subjective choice of the researcher affected the portrayal of the actor – the choice of the initial pool of guide videos. The author attempted to select a diverse range of videos for each of the basic emotions, although it was difficult to find EEs for some emotions where the entire body was visible (i.e., sadness, disgust and surprise). The main priority was to select videos where as much of the body as possible was visible.

2.3 Brief validation of body expression guide videos

The guide videos obtained by the researcher were subjected to a rating study designed to select a smaller amount of videos out of the total pool for each emotion.

2.3.1 Methods

Participants consisted in University of Lincoln psychology students recruited via SONA who completed the study for practicum credit, as well as other students recruited via social media (n = 119). Most participants were female (n = 98), with 20 participants identifying as male and 1 as agender. The mean age of the sample was 20.142 (SD = 3.508).

The **materials** consisted of the videos of people expressing spontaneous emotions, with most of the body being visible in all of them. Expression clips were cut to 1 - 10 seconds from the original videos (using Shotcut; Meltytech, LLC, 2022). The considered characteristics of videos were of the practical kind, not judgments about how “good” the emotional content of the expressions was. Videos that had most of the body visible, with acceptable resolution, partial visibility of the face, and the ability to either crop out other humans in the video or highlight the human to which participants needed to pay attention to were selected. Based on those considerations, the main researcher managed to select 51 videos in total: 10 of anger, 8 of disgust, 9 of fear, 9 of joy, 7 of sadness, and 8 of surprise. The type of emotion present in each video was determined by the main researcher subjectively, based on the context of the videos and titles (e.g., “parents surprised to find that they will be grandparents”). This is the second stage in the stimulus creation process where the main author had a subjective input.

Figure 2.3

Screenshots from videos used in the study: A = anger, B = fear, C = joy

A B C

Note. In video A, the person that the viewer should focus on is highlighted with a red rectangle at the start of the video.

The video rating study was deployed online using Qualtrics (Qualtrics, 2022). Each page presented a single video, with what emotion was being presented being specified at the top of the page. Participants were able to replay the video as many times as they needed; there were no time constraints. Below the video, three sliders were presented, asking participants to rate the video, from 0 to 100, on its realism, intensity, and stereotypicality. The following item questions were used: “How realistic did you find the emotional expression?” (realism), ”How intense did you perceive the expression to be?” (intensity), and “How stereotypical for <emotion> did you find the expression to be?” (stereotypicality). The definitions and more detailed explanations of what each rating represents were presented on the instruction page before the videos (Appendix A.1.1).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

2.3.2 Results and discussion

Means of each rating per video, and means across videos are displayed in Table 2.2.

Table 2.2

Means of ratings per emotion

Anger	real	int	stereo	Fear	real	int	stereo	Sadness	real	int	stereo
1	**81.84**	82.64	**83.89**	1	**68.09**	**57.65**	**65.71**	1	**84.15**	80.58	**86.82**
2	**77.87**	71.87	**80.73**	2	**69.20**	**38.44**	58.34	2	**61.02**	**37.07**	44.28
3	**76.17**	75.61	**76.35**	3	**74.58**	**63.06**	**72.80**	3	**65.19**	**47.77**	46.68
4	**70.45**	**60.66**	**66.69**	4	**80.49**	87.82	**85.64**	4	**75.82**	**65.59**	**76.99**
5	57.82	**60.79**	**61.25**	5	**75.49**	**67.54**	**72.89**	5	**76.04**	72.12	**69.66**
6	**79.07**	79.34	79.08	6	**81.24**	**67.98**	**78.93**	6	**64.55**	**47.08**	**65.83**
7	**72.72**	**66.76**	**73.06**	7	**71.97**	71.65	**76.87**	7	**63.89**	**63.14**	**61.89**
8	**78.46**	73.86	**77.34**	8	**68.38**	**60.61**	**65.29**				
9	**71.08**	**55.67**	**63.98**	9	53.15	**56.59**	57.54				
10	**76.29**	74.08	**75.66**								
mean	74.18	70.13	73.80	mean	71.40	63.48	70.45	mean	70.09	59.05	64.59

Disgust	real	int	stereo	Joy	real	int	stereo	Surprise	real	int	stereo
1	**64.70**	**49.82**	56.45	1	**81.45**	**65.40**	**77.67**	1	55.15	**49.28**	**67.67**
2	**65.97**	**50.69**	44.48	2	**76.11**	**66.81**	**71.29**	2	55.47	**50.39**	53.94
3	**64.76**	**46.07**	53.83	3	**71.21**	**67.53**	**75.50**	3	**71.94**	74.87	**76.24**
4	57.28	**66.30**	**71.49**	4	56.61	**68.87**	51.75	4	**73.70**	73.92	**77.57**
5	**65.24**	**45.84**	**62.39**	5	**73.82**	77.12	**81.03**	5	**77.36**	**61.53**	**79.41**
6	**74.08**	**65.60**	**78.79**	6	**77.73**	80.79	**82.19**	6	**75.63**	**68.13**	**81.20**
7	**64.97**	**63.77**	**65.24**	7	**62.41**	76.80	**69.81**	7	**70.87**	**63.66**	**64.18**
8	57.00	**48.78**	58.25	8	**70.89**	79.46	**81.32**	8	**70.77**	71.47	**76.94**
				9	**79.55**	73.81	**82.71**				
mean	64.25	54.61	61.36	mean	72.20	72.95	74.81	mean	68.86	64.16	72.14

Note. Bolded numbers are numbers that met the selection criteria of their specific dimension; Highlighted in green are the videos that met the criteria of all three dimensions.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Arbitrary video selection criteria were selected with the purpose of selecting the videos with the best ratings. Videos with high realism and high stereotypicality, but with not very high intensity, were selected, as research shows that high intensity expressions can lead to accuracy ceiling effects on some emotions (Bänziger et al., 2006). Given that most average ratings for all emotions were roughly between 60-70, the selection criteria were set at > 60 for realism and stereotypicality, and < 70 for intensity. The cut-off points were decided arbitrarily, with no statistical reasoning other than observing the range of averages. The final guide videos to be used in stimulus creation were required to meet the criteria on each dimension (see Figure 2.2). Ultimately, 19 videos were selected: three for each emotion with the exception of fear, where four videos qualified (Appendix A.1.2).

2.3 Filming of a new stimulus set

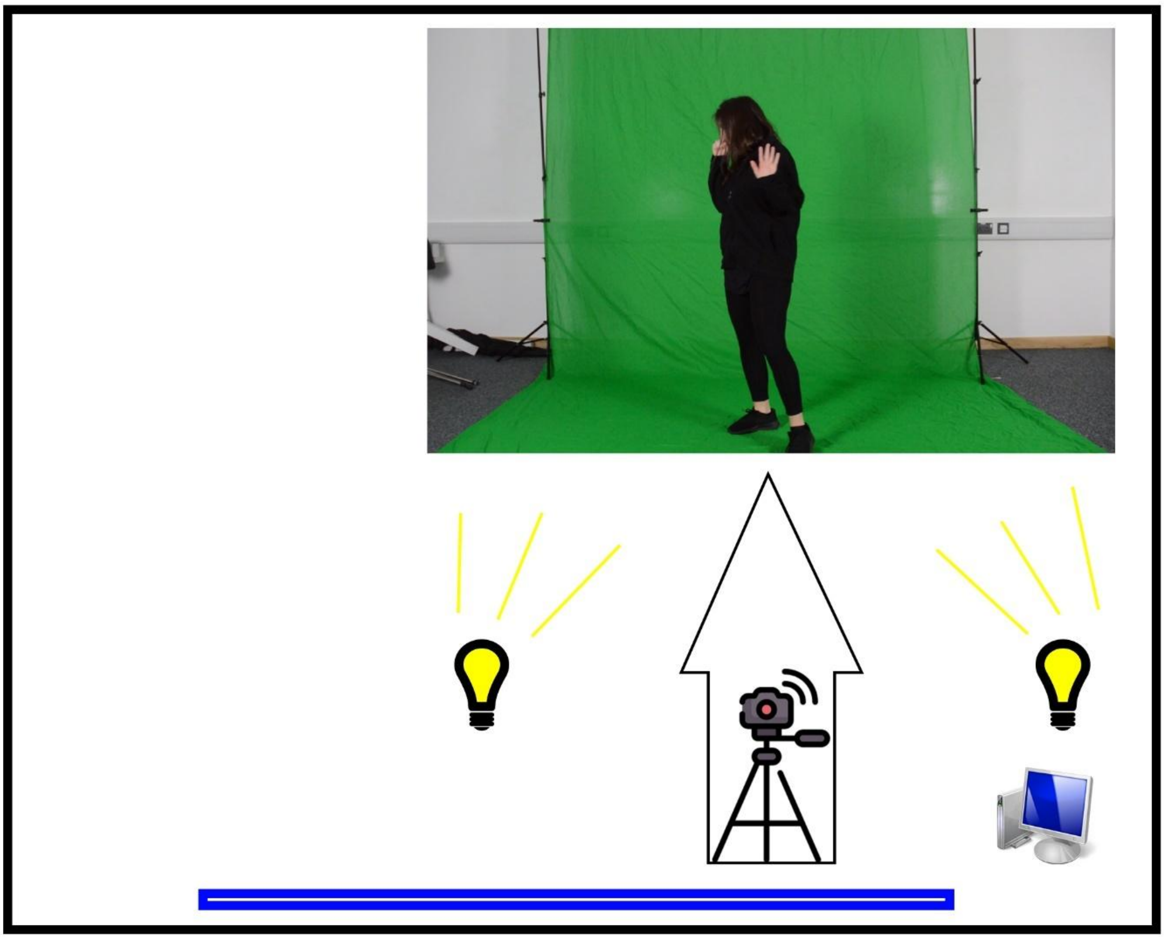
The filming "studio" was set-up in a university seminar room by the main researcher using a portable green screen frame and filming equipment. The green screen frame covered 3 x 3 meters behind the actor, and 3 x 3 meters below the actor. It was intended that actors would be allowed to move on the 3 x 3 meter area that the green screen covered in order to have more freedom of movement during an expression. Distances to the green screen were not measured; instead, the director (main author) placed the tripod camera in front of the green screen in a manner that captured the entire greenscreen along with the entire three-meter area under the actor, rolling forward from the green screen frame (see Figure 2.4). This uniformised the distance to the actors sufficiently. A minimalistic lighting set-up was used: two key lights, no back light or screen lights. The two lights were placed on stands and covered with a diffuser. A Nikon D3200 camera (lens: Nikon AF-S DX Nikkor 18-70mm f/3.5-4.5G ED IF) was used to film from a frontal angle. Guide videos were played on a standard university projector placed behind the director/camera.

The procedure for filming a body expression trial involved showing guide videos to actors to film their emotion expressions. The director would play the guide video after telling the actor what emotion was going to be played on the projector screen (played using VLC media player (VideoLAN, 2021). The actor was asked to express the given emotion, and was told that the video is there to help them but that they should feel free to express the emotion as they see fit. Additionally, actors were told that they could vocalise in any way they wanted if that helped them with the expression, assuring them that the videos will be muted and the faces covered. Once the actor thought of a way to express the emotion, they would ask the director to stop the video. They were asked to express the emotion starting from a neutral posture. The director would then move to the position of the camera, where he would begin the recording. The actor was given an OK sign to confirm that the camera was recording. After the actors executed the expression, they were told if they went out of frame or if the recording was successful. Actors would only be asked to express again if they were substantially off-screen. Actors were allowed to ask for as many re-takes as they wanted. After going through all 19 of the body guide videos, the actor was asked for one more take of a neutral body expression. Actors were asked to just stand still, but slightly move or sway just so that some observable motion was recorded.

Figure 2.4

Filming room configuration

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display



Note. Black rectangle = seminar room; blue rectangle = projector screen where guide videos were displayed; computer icon = seminar room lectern with computer for playing the videos; lightbulbs = filming lights; camera = position of the director and the camera; arrow = direction of the filming. Sketch is not perfectly true to scale.

After completing the body expression filming, the camera was repositioned closer to the green screen and zoomed in on the actor's face. The actor was asked to stand in the centre of the green screen in order to obtain uniform lighting. For each emotion, the actor was shown four example facial expressions from the KDEF (Lundqvist et al., 1988), looping through the images until the actor was ready. Actors were told that the images were intended to help them think about the emotion, and that they could express using their faces as they see fit. They were asked to express the emotion starting from a "no expression" face. Actors were also asked to try their best not to move their body at all, or put their hands in front of their face, and just express

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

using their faces. This was particularly difficult for expressions of disgust, where actors had the propensity to move their body and/or head back. In such cases, the director asked for a few retakes. Once the actor was ready, the director gave an OK signal and started the recording. Same as with body expressions, actors were allowed to re-take the expression if they desired. For neutral expressions, actors were asked to stand still and blink passively a couple of times, so that some motion was recorded.

After piloting the filming set-up with colleagues, in order to perfect the room lighting and the editing process, four volunteer actors were recruited (two males, two females) via word of mouth and leaflets spread around the University of Lincoln campus. At least three body EE video for each emotion were obtained from each actor, and at least one face EE video for each emotion.

2.4 Video processing

Videos were edited using Adobe AfterEffects (Adobe Inc., 2020) and Shotcut (Meltytech, LLC, 2022). AfterEffects was used for the main editing process; Shotcut was used for converting videos to .webm format. For body expressions, the videos were cropped to the edges of the greenscreen. Facial expressions were cropped to contain the head of the actor, just above the shoulders. Videos needed to have varied sizes, given that actors often started the EE from close or from further away from the camera depending on the emotion (for body expressions). Videos were then cut to no longer than four seconds, starting from neutral, right before the actor would begin moving, and ending when the actor relaxed. Some body expressions were comprised of a set of consecutive movements (e.g., jumping back with hand to the chest, then covering mouth and turning sideways for a fear expression), others contained only one movement (e.g., a forward stomp with clenched fists for an anger expression). Most body and face EEs were shorter in duration before cutting, possibly due to actors being aware of the aim to create brief and direct expressions that would be recognisable without context. The green screen was keyed (using Keylight 1.2 in AfterEffects) and replaced with a grey background (RGB: 84,84,84), and videos were converted to grayscale. For the body expressions, dark grey (RGB: 128,128,128) masks were applied to the face, then the movement of the actor's head was traced using AfterEffect's mask motion tracking. As the motion tracking is not perfect, the main author had to manually trace some of the expressions or parts of the expressions. The sound was removed for all videos. The final product was converted to .webm using Shotcut, this format was chosen for its compact file size.

2.5 Video selection procedure

As there was a higher number of clips for body expressions due to the validation of the guide videos resulting in multiple videos, the author selected a single expression for the final stimulus set. The selection of the video prioritised a few characteristics: duration and complexity (favouring shorter, simpler expressions), movement inside the green screen area (favouring videos with the least amount of movement lost due to moving off the green screen), and videos where the actor was not smiling or laughing during the body expressions. Although, for the present thesis, only body expression with covered faces will be used, other research might want to use the body expressions with the face visible in the future. Some of the final videos had hands or legs out of frame at some points in the video. For the facial expressions, there was usually a single video for each emotion with no additional takes, requiring no selection from the author. This is the third occurrence where the subjective decision of the author affected stimulus creation. The final set consisted of 14 videos for each actor (7 emotions, body and face).

In order to explore static vs. dynamic differences, images needed to be obtained from the videos. A small-sample study was set up in order to have participants select images from the videos. Due to time pressures at the in deploying the studies that form this thesis (see COVID-19 lockdowns impact statement), a quick method for selection of images was desired. The author selected three images for each video in the stimulus set. The selection was based on having a variety of postures and gestures captured in the three images, attempting not to have two similar images in the set. The alternative was for the main author to choose the best frame, adding subjectivity, or to pick three images at random, which could have led to frames being selected just from the start or end. Additionally, the main author attempted to select emotions with the least amount of motion blur. This proved difficult, given that the videos were fairly short and most had a single peak of emotion, especially in the case of facial expressions, where often the three images were very similar. N = 14 participants were recruited via mailing inside of the School of Psychology at the University of Lincoln using an online Qualtrics survey. Out of the 14 participants, four were postgraduate students, whilst 10 were lecturers/researchers; 12 out of 14 reported having experience with ER or body/face image studies. Participants were asked to select images that they think best fit a given emotion (the emotion was displayed on the page for each stimulus). Based on participants' answers, the most selected image for each stimulus was selected as the corresponding static stimulus for each video. When there were ties, a random image was selected out of the two. Most of the ties were very similar images, with most occurring for facial expressions due to their high configural similarity.

The final set of stimuli contained one static and one dynamic body and face expression for each emotion, for each actor, for a total of 112 stimuli (2x2x7x4). All stimuli can be found in Appendix A.2.1 (images) and A.2.2 (videos). The stimuli will be used in Study 1 and 2, with study three containing the creation of a new stimulus set using similar methodology as described in this chapter, but with a larger actor pool (described in more detail in Chapter 6).

Chapter 3 – Study 1: ER of faces and bodies: the impact of individual differences and task characteristics

This first study has two main aims: to explore fER and bER differences in both static and dynamic expressions, and to investigate how demographics (age and gender) and personality traits (alexithymia, anxiety, ALTs, and empathy) are related to fER and bER. A new ER test was created for these purposes using the stimuli created in Chapter 2. Actor-specific differences are also explored.

3.1 Introduction

3.1.1 ER of static vs. dynamic expressions

The implications of the use of dynamic rather than static facial EEs are fairly well known. Dynamic facial EEs are easier to recognise, especially when emotions are less intense (i.e., more subtle); they are more ecological, employ more brain resources in their processing, and offer more emotional information via temporal dynamics (for a review, see Krumhuber., et al, 2013). Although many of these findings may extrapolate to body EEs, less is known about dynamic bER. Atkinson et al. (2004) uncovered a similar advantage of dynamic body EEs when comparing body PLDs to FLDs. Dynamic stimuli were easier to recognise than static stimuli across the basic emotions (surprise not used), with some emotions (i.e., anger) having a larger accuracy gap than others (i.e., joy). There were no differences in ERI, and no measurements of ERS. The authors attributed this advantage to neural systems specialised in (biological) motion detection that may aid in emotion recognition (Narumoto et al., 2001). These ERA and ERI findings were confirmed by Pollux et al. (2019) in both body EEs and face-body EEs, with a novel discovery of higher ERC for dynamic stimuli. The authors suggested that dynamic EEs that contain a change from neutral to peak emotion contain key information that increases the ERA compared to static stimuli. However, in a recent study, Mazzoni et al. (2020) found no differences between static FLDs, dynamic FLDs, and dynamic PLDs in

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

accuracy, with overall similar RTs between the three conditions. The non-finding was explained by the simplicity of the task: three-choice categorization task. More research is required to determine the complete pattern of static vs. dynamic differences in all basic emotions, as the study by Pollux et al. (2019) did not use EEs of disgust and surprise, and Atkinson et al. (2004) did not include surprise. Moreover, there are no studies, to the author's knowledge, that have investigated whether the advantage of dynamic stimuli is different in facial compared to bodily EEs.

Another explanation that has been offered by some authors for the advantage of dynamic stimuli is simulation theory, which suggests that individuals attribute mental states to others by replicating part of the same state in their own cognitive system (Goldman & Sripada, 2005). The simulationist models are included as a part of larger embodied cognition theories under the concept of "embodied simulation" (Gallese & Sinigaglia, 2011). Embodied simulation theory posits that ER is facilitated by simulating the perceived movements observed in others in order to categorise salient emotion expressions in the observer's own cognitive system (Niedenthal et al., 2010). Evidence supporting the embodied simulation theory of ER results largely from studies using facial expression stimuli, as researchers opted to explore this paradigm using established methodology (e.g., Ponari et al., 2012). The neural underpinning of embodied simulation is the mirror neuron system (MNS; Rizzolatti & Craighero, 2004), a network of brain structures that was initially described as an action understanding and imitation system (Di Pellegrino et al., 1992; Rizzolatti et al., 1996) but was later discovered to be involved in human social cognition (Gallese et al., 2004). Neuroscientific ER research demonstrated that dynamic stimuli lead to greater to MNS activity compared to static stimuli (Kilts et al., 2003; Sato et al., 2004; Van der Gaag et al., 2007). Thus, embodied simulation occurring in the MNS can explain the advantage of dynamic stimuli.

Early research suggests that the recognition of facial expressions triggers a fast (<500 ms), unconscious, and intensity sensitive imitation of emotion-specific facial muscle movements in the viewer that can be measured using EMG (Cacioppo et al., 1986; Dimberg & Thunberg, 1998). This process, termed 'mimicry', has been observed in infants (Isomura & Nakano, 2016), suggesting its innateness in humans. Theorists consider mimicry to be a form of unconscious embodied simulation (Atkinson & Adolphs, 2005), as it is considered to aid ER via proprioceptive feedback (Goldman & Sripada, 2005; Hatfield et al., 2014). Experimental evidence suggests that blocking mimicry via wilful physical manipulations, such as having participants hold a pen in their mouth or chew gum (Oberman, Winkielman, & Ramachandran, 2007), can inhibit ERA, with recognition of specific emotions being dependent on the associated muscles for which mimicry was disrupted (Niedenthal et al., 2001; Ponari et al., 2012). This is not to be confounded with studies where a mood-congruent feedback was induced by experimental manipulations aimed at facilitating emotion expressions that participants were aware of and intended to perform (e.g., holding a pen so as to form a clear smile; Strack, Martin, & Stepper, 1988). Additionally, completely blocking the function of facial muscles involved in emotion expressions, effectively stopping mimicry, results in ERA deficits. Botox injections have been reported to result in specific impairments of ERA on emotions for which their associated facial expression muscles were blocked (Neal & Chartrand, 2011), with blocking of muscles involved in sadness expressions resulting in a reduction of the magnitude and quantity of depression symptoms (Finzi & Rosenthal, 2014). Reviews of clinical literature suggest that Parkinson's disease patients present with deficits in ERA due to lower mimicry responses caused by the hypomimia characteristic of the disorder, as opposed to long-term cognitive degeneration (Livingstone et al., 2016; Prenger & MacDonald, 2018). Of more importance for the present thesis, there is evidence suggesting that dynamic stimuli elicit significantly higher mimicry responses than static stimuli (Rymarczyk et al., 2018), an effect that is modulated by individual differences such as trait empathy (Rymarczyk et al., 2016b; Rymarczyk et al., 2019) and gender (Rymarczyk et al., 2016a). These findings provide more evidence for the embodied simulation explanation of the dynamic stimuli advantages. However, more research is needed for decisive conclusions, given that there is evidence suggesting that mimicry does not mediate ER (Hess & Blairy, 2001; Rives Bogart, & Matsumoto, 2010). Understanding static compared to dynamic bERA vs. fERA can further the understanding of simulationist models, and pave the road for further mimicry research using body expressions. For example, if dynamic stimuli aid the recognition of bodies more than faces, it could suggest the possibility of mimicry being employed more when recognising bodies, and could warrant further body mimicry research.

3.1.2 Individual differences in emotion recognition

Studies tend to find small positive relationships between **empathy** and fERA (Gery et al., 2009; Besel & Yuille, 2010; Sucksmith et al., 2013; Chikovani et al., 2015; Melchers et al., 2016; Olderbak & Wilhelm, 2017), or fERI (Martin et al., 1996). Furthermore, other studies have found small relationships only between some facets of empathy and fERA, such as empathic concern and personal distress (see Davis, 1983 for definitions). Israelashvili et al. (2020) have found a positive relationship between fERA (and fbERA) and empathic concern, and a negative relationship with personal distress. In contrast, Beals et al. (2022) found a negative relationship between empathic concern and fERA, but no relationships with personal distress. Israelashvili et al. (2020) suggested that the mixed findings are due to problems with the conceptualisation of empathy, particularly with unclear distinctions between cognitive and affective empathy in some measures of empathy. There are many studies that have measured empathy and ER, aiming to investigate relationships with other constructs but that did not report the correlations between ER and empathy (e.g., Wai & Tiliopoulos, 2012; Holland et al., 2021). One possible reason for this is the aforementioned close conceptual link between empathy and ER, with researchers viewing both as a measure of the same latent construct. Most research has focused on affective empathy; less is known about the relationship between fER and cognitive empathy. Researchers have begun constructing explicit measures of affective and cognitive empathy, suggesting that not distinguishing between the two types of empathy could be a cause for the mixed findings (Reniers et al., 2011). However, studies that differentiated affective and cognitive empathy also produced mixed results. Some studies found associations between fERA and cognitive empathy, but not affective empathy (Moret-Tatay et al., 2022), whereas other studies found no relationships between ERA and either empathy types (Vilaverde et al., 2020), and others did not report relationships between empathy and ERA despite measuring both (Gonzalez-Gadea et al., 2014; Khanjani et al., 2015). Overall, research tends to produce very mixed findings; more studies are required to clarify the relationship between

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

empathy and fER. Studies investigating bERA and empathy are scarcer than fERA studies. Two studies have found a positive relationship between empathy (cognitive and affective) and bERA measured using computer-generated body expressions in children (Metcalfe et al., 2019), but not in adults (Martin et al., 2019). A study using body PLDs found a relationship between empathy and bERA using dynamic stimuli, but not static stimuli (Sevdalis & Keller, 2012). Given the assumption that dynamic stimuli elicit embodied simulation (Van der Gaag et al., 2007), this finding could be explained by the meta-analytic association that has been found between facial mimicry and empathy (Holland et al., 2021), linking empathy to simulationist models of social cognition. No studies have directly compared relationships between empathy and fERA vs. bERA in the same testing paradigm (using body and face EEs from the same actors in an identical categorisation task). Further research is also needed to investigate the link between static vs. dynamic ER and empathy.

The knowledge base about the relationships between **anxiety** and fERA based on multiple different emotions (or all basic emotions) is much smaller than the one on attentional biases towards threatening stimuli. Studies based on inducing state anxiety, such as via threat of receiving an electric shock or social stress protocols, have uncovered increased accuracy only for threatening stimuli (Robinson et al., 2011; Brüne et al., 2013). One study examining similar induced effects, but using a carbon dioxide anxiety-inducing manipulation has found an overall reduction in ERA which was not emotion-specific (Attwood et al., 2017). In the same study, trait anxiety was found to be associated negatively with fERA, but this association was mediated by state anxiety. However, in a replication of the study using a similar carbon dioxide paradigm, the same research team found no associations between trait anxiety and fERA, just between state anxiety and fERA (Dyer et al., 2022). In contrast, other studies have found that high trait anxiety individuals have increased fERA for fearful stimuli, but no other fERA differences for other emotions (Surcinelli et al., 2006; Japee et al., 2009). One study found higher fERA and fERS for fear, but reduced fERA for anger in high anxiety adolescents (Simcock et al., 2020). Some authors found no differences between high and low trait anxiety individuals on fERA (Cooper et al., 2008). When looking at anxiety disorders, the picture of ER – anxiety relationships and which specific emotions are

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

linked to anxiety is no clearer. A meta-analysis found that people diagnosed with anxiety disorders have lower fERA overall than controls (Demenescu et al., 2010). However, some studies find emotion-specific differences, with lower fERA on anger (Jarros et al., 2012), anger and disgust (Montagne et al., 2006), sadness (Bell et al., 2011), or fear, joy, and surprise (Oh et al., 2018). Some studies report no differences in fERA (Palm et al., 2011). Authors tend to blame the mixed findings both on varying anxiety levels and lack of integration in the use of fERA tasks (Dyer et al., 2022). It is certain that the relationships between fERA and anxiety need further research, or at most, fERA studies should control for anxiety to avoid unsystematic variance problems. In contrast, the relationship between bER and anxiety is mostly unknown. One study by Kret et al. (2013), investigated the perception and recognition of faces and bodies alongside a measure of trait anxiety, using static stimuli. It was found that trait anxiety is positively related to the fER accuracy of fear, but negatively related to the bER accuracy of fear, with no relationships for joy or anger. There were no effects of trait anxiety on incongruent fbERA recognition tasks.

In summary, it is unclear whether state and trait anxiety are related to fER due to contradictory findings, and relationships with bER are underexplored. The present study will assess relationships between both state and trait anxiety, ERA, ERS, ERI, and ERC using faces and bodies, exploring differential relationships to ER of static and dynamic stimuli, and investigating relationships to the recognition of all basic emotions.

Given that **alexithymia** presents with difficulties identifying and describing one's own emotions, researchers hypothesised that alexithymic individuals could struggle with identifying others' emotions as well (Singer & Lamm, 2009). However, similar to empathy and anxiety, the emerging alexithymia and fER literature suffers from heterogenous findings. A review by Grynberg et al. (2012) found that ten out of twelve studies to that date found impaired ERA in individuals with high alexithymia. The authors concluded that alexithymic individuals have impaired ER only when presentation or response time windows are short. One study not included in the review found no difference between alexithymics and controls in fER (McDonald & Prkachin, 1990). In the clinical literature, analysis of alexithymia and fER relationships in clinical samples produces mixed findings. Some studies of eating disorders, alexithymia, and

ER find no relationships between alexithymia and fER (Kessler et al., 2006), whilst others find alexithymia responsible for the reduced fER of patients (Brewer et al., 2015). Jongen et al. (2014) found alexithymic individuals have only slightly worse fERA, and suggested the small effect sizes as an explanation for past mixed findings. A very recent review of the alexithymia and social cognition literature, summarising the findings of 44 alexithymia – fER studies, found that only eight studies did not find a relationship (Di Tella et al., 2024). The authors attributed the non-findings to a different cause than Jongen et al. (2014): heterogeneity in the task characteristics of fER tests used. It is important to note that difficulties describing feelings is the dimension of alexithymia that tends to be the most related to ERA, more than the overall alexithymia score (Parker et al., 2005; Ihme et al., 2014a; Ihme et al., 2014b). Overall, the relationship between fER and alexithymia seems to be more robust than the relationships with anxiety or empathy. Alexithymia is also negatively related to fERC (Lorey et al., 2012; Torunsky & Vilares, 2020). Much less is known about the relationship between bER and alexithymia. An early study found no relationship between alexithymia and ER of face and body cues (Berenbaum & Prince, 1994). However, the study used stimuli from the Profile Of Nonverbal Sensitivity (PONS; Rosenthal et al., 1979), a tool that is not designed specifically as an emotion recognition test and suffers from a number of limitations, especially in terms of body expressions, and has slowly been phased out in favour of more modern bER stimuli and tests (De Gelder, 2006). A clinical study found no relationship between bERA or fERA and alexithymia in multiple sclerosis patient and controls (Cecchetto et al., 2014), but it allowed participants unlimited time to categorise the emotions, whereas most studies have a timer for the categorisation; the authors argued that it could have reduced ERA variability. A more recent ERP study also found no relationship between bERA or bERS and alexithymia (Borhani et al., 2016), but found that alexithymia impacts early emotion processing of body EEs. This study did have a short response time window, however, it made use of only two emotions (one negative, one positive, and neutral), which resulted in ceiling effects for each emotion. It is still unknown whether alexithymia is related to bERA, but the relationship with fERA seems clearer. This study aims to clarify these relationships whilst using an improved measure of alexithymia designed to improve on classical measures (Preece et al., 2018; more methodological details in subchapter 3.2.2).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Gender differences in ERA are more well understood than other individual differences. Initially, it was believed that females have an advantage over males in recognising only subtle or brief EEs (Hall & Matsumoto, 2004; Hoffmann et al., 2010). However, a very recent meta-analysis of an astounding 1011 studies uncovered a clear, but small (d = .24) advantage for women in ER, largely from facial and vocal expressions (Hall et al., 2025). Notably, a review by Kret & De Gelder (2012) found that men have a greater response to threatening stimuli, despite having overall lower ERA than women. It is possible that gender differences in bERA are more complex. An early study using the PONS found that women have higher bERA than men (Blanck et al, 1981). More recent research, however, tends to find more complex relationships. Sokolov et al. (2011), using PLDs of emotional actions, found that males and females excel at recognising different emotions – females are more accurate at recognising anger and neutral, males are more accurate at recognising joy, with no ERS differences. In another similar study, but using PLDs recorded from males and females, Krüger et al. (2013) found a cross-gender effect: females had higher bERA only on male anger expressions, and males had higher bERA on female joy expressions. Females had higher ERS, but only when recognising EEs of joy. Conversely, other PLD studies found no differences between genders (Isernia et al., 2020), but some found that males had lower bERS (Alaerts et al., 2011). In a study comparing fERA and bERA (both using PLDs), Pavlova et al. (2022) found that females had an advantage on bERA, with no fERA differences. Body EEs were harder to recognise than face EEs, making the findings align with the hypothesis that females might be better when EEs are more difficult to recognise. Using FLDs, a recent study observed cross-gender differences in ERPs, but without any accuracy differences (He et al., 2018). More research is needed to address mixed findings, likely resulting from heterogeneity of task characteristics (for a review, see Pavlova, 2017). Given that very little is known about bER from FLDs, the present study aims to add to the literature by investigating body FLDs using balanced male-female stimulus sets, and exploring all basic emotions in a static vs. dynamic paradigm.

An important consideration for ER studies is the fact that the aforementioned individual differences (gender differences, anxiety, alexithymia and empathy) that are related to ER are also related to each other. There are small gender differences in

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

alexithymia (Mendia et al., 2024), and slightly more pronounced differences in empathy (Christov-Moore et al., 2014) and anxiety (Stoner & Spencer, 1986; Farhane-Medina et al., 2022). Alexithymia is comorbid to most types of anxiety disorders (Berardis et al., 2008), and is also related to state and trait anxiety (Franzoi et al., 2020). Anxiety is related to empathy, mostly to affective empathy (Nair et al., 2024). Alexithymia and empathy have a complex relationship. Some authors have proposed the shared network hypothesis of empathy, which suggests that when observing another's emotions, a similar representation is activated in the observer (Singer & Lamm, 2009). The hypothesis is informed by neuroimaging studies showing common neural structures for empathy and emotion (Singer et al., 2009). The present thesis will add to the shared network hypothesis by investigating the empathy-alexithymia-ER triad and explore a novel line of research using body EEs.

3.1.3 Aims and research questions

The first study in the project aimed to compare fER and bER in a sizeable sample, allowing for the exploration of individual differences and task characteristics. More specifically, fER and bER were compared in two conditions based on motion: static vs. dynamic, and for each of the six basic emotions (Ekman, 1992), plus a neutral condition. Differential relationships with regards to modality between ER and the following individual traits and demographics were assessed: alexithymia, anxiety, ALTs, empathy, age, and gender. The ER test used stimuli from four actors (two female), aiming to explore actor differences in preparation for Study 3, which will address actor differences in more detail. The study aims to address the following research questions, both at an overall ER level (averaging across emotion trials) as well as at an emotion-specific level (for each emotion):

(A) Are there differences between fER and bER? It is slightly more likely that bodies will be harder to recognise than faces; despite the mixed findings and the use of PLDs exclusively, most past research tends to find lower overall bERA (Pavlova et al., 2022). Emotion specific differences between bERA and fERA will be explored; no previous study has used EEs of all basic emotions when comparing bERA and fERA (see Chapter 1.2).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

(B) Is there a differential dynamic advantage for bER compared to fER? It is hypothesised that dynamic stimuli will be easier to recognise than static stimuli (replicating previous findings, i.e., Atkinson et al., 2004; Pollux et al., 2019; Khosdelazad et al., 2020). Motion will be more important for bodies than faces: higher bERA difference between static and dynamic stimuli; given that there is more motion involved in body EEs, it is speculated that simulation is more beneficial for bER, making dynamic body stimuli more salient (Van der Gaag et al., 2007; Niedenthal et al., 2010; Rymarczyk et al., 2018). Previous research has found that dynamic vs. static differences affect specific emotions. For bER, dynamic stimuli are expected to increase the ERA and ERC of fear and joy EEs, but reduce them for sadness (Pollux et al., 2019). For fER, disgust, fear, sadness, and surprise are expected to be enhanced by dynamic stimuli (see Khosdelazad et al., 2020; note that authors did not use EEs from the same actors when comparing static and dynamic stimuli).

(C) Are demographics and personality traits formerly associated with fER also related to bER? It is expected that state and trait anxiety, trait autism (ALTs), alexithymia, cognitive and affective empathy, gender, and age are related to ER (replicating previous findings, see Chapter 1.4).Differences in relationships between fER and bER will be explored; most research has been conducted on fER, with very little being known about bER, making hypothesising speculative. Regardless, it is expected that anxiety will be more related to bER than fER, given that bER might generate more physical threat, therefore attracting more attention from observers (Cisler & Koster, 2010). The study will explore if relationships with individual differences are different between static and dynamic ER; this is largely exploratory, but similarly to the previous prediction, it is possible that anxiety will have a stronger relationship with dynamic stimuli, as they could be perceived as more threatening. Additionally, since dynamic stimuli tend to aid older adults in ER (Grainger et al., 2017), a larger relationship between age and dynamic ER is expected. Relationships with image faces, image bodies, static faces, and static bodies will be explored separately. This is a very novel research question. Some emotions are more likely to be related to certain traits: recognition of anger and fear will be related to state and trait anxiety (Simcock et al., 2020); recognition of disgust will be related to ALTs (Jayashankar & Aziz-Zadeh, 2023); age will be related to the ER of anger,

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

fear, and sadness (Richter et al., 2011); gender differences will be larger for anger and joy (Sokolov et al., 2011; Krüger et al., 2013).

(D) Do different actors express emotions differently in terms of recognisability? Are there any cross-gender effects? Actor differences will be explored in order to understand inter- and intra-actor variability. Study 3 will explore actor differences in a more detailed manner.

Most of the hypotheses listed above pertain to ERA, as research on ERS and ERC is too scarce for anything more than speculation. However, all of the hypotheses will be tested using all three measures of ER, with ERS and ERC being investigated largely in an exploratory fashion.

3.2 Methods

3.2.1 Participants

Data from an opportunity sample of N = 391 was collected at the University of Lincoln. Data collection took place from 2022 to 2024, and included a variety of online opportunity data collection methods. Firstly, data was collected via Sona (n = 134), a participant recruitment system that awards psychology students from the University of Lincoln with course credit for participating in research. Secondly, data was collected by second-year students as part of a research skills module assessment (n = 169). They collected data mostly from volunteer friends and family via word-of-mouth and snowballing (no remuneration). Finally, one sample was collected from Prolific.co (Prolific, n.d.), where participants were paid £4 for participating in the study, which took on median 25 minutes to complete (n = 88).

Participants were allowed to enter their own gender identity in the study: 248 were female, 109 were male, and seven were non-binary. Due to data protection constraints in one small part of the data collection process, 25 participants had missing demographics data. Participants were aged 18 to 80, heavily skewed towards young adults (M = 29.7, Mdn = 21, SD = 14.7). Roughly half of the sample were students

(51.9%) out of which 96.3% were undergraduates. Most participants were native English speakers (90.7%).

3.2.2 Measures

AQ-10: The Autism Quotient 10 (Allison et al., 2012) is a short-form questionnaire of the 50-item Autism Quotient (AQ; Baron-Cohen et al., 2001). It contains 10 questions used to assess ALTs. All questions are answered on a four-point Likert scale (1 - definitely agree to 4 - definitely disagree). The scores are converted to 0 and 1 regardless of the degree of agreement, with resulting scores ranging from 0 to 10. Allison et al. (2012) recommend that scores higher than 6 be considered high ALTs. In the present sample, the AQ had good internal consistency (α = 0.75), which is lower than in the validation sample (α = 0.85). It is important to note that the AQ-10 has recently been criticised for having very low test-retest reliability (r = .28) and low convergent validity with the AQ (r = .55) in an online study of university students (Cheung et al., 2023). Another study also found low internal consistency (α = .48; Jia et al., 2019). Although its psychometric properties have been questioned, the AQ-10 remains a powerful tool for rapid measurement of ALTs.

QCAE: The Questionnaire of Cognitive and Affective Empathy (Reniers et al., 2011) measures cognitive and affective empathy as defined in Chapter 1.4. Cognitive empathy has two sub-dimensions: perspective taking and online simulation, whilst affective empathy has three: emotion contagion, proximal responsivity and peripheral responsivity. The questionnaire measures empathy using 31 statements (19 for cognitive empathy, 12 for affective empathy) by querying agreement using a 1 (strongly agree) to 4 (strongly disagree) Likert scale. An example a cognitive empathy item is: "I can easily work out what another person might want to talk about." An example of an affective empathy statement is: "I am happy when I am with a cheerful group and sad when the others are glum.". The questionnaire demonstrated good test-retest reliability at two weeks (*r* = .69 - .79; Şakir et al., 2021). The initial validation study found good internal consistency for the subscales and total empathy score (α = .65 - .85), with the exception of the peripheral responsivity scale (α = .42). In the present study, internal

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

consistency was acceptable for all five subscales (α = .63 - .89), and very good for the cognitive (α = .90), affective (α = .80), and total scores (α = .89).

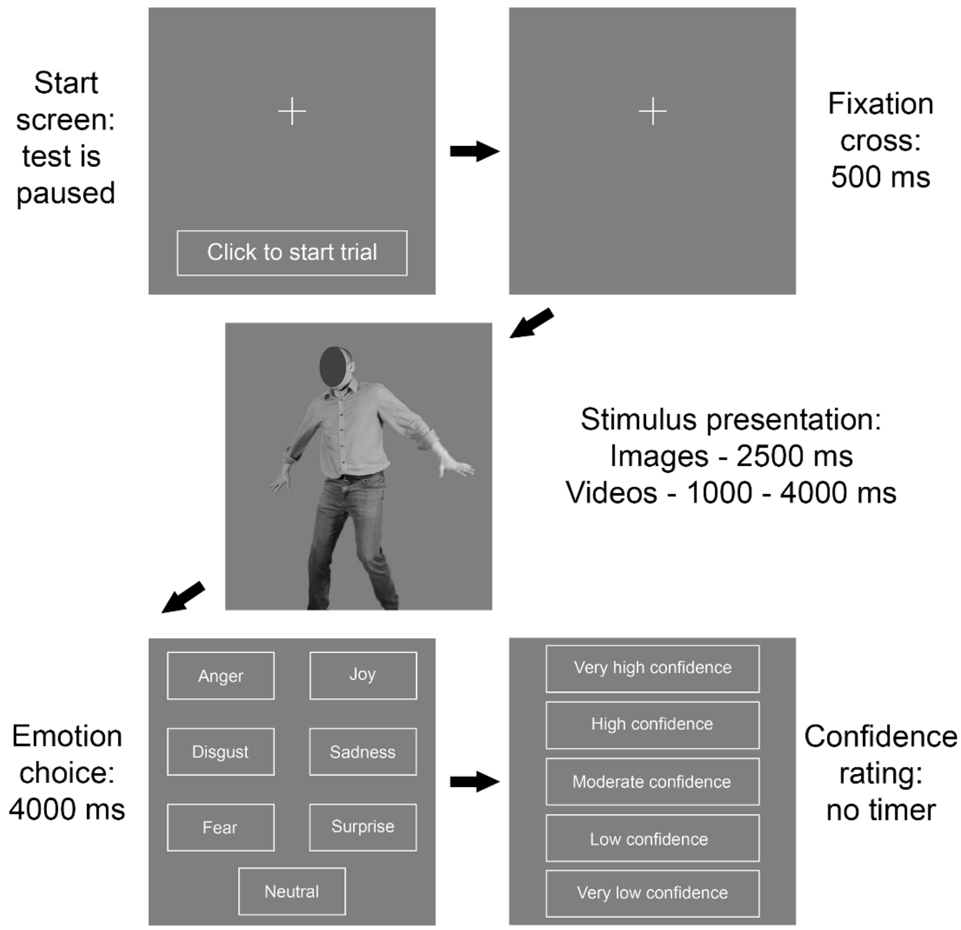
STAI: State and Trait Anxiety Inventory (Y form; Spielberger, 1983) is a questionnaire that measures state anxiety, defined as the degree of anxiety felt at a point in time, and trait anxiety, defined as a personality trait that measures the degree of anxiety experienced on a regular basis, self-reported retrospectively. The state and trait forms each have 20 items using 4-point Likert scales. The state form contains items such as “I feel calm” or “I am worried” and queries how much the participant “feels like that now” (“Not at all” to “Very much”). The trait form, on the other hand, asks the participant to indicate how often “they generally feel” like the statement (e.g., “I worry too much over something that really doesn’t matter”), from “almost never” to “almost always”. For the measurement of state anxiety, a shorter, 6-item version of the questionnaire was used in order to reduce participation time (STAIs-6; Marteau & Bekker, 1992). The STAI trait questionnaire (STAIt) has demonstrated very good test-retest reliability (r = .97; Metzger, 1976) and internal consistency (α = .93; Vera-Villarroel et al., 2009). The short form STAIs-6 was also internally consistent (α = .82; Marteau & Bekker, 1992), but does not get regularly assessed for test-retest reliability, as it is a state measure and is expected to fluctuate (Spielberger, 1983). In the present sample, internal consistency was very good for both the STAIt (α = .95) and the STAIs-6 (α = .86).

PAQ: Perth Alexithymia Questionnaire (Preece et al., 2018) is a self-report scale that measures alexithymia (defined in Chapter 1.4). The questionnaire measures the same aspects of alexithymia as more classic alexithymia questionnaires (Preece et al., 2017): difficulties identifying feelings (DIF), difficulties describing feelings (DDF), and externally oriented thinking (EOT). The PAQ has improved psychometrics compared to the older, and more popular alexithymia questionnaires (such as the TAS-20 and BVAQ; Bagby et al., 1994; Vorst & Bermond, 2001). In addition, it improves the theoretical scope of alexithymia by measuring the three dimensions of it in relation to both positive and negative feelings (e.g., “When I’m feeling bad, I get confused about what emotion it is.”, “When I’m feeling good, I can’t make sense of those feelings.”). The PAQ uses an agreement-based Likert scale from 1 (Strongly disagree) to 7 (Strongly agree). The scale has very good internal consistency (α > .87; Preece et al., 2018) and test-retest reliability (r ≥ .85; Larionow et al., 2022). In the current sample, internal consistency was also very good (α > .89).

Body and Face Emotion Recognition (BaFER) Test. An emotion recognition test was created for the purpose of this study, with the intention to measure static and dynamic emotion recognition from bodies and faces. The test was created using pure JavaScript with no libraries, and implemented in JavaScript questions on Qualtrics/QuestionPro (Qualtrics, 2022; QuestionPro, 2024). The stimuli created in Chapter 2 were used in the test, resulting in a total of 112 emotion categorisation trials (2 modalities x 2 motion conditions x 4 actors x 7 emotions). The stimuli were stored in Qualtrics/QuestionPro. Each trial began with a starting screen where participants could pause indefinitely, having to press a button to begin the trial. The starting screen was followed by a 500 ms fixation cross that was slightly higher than the centre of the task window (40% of the distance from the top), corresponding to the eyes of most facial expressions and the chest of most body expressions. The stimulus was presented after the fixation cross disappeared, with a fixed duration for images (2500 ms) and variable duration for videos (1000 – 4000 ms). Immediately after the stimulus presentation, the emotion choice (anger, fear, disgust, joy, sadness, surprise, and neutral) was presented to the participant, with a timer of 4000 ms. Response times were recorded from the start of the emotion choice screen. As soon as the participant pressed a button or the timer ran out, the confidence rating screen was presented asking the participant to rate how confident they were that they categorised the emotion correctly on a 5-point Likert scale (see Figure 3.1). The confidence screen had no timer. Due to no timers being implemented in the confidence and starting screens, the trial duration could be a minimum of six seconds, but an unknown maximum. The pauses were intended to reduce cognitive tiredness and allow participants to pause the participation process, given the possibility of distraction due to the online data collection. All trial screens, including the stimuli, had a grey background (RGB: 128,128,128; see Figure 3.1) and were presented in a webpage with the same background. The app window was a square with the length of 600 pixels with a black border. In order to avoid stimuli not being displayed due to slow internet speed, the test began with an animated loading screen that disappeared as soon as all the videos and images were loaded. A loading function was created in JavaScript that ensured that all videos or images were loaded before beginning (See Appendix B.1).

Figure 3.1

Sequence of screens in one trial



Note. ms – milliseconds

The test was structured in four blocks: face images, body images, face videos, and body videos, preceded by two practice blocks: three image trials, and three video trials, respectively. Thorough written and visual instructions (Appendix B.2) were given before the test, as well as in the participant information sheet. Given the fact that the images were extracted from the videos, there were concerns about learning effects. To control for this, the four blocks were counter-balanced in a pseudo-randomised fashion, being presented in four possible orders:

1. image face > image body > video face > video body (if-ib-vf-vb)
2. image body > image face > video body > video face (ib-if-vb-vf)

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

3. video face > video body > image face > image body (vf-vb-if-ib)
4. video body > video face > image body > image face (vb-vf-ib-if)

The ordering was based on avoiding presenting an image and video block of the same modality in succession, ensuring some delay between seeing the same expression in a different motion condition. Each block contained 28 trials (4 actors x 7 emotions), all presented in a fully randomised order. There is a possibility that seeing the videos before the images results in a larger learning effect. Given that an image stimulus is a still frame extracted from a video stimulus (see Chapter 2), when viewing an image for which one has already viewed the parent video, they are technically seeing that image again. Average differences between the four orders will be computed and plotted to verify possible learning effects, both for understanding the present findings, and for informing future methodology.

3.2.3 Procedure

The study took place entirely online. After information and consent, participants first completed demographic questions and the STAIs-6, followed by the BaFER test, and finishing with the rest of the personality questionnaires. The study took on median approximately 25 minutes to complete. For the BaFER test, participants were told that speed is important, and they should aim to be as fast as possible. The study could only be run on computers (not on mobile devices), and the videos did not work on Safari. Participants using macOS were asked to run the study in a different browser. A question that verified if the participants were using a computer and not using Safari was implemented; it instructed participants to switch if they tried running the study with an incorrect set-up. The study received approval from the University of Lincoln Research Ethics Committee (reference code: 2020_3460).

3.2.4. Statistical analysis

Data was analysed using jamovi (The jamovi project, 2022) and R/RStudio (R Core Team, 2023; RStudio Team, 2023). Jamovi was used for obtaining descriptive statistics, computing correlation tables (that were subsequently formatted in Excel), checking some basic assumptions, and conducting methodological checks. RStudio was used for complex inferential analysis, such as multifactorial ANOVAs and multiple linear regressions, as well as for plotting interaction plots. Given the large number of ANOVAs required for the project, interaction plots, estimated marginal means, and post-hoc pairwise tests were obtained using a custom function created by the author for the purpose of this project (Appendix B.3). All subsequent studies will be analysed using the same software.

The ER test measured three variables per trial: accuracy (percentage hit rate; ERA), speed (response time; ERS), and confidence (1 – very low confidence to 5 – very high confidence; ERC). Lower response times (RT) indicate higher ERS. The stimulus recognised in each trial varied by four conditions: motion (image or video), modality (face or body), actor (four different actors), and emotion (six basic emotions plus neutral), for a 2x2x4x7 repeated-measures design (N = 112 trials). Unbiased hit rates (U) were calculated from the hit rates (H) using Wagner's method (Wagner, 1993). U was calculated based on the formula $a^2/b*c$, where "a" is the number of hits for a specific emotion, "b" is the number of trials containing that emotion, and "c" is the frequency of selecting that emotion category (hit rate + incorrect rate). U was calculated for each emotion within all other conditions (modality, motion and actor), as well as for the total ER score. Unbiased hit rates correct accuracy based on the number of times an emotion was chosen, therefore controlling for biases towards a particular emotion.

Most past research has explored accuracy using tests of differences between means and ANOVAs (Bänziger, 2016). This trend exists likely due to the interpretability of average accuracy scores. However, accuracy data is binary categorical data (correct/not correct), lending itself to binomial GLM analysis using loglinear transformations. To put it simply, concluding that, for example, women are 5% more accurate than men is more accessible than presenting differences in log-odds or odds

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

ratios. This is especially the case in complex repeated-measures designs where interaction effects represent the differences between numerous combinations of conditions. For example, a 2x2x7 interaction is the comparison of 28 repeated measures. Interpreting the differences between 28 log-odds is much less facile than inspecting a bar plot with 28 bars representing accuracy in percentages, clustered by two conditions. Moreover, a binomial GLM model could not be employed with unbiased hit rates as DVs, as the unbiased hit rate transformation turns binary (0/1) scores into scores in the range of 0 – 1, but on a variable discrete scale that differs between trials based on the frequency of incorrectly selecting each emotion. For example, the score of anger, actor 1, face, image can be on a 0 – .25 – 1 scale, whilst the score of disgust, actor 1, face, image can be on a 0 – .33 – .5 – 1 scale. Opting for a logistic regression instead of an ANOVA would require the use of hit rates instead of unbiased hit rates, but unbiased hit rates are becoming a golden standard for emotion recognition research (Schlegel et al., 2012).

3.2.4.0 Methodological checks

Some tests will be conducted in order to verify the effects of some possible extraneous variables. A one-way ANCOVA will compare whether there are differences in ER between the three sampling methods described in the participants section when controlling for age. Another ANCOVA will verify if there are differences between students and non-students, controlling for age. As Study 1 was conducted in a similar time period to Study 2, both of them using some of the same stimuli, a question was added to the studies asking participants if they saw the videos before. Participants that have seen the videos previously will be compared to participants that have reported never seeing them before. The former will be removed from the analysis if the differences are substantial.

Due to the study being conducted online, participants have the freedom to choose what hardware they use for the study. Particularly, it is possible that the use of a touchpad could slow participants' performance. Participants were asked to use a mouse in the instructions and participant information sheet, but the main author noticed that students were using a touchpad regardless of the instruction. Halfway through the study, a question asking participants which they used was added after the ER test. Differences between mouse and touchpad users in ERA and ERS will be assessed, and controlling for differences will be considered if there are any significant differences.

Correlations between ERA and ERS will be computed to verify if there are any accuracy – speed trade-offs. If a positive relationship is detected, suggesting that people who spend more time thinking are more accurate, a compound measure of accuracy and response time will be calculated and used as a measure of ERA.

Finally, a 4 x 2 x 2 mixed ANOVA will verify if the order of blocks impacted a possible learning effect for the modality and motion conditions.

3.2.4.1 Task characteristics

In order to test overall and emotion-specific differences between bER and fER, a 2x2x7 RM design will be employed for ERA, ERS, and ERC.

3.2.4.2 Individual differences

As the main analysis for this objective, correlations between the overall face and body task measures (accuracy, speed, and confidence, see 3.1.2.1) and all the personality trait measures (state anxiety, trait anxiety, cognitive empathy, affective empathy, alexithymia, ALTs), as well as age, will be calculated. Independent samples t-tests will be conducted to compare fER and bER between the two major gender categories. Gender differences in personality traits and age will also be investigated using t-tests. To assess the total impact of individual differences, as well as unique influences after controlling for covariation, several multiple linear regression analyses will be conducted with the personality traits, age, and gender as predictors, and each ER measure separately for body and face. This set of analyses will be replicated for measures on static and dynamic conditions, both when averaging across body and face conditions and for each combination of motion and modality: static faces, dynamic faces, static bodies, and dynamic bodies. Additionally, correlations between the personality measures, as well as between the overall task characteristics, will be explored.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

To condense the emotion-specific analysis, only a similar pattern of regressions will be conducted for each emotion score for bodies and faces (3.1.2.2), not the separate zero-order correlations as well. Due to the large number of regressions (2x7 for all three ER measures), the results will be condensed in a large regression table.

3.2.4.3 Actor differences

Treating actors as a condition (with four levels), the recognisability (EEA) of each actor will be explored.

To explore if there are own-gender or cross-gender preferences, the scores of actors will be averaged by their gender, resulting in a male actor score and female actor score. A mixed design comparing preferences for the two gender conditions between male and female participants will be employed. As this analysis focuses on actor EEA, comparing static vs. dynamic stimuli is not relevant, given that static images may be influenced by the raters that participated in the image selection study described in Chapter 2.

3.3 Results

An initial exploration of the normality of the main variables (age, personality traits, and overall recognition scores) demonstrated normal distributions, with the exception of age, which was heavily positively skewed (see Appendix C.1.0.0). Splitting variables by gender also yielded mostly normal distributions (see Appendix C.1.0.0). Normality was assessed via visual inspection of histograms and Q-Q plots, and skewness and kurtosis values (±1 from the centre value). Tests of normality (i.e., Shapiro-Wilk tests) were avoided due to their sensitivity to small deviations from normality in larger samples ($N > 50$; Shapiro & Wilk, 1965)

Descriptive statistics and confidence intervals of the mean for personality traits, age, and overall scores of the ER test, including separate statistics by gender, can be found in Table 3.1.

Table 3.0

Descriptive statistics and CIs of total sample, and separated by gender

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Variable	N	M	95% M CI LL	95% M CI UL	SD	N		M		95% M CI LL		95% M CI UL		SD	
			Total			F	M	F	M	F	M	F	M	F	M
Age	366	29.7	28.2	31.2	14.7	248	109	27.5	35.4	25.8	32.3	29.2	38.6	13.4	16.5
PAQ	391	84.2	81.4	87.1	29	248	109	83.7	85.2	80	79.7	87.4	90.7	29.3	29
AQ-10	391	3.92	3.68	4.15	2.38	248	109	3.75	4.04	3.47	3.56	4.04	4.51	2.25	2.49
STAIt	391	49.5	48.2	50.7	12.6	248	109	50.9	45.7	49.3	43.5	52.4	48	12.4	11.9
STAIs-6	365	11.7	11.3	12.1	4.08	248	108	12	10.7	11.5	10	12.5	11.4	4.09	3.65
QCAE cognitive	391	57.5	56.6	58.4	9	248	109	58.3	56.8	57.2	55.3	59.5	58.2	9.43	7.89
QCAE affective	391	36.1	35.5	36.6	5.59	248	109	36.9	33.6	36.2	32.5	37.5	34.7	5.2	5.82
QCAE total	391	93.6	92.4	94.8	12.2	248	109	95.2	90.4	93.7	88.2	96.8	92.5	12.5	11.2
U total	391	0.55	0.54	0.56	0.10	248	109	0.55	0.53	0.54	0.51	0.57	0.55	0.10	0.09
U body	391	0.56	0.54	0.57	0.11	248	109	0.56	0.53	0.55	0.51	0.58	0.55	0.11	0.11
U face	391	0.56	0.55	0.57	0.11	248	109	0.56	0.54	0.55	0.52	0.58	0.56	0.11	0.11
RT total	391	1296	1267	1325	291	248	109	1291	1322	1256	1261	1326	1382	281	318
RT body	391	1326	1296	1357	306	248	109	1316	1361	1280	1297	1352	1426	291	340
RT face	391	1267	1236	1297	306	248	109	1266	1282	1229	1220	1304	1344	299	328
Con total	391	3.71	3.65	3.76	0.54	248	109	3.7	3.79	3.63	3.68	3.76	3.89	0.53	0.54
Con body	391	3.61	3.55	3.66	0.56	248	109	3.6	3.68	3.54	3.57	3.67	3.8	0.53	0.59
Con face	391	3.81	3.75	3.86	0.56	248	109	3.79	3.89	3.72	3.78	3.86	3.99	0.56	0.53

Note. M = mean; SD = standard deviation; 95% M CI LL = Lower limit of the 95% confidence interval of the mean; UL = upper limit; F = female; M = male; U = unbiased hit rates; RT = response times; Con = confidence ratings.

3.3.0 Methodological checks

An ANOVA showed a significant difference in total ERA between the samples obtained from the three different data collection methods (volunteers, student credit, paid participation), $F(2,363) = 4.07$, $p = .018$, $\eta_p^2 = 0.02$, but the effect became non-significant after controlling for age in an ANCOVA, $F(2,362) = 2.24$, $p = .108$, $\eta_p^2 = 0.01$. Similar patterns were found when testing fERA and bERA separately.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

When comparing ERA between students and non-students, a similar approach revealed a significant difference, $F(1,364) = 7.56$, $p = .006$, $\eta_p^2 = 0.02$, that was made non-significant by controlling for age, $F(1,363) = 0.12$, $p = .729$, $\eta_p^2 < 0.01$.

Participants who have seen the videos previously (N = 36) were 2.62% more accurate on the ER test than participants who have not (N = 311), but the difference was not statistically significant, $F(1,345) = 2.29$, $p = .131$, $\eta_p^2 < 0.01$. The findings apply when looking at fERA and bERA separately (see Appendix C.1.0.1)

Comparing mouse (N = 44) vs. touchpad users (N = 106), there were no significant differences between the groups on ERA ($t(148) = –0.31$, $p = .759$) or ERS (t(148) = –1.17, p = .244), but mouse users were slightly faster (see Appendix C.1.0.1).

There were moderate negative relationships between accuracy and response times, both overall and separately for body and face conditions, $r(389) = –.30$ to $–.40$, $p < .001$. This suggests that Ps who were more accurate were also faster, not warranting accuracy/RT trade-off composite scores.

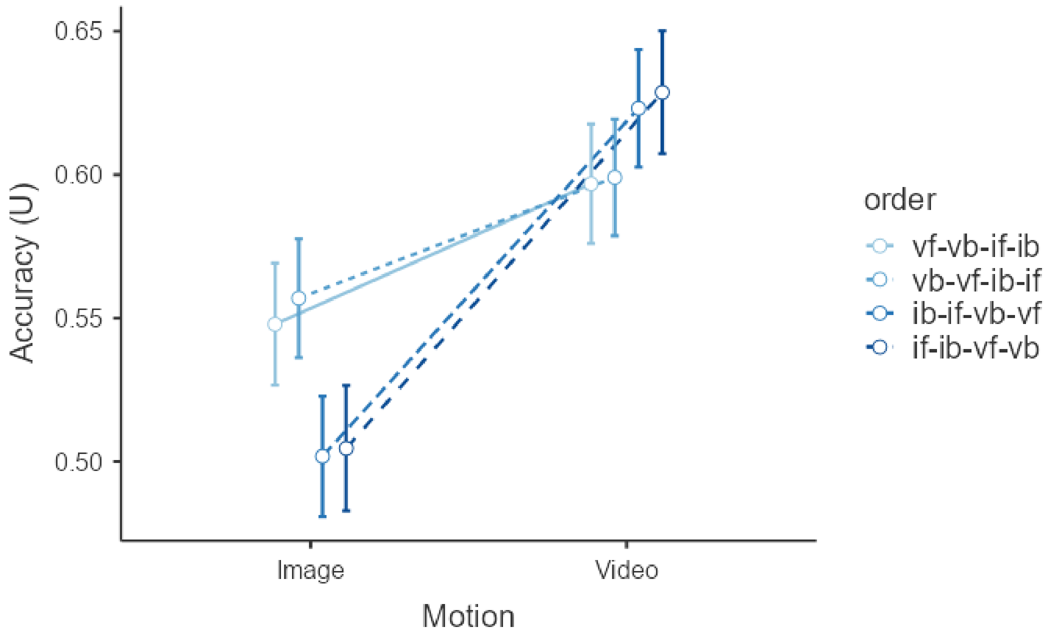
Given the above findings, none of the additional methodological changes discussed in the statistical analysis section were required.

A 4 x 2 x 2 Mixed ANOVA on accuracy (U) with the factors order (vf-vb-if-ib, vb-vf-ib-if, ib-if-vb-vf, if-ib-vf-vb), modality (face, body) and motion (image, video) was conducted to investigate if there are learning effects on accuracy in recognising bodies and faces in the different motion conditions. There was no significant main effect of order, no interaction effect of order x modality, and no three-way interaction of order x modality x motion. However, there was a significant effect of order x motion, ($F(3,387) = 23.34$, $p < .001$, $\eta_p^2 = .15$). The results suggest that seeing videos before images (drawn from the previous videos) increases the accuracy of images due to a learning effect, but not for videos after seeing images (Figure 3.2, see Appendix C.1.0.2 for post-hoc tests). Implications are discussed.

Figure 3.2

Learning effects: accuracy on image and video stimuli for each of the four orders of blocks

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display



Note. U = unbiased hit rates; if = image faces, ib = image bodies, vf = video faces, vb = video bodies; Error bars represent 95% CIs.

3.3.1 Task characteristics

Three 2x2x7 RM ANOVAs were conducted with each ER measure as DVs: accuracy (U), speed (RT), confidence (1-5 Likert rating). The factors were modality (face, body), motion (static, dynamic), and emotion (anger, disgust, fear, joy, neutral, sadness, surprise). The ANOVAs met all assumptions (Appendix C.1.1) with Greenhouse-Geisser sphericity corrections being applied accordingly. Although the confidence measure is an ordinal scale, when averaging across conditions the variable is turned into a pseudo-interval scale.

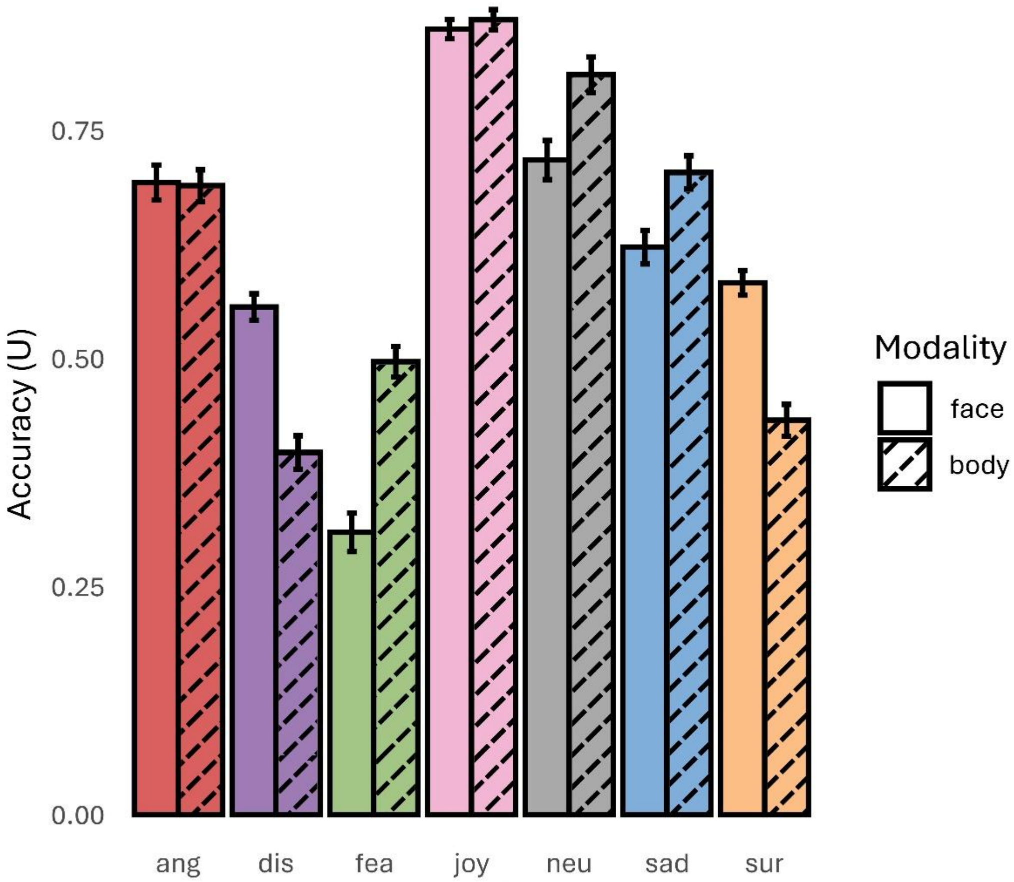
Accuracy: There was a significant main effect of motion (F(1,390) = 285.85, p <.001, η_p^2 = .42) and emotion (F(4.97, 1938.80) = 813.01, p <.001, η_p^2 = .68), but no significant main effect of modality (F(1,390) = 2.79, p = .096, η_p^2 < .01). There was a significant 2x2 interaction of modality and motion, (F(1,390) = 49.21, p <.001, η_p^2 = .11). Emotion interacted both with modality (F(5.36, 2089.16) = 163.70, p <.001, η_p^2 = .30) and with motion (F(5.45, 2123.65) = 33.99, p <.001, η_p^2 = .08). The three way interaction (2x2x7) was statistically significant, (F(5.45, 2123.65) = 25.08, p <.001, η_p^2 = .06). Post-

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

hocs and descriptives can be found in appendix C.1.1. For the 2x7 modality x emotion interaction, Figure 3.3 shows the accuracy by modality for each emotion. Figure 3.4 shows the three-way interaction.

Figure 3.3

Estimated Marginal Means of the 2x7 interaction of modality and emotion for accuracy.

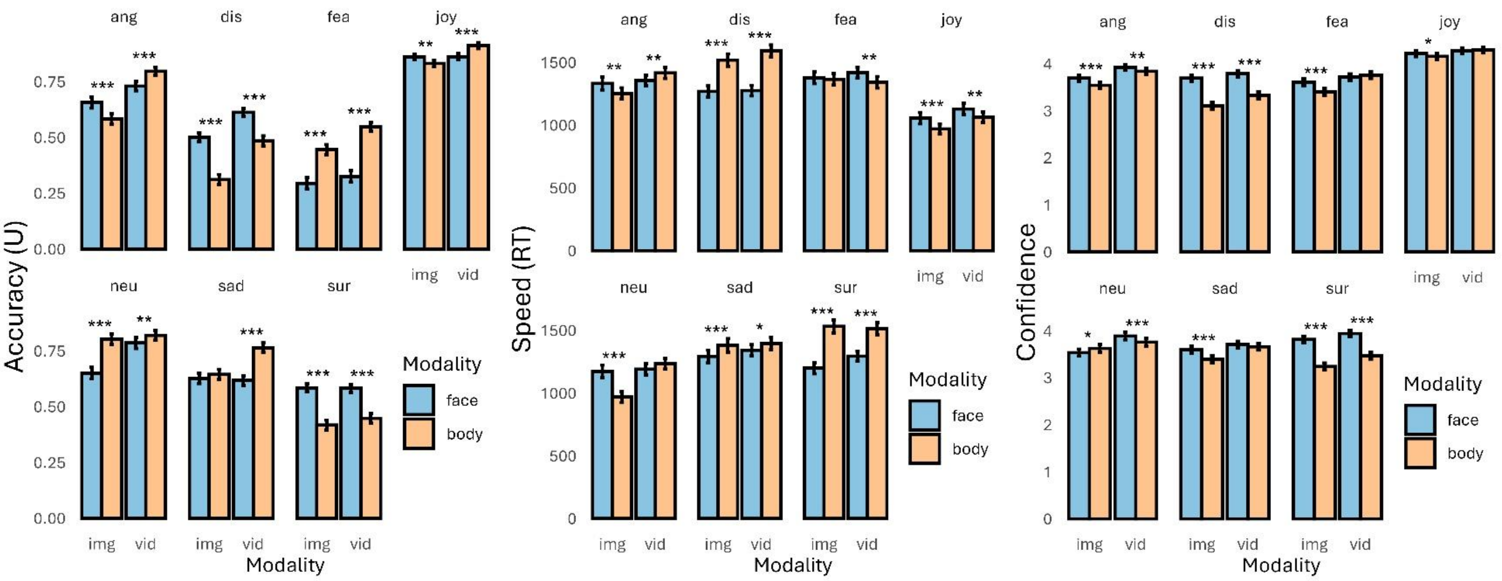


Note. U = unbiased hit rates; ang = anger, dis = disgust, fea = fear, neu = neutral, sad = sadness, sur = surprise;
Error bars represent 95% CIs.

Figure 3.4

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Estimated Marginal Means of the 2x2x7 interaction of modality, motion and emotion for accuracy, speed and confidence



Note. U = unbiased hit rates, RT = response times; ang = anger, dis = disgust, fea = fear, neu = neutral, sad = sadness, sur = surprise; img = images, vid = videos;

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

Error bars represent 95% CIs.

Speed and confidence: In the analogous 2x2x7 ANOVAs for speed and confidence, all main and interaction effects were statistically significant (Table 3.1).

Table 3.1

2x2x7 ANOVAs for speed and confidence

effect	df	F	η_p^2	p
Speed (RT)				
Modality	1, 389	39.82	.09	<.001
Motion	1, 389	21.89	.05	<.001
Emotion	5.52, 2148.99	184.78	.32	<.001
Modality x Motion	1, 389	6.39	.02	.012
Modality x Emotion	5.84, 2271.57	87.72	.18	<.001
Motion x Emotion	5.89, 2291.94	8.29	.02	<.001

Modality x Motion x Emotion	5.74, 2233.71	16.49	.04	<.001
Confidence				
Modality	1, 389	171.93	.31	<.001
Motion	1, 389	144.95	.27	<.001
Emotion	4.70, 1826.77	288.45	.43	<.001
Modality x Motion	1, 389	12.51	.03	<.001
Modality x Emotion	5.53, 2151.42	107.91	.22	<.001
Motion x Emotion	5.86, 2280.60	8.73	.02	<.001
Modality x Motion x Emotion	5.87, 2283.59	15.43	.04	<.001

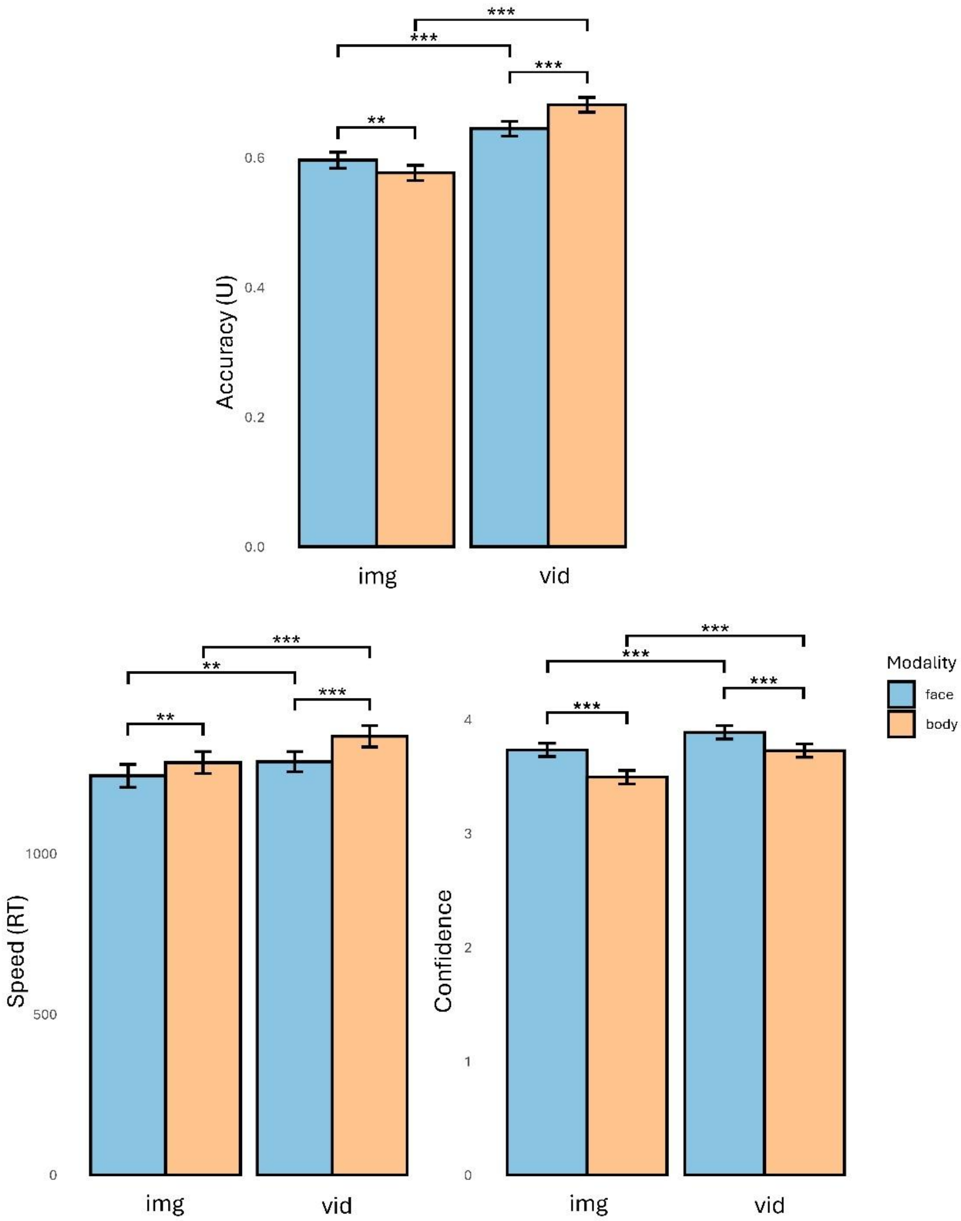
Note. Effects with non-integer degrees of freedom have been Greenhouse-Geisser corrected for sphericity.

All descriptives, post-hoc tests and plots can be found in Appendix C.1.1. Estimated marginal means of the modality by motion interaction are depicted in Figure 3.5.

Figure 3.5

Estimated Marginal Means of 2x2 interaction of modality and motion for accuracy, speed and confidence

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display



Note. img = images, vid = videos, U = unbiased hit rates, RT = response times; ang = anger, dis = disgust, fea = fear, neu = neutral, sad = sadness, sur = surprise; img = images, vid = videos;

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

Error bars represent 95% CIs.

Confusion matrices (Table 3.2) have been computed based on hit rates (biased), as unbiased hit rates cannot form confusion matrices, since the scores are transformed into non-binary responses (e.g., 0 - .33 - .5 - 1 instead of 0 - 1). More confidence matrices for other conditions of the ER task can be found in Appendix C.1.1.2.

Table 3.2

Confusion matrices for all trials, body trials and face trials.

	anger	disgust	fear	joy	neutral	sadness	surprise
			% out of all trials				
anger	73.02	1.09	0.78	0.42	2.30	1.66	3.63
disgust	8.82	56.95	10.55	0.06	3.21	9.38	3.13
fear	1.49	10.17	48.55	0.18	1.37	3.74	12.85
joy	7.08	4.52	0.48	95.59	0.18	0.22	6.23
neutral	3.76	5.29	1.55	0.48	83.54	6.52	2.19
sadness	1.55	12.74	4.35	0.30	4.67	75.24	1.82
surprise	2.24	6.94	31.79	2.00	3.55	1.26	67.81
			% out of body trials				
anger	75.10	1.73	1.25	0.70	2.56	2.53	7.10
disgust	1.89	44.15	9.18	0.03	1.50	3.32	5.69
fear	1.12	18.06	64.29	0.16	1.02	4.28	23.18
joy	14.10	1.15	0.61	95.59	0.19	0.32	1.66
neutral	3.36	5.82	1.63	0.13	88.11	5.24	3.64
sadness	0.54	14.35	4.70	0.26	4.38	79.92	3.04
surprise	2.05	11.99	16.27	2.37	0.96	1.89	52.49
			% out of face trials				
anger	70.94	0.45	0.32	0.13	2.05	0.80	0.16
disgust	15.76	69.76	11.92	0.10	4.92	15.44	0.58
fear	1.85	2.27	32.80	0.19	1.73	3.20	2.53
joy	0.06	7.90	0.35	95.59	0.16	0.13	10.81
neutral	4.16	4.76	1.47	0.83	78.96	7.80	0.74
sadness	2.56	11.13	4.00	0.35	4.96	70.56	0.61
surprise	2.43	1.89	47.31	1.63	6.14	0.64	83.12

Note. All scores are percentages; response choices (rows) do not add up to 100%, as the trials where the participant made no response, and the timer ran out, were not included in the table.

3.3.2 Individual differences

Descriptive statistics for the questionnaire measures, age, and the main task measures, both separated by gender, and for the total sample, can be found in Table 3.0.

Correlations between personality traits and the main test variables for body expressions, face expressions, and a total of both modalities are presented in Table 3.3. The relationship between face and body accuracy ($r(387) = .51$, $p < .001$) was smaller than the relationship for speed ($r(387) = .81$, $p < .001$), and confidence ($r(387) = .85$, $p < .001$).

Table 3.3

Correlations between personality traits, age and overall ER test measures

Variable	Total			Body			Face		
	U	RT	Con	U	RT	Con	U	RT	Con
RT	-.39***			-.33***			-.40***		
Con	.19***	-.19***		.12*	-.16		.26***	-.22***	
PAQ	-.03	-.01	-.06	-.01	-.02	-.03	-.05	.01	-.09
QCAE affective	.20***	-.10	.13*	.14**	-.09	.10	.21***	-.10*	.15**
QCAE cognitive	.04*	-.00	.21***	-.01	.03	.16**	.08	-.03	.24***
QCAE total	.12	-.05	.22***	.05	-.02	.17**	.16**	-.07	.25***
STAIt	.14**	-.14**	-.09	.15**	-.15**	-.07	.09	-.12*	-.11*
STAIs-6	.01	.04	.01	.00	.03	.05	.02	.05	-.03
AQ-10	-.01	-.07	-.11*	-.00	-.08	-.10	-.02	-.05	-.16*
Age[a]	-.18***	.12*	-.08	-.16**	.14**	-.13*	-.13*	.10	-.04

Notes. correlations on the first three rows are between the task variables on the columns and other task variables from the same condition (total, face or body); U = unbiased hit rates; RT = response times; Con = confidence ratings.

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

[a] correlations with age are non-parametric (Spearman's rank coefficients); sample size for the correlations with age is n = 366

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

A series of independent samples t-tests verifying gender differences in the main ER test measures and personality differences can be found in Table 3.4. Assumptions of the tests were met for all variables except age (see Appendix C.1.2.1).

Table 3.4

Independent samples t-tests between gender groups for each questionnaire variable, age and overall ER test measures.

	t	p	d̄	95% CI d̄ LL	95% CI d̄ UL	Cohen's d
age*	-4.80	<.001	-7.93	-11.18	-4.68	0.34
PAQ	-0.45	0.65	-1.51	-8.11	5.10	-0.05
AQ-10	-1.06	0.29	-0.28	-0.81	0.24	-0.12
STAIt	3.63	<.001	5.13	2.35	7.91	0.42
STAIs-6	3.11	0.00	1.43	0.52	2.33	0.36
QCAE cognitive	1.54	0.12	1.59	-0.44	3.63	0.18
QCAE affective	5.23	<.001	3.25	2.03	4.47	0.60
QCAE total	3.47	<.001	4.84	2.09	7.59	0.40
U total	2.22	0.03	2.51%	0.28%	4.75%	0.25
U body	2.27	0.02	2.93%	0.39%	5.46%	0.26
U face	1.56	0.12	2.01%	-0.53%	4.54%	0.18
RT total	-0.91	0.36	-30.63	-96.75	35.49	-0.10
RT body	-1.29	0.20	-45.28	-114.58	24.01	-0.15
RT face	-0.45	0.65	-15.98	-85.62	53.66	-0.05
Con total	-1.45	0.15	-0.09	-0.21	0.03	-0.17
Con body	-1.31	0.19	-0.08	-0.21	0.04	-0.15
Con face	-1.48	0.14	-0.09	-0.22	0.03	-0.17

Note. *for age, a Mann-Whitney U test was conducted instead, due to the non-normal distribution of age (Appendix C.1.0.0); the test statistic for age is a Mann-Whitney U statistic, and the effect size is a rank-biserial correlation coefficient.

95% CI d̄ LL = Lower limit of the 95% confidence interval of the mean difference; UU = upper limit; U = unbiased hit rates; RT = response times; Con = confidence ratings.

Pearson's correlations between the questionnaire measures (and age) were also computed in order to explore relationships between the personality traits (Table 3.5).

Table 3.5

Correlations between personality traits and age

		Age[a]	PAQ	AQ-10	STAIt	STAIs-6	QCAE cognitive	QCAE affective	QCAE total
PAQ	r	-.18***							
	N	366							
AQ-10	r	-.14**	.48***						
	N	366	391						
STAIt	r	-.20***	.49***	.45***					
	N	366	391	391					
STAIs-6	r	-.27***	.22***	.22***	.52***				
	N	365	365	365	365				
QCAE cognitive	r	.06	-.33***	-.57***	-.26***	-.15**			
	N	366	391	391	391	365			
QCAE affective	r	-.15**	-.03	.02	.24***	.12*	.36***		
	N	366	391	391	391	365	391		
QCAE total	r	-.03	-.25***	-.42***	-.08	-.05	.90***	.72***	
	N	366	391	391	391	365	391	391	

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

[a] For age, Spearman's rank correlations were computed instead, due to the non-normal distribution.

To obtain a full picture of the relationship between individual differences and overall ER, nine regression models were computed for each of the overall measures of the ER test: total, body, face, static, dynamic, and for the specific modality x motion measures: static face, static body, dynamic face, dynamic body with the predictors: age, gender, PAQ, AQ-10, STAIt, STAIs-6, QCAE cognitive, and QCAE affective. Nine regression models were computed for each ER measure, resulting in a total of 27 regressions. Results are summarised in Table 3.6. Assumptions of all 27 regression models can be found in Appendix C.1.2.2.

Table 3.6

Multiple linear regressions models displaying the relationship between personality traits, age, gender, and overall ER measures.

	model		predictors																							
			gender			age			PAQ			AQ-10			STAIt			STAIs-6			QCAE cog			QCAE aff		
	R^2	p	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β
U																										
Total	0.09	***	-0.18%		-0.01	-0.12%	***	-0.19	-0.04%		-0.11	-0.41%		-0.10	0.14%	*	0.17	-0.19%		-0.08	-0.05%		-0.05	0.26%	*	0.15
Body	0.08	***	-0.70%		-0.03	-0.13%	**	-0.17	-0.03%		-0.09	-0.52%		-0.11	0.18%	**	0.20	-0.28%		-0.10	-0.10%		-0.08	0.19%		0.09
Face	0.07	**	0.33%		0.01	-0.11%	**	-0.15	-0.04%		-0.11	-0.27%		-0.06	0.09%		0.10	-0.12%		-0.04	-0.01%		0.00	0.33%	*	0.16
Image	0.08	***	-0.65%		-0.03	-0.14%	**	-0.18	-0.04%		-0.11	-0.38%		-0.08	0.10%		0.11	-0.01%		0.00	-0.05%		-0.04	0.27%	*	0.14
Video	0.07	**	0.55%		0.02	-0.11%	**	-0.15	-0.03%		-0.08	-0.47%		-0.10	0.18%	**	0.21	-0.39%	*	-0.15	-0.06%		-0.05	0.23%		0.12
Img body	0.05	*	-1.73%		-0.06	-0.12%	*	-0.14	-0.03%		-0.06	-0.43%		-0.08	0.09%		0.09	-0.12%		-0.04	-0.15%		-0.11	0.24%		0.11
Img face	0.07	***	0.55%		0.02	-0.14%	**	-0.16	-0.06%	*	-0.13	-0.35%		-0.06	0.10%		0.10	0.06%		0.02	0.04%		0.03	0.29%		0.12
Vid body	0.07	***	0.94%		0.03	-0.14%	**	-0.16	-0.04%		-0.09	-0.63%		-0.12	0.27%	***	0.27	-0.47%	*	-0.15	-0.05%		-0.03	0.13%		0.06
Vid face	0.04		0.20%		0.01	-0.07%		-0.09	-0.02%		-0.04	-0.35%		-0.07	0.07%		0.08	-0.28%		-0.09	-0.08%		-0.06	0.36%	**	0.17
RT																										
Total	0.13	***	-36.98		-0.06	6.38	***	0.32	1.29	*	0.13	0.87		0.01	-5.58	***	-0.24	14.52	***	0.20	-0.54		-0.02	-1.87		-0.04
Body	0.15	***	-23.04		-0.03	6.96	***	0.34	1.25		0.12	0.77		0.01	-6.00	***	-0.24	16.80	***	0.22	0.28		0.01	-1.46		-0.03
Face	0.10	***	-50.92		-0.08	5.80	***	0.28	1.33	*	0.13	0.96		0.01	-5.16	**	-0.21	12.24	**	0.16	-1.37		-0.04	-2.29		-0.04
Image	0.09	***	-24.09		-0.03	5.86	***	0.26	1.11		0.10	1.75		0.01	-5.27	**	-0.20	12.13	*	0.15	-0.25		-0.01	-1.59		-0.03
Video	0.14	***	-49.60		-0.07	6.91	***	0.33	1.46	*	0.14	0.01		0.00	-5.90	***	-0.24	16.93	***	0.22	-0.84		-0.02	-2.13		-0.04
Img body	0.10	***	10.79		0.01	6.54	***	0.28	0.74		0.06	-1.45		-0.01	-5.40	**	-0.19	15.15	**	0.18	-0.64		-0.02	0.24		0.00
Img face	0.06	**	-58.98		-0.07	5.17	***	0.21	1.48		0.12	4.96		0.03	-5.13	*	-0.18	9.10		0.10	0.13		0.00	-3.41		-0.05
Vid body	0.14	***	-56.02		-0.08	7.40	***	0.33	1.74	*	0.15	3.08		0.02	-6.63	***	-0.25	18.49	***	0.22	1.18		0.03	-3.07		-0.05
Vid face	0.11	***	-42.87		-0.06	6.43	***	0.30	1.18		0.11	-3.03		-0.02	-5.19	**	-0.20	15.38	**	0.19	-2.87		-0.08	-1.17		-0.02
Conf																										
Total	0.08	***	0.17	*	0.14	-0.01	***	-0.19	0.00		-0.02	0.00		0.01	0.00		-0.04	-0.01		-0.06	0.01		0.13	0.01		0.11
Body	0.06	**	0.17	*	0.14	-0.01	***	-0.20	0.00		0.00	0.00		-0.02	0.00		-0.04	0.00		-0.03	0.01		0.08	0.01		0.09
Face	0.09	***	0.17	*	0.14	-0.01	**	-0.16	0.00		-0.04	0.01		0.04	0.00		-0.05	-0.01		-0.08	0.01	*	0.17	0.01		0.11
Image	0.06	**	0.14	*	0.12	-0.01	***	-0.19	0.00		-0.03	0.01		0.04	0.00		-0.06	0.00		-0.02	0.01		0.11	0.01		0.10
Video	0.08	***	0.19	**	0.16	-0.01	**	-0.17	0.00		-0.01	0.00		-0.02	0.00		-0.02	-0.01		-0.09	0.01		0.14	0.01		0.11
Img body	0.05		0.13		0.10	-0.01	***	-0.21	0.00		0.00	0.00		0.02	0.00		-0.07	0.00		0.01	0.00		0.06	0.01		0.08
Img face	0.07	***	0.16	*	0.12	-0.01	**	-0.16	0.00		-0.06	0.02		0.07	0.00		-0.05	-0.01		-0.06	0.01	*	0.15	0.01		0.11
Vid body	0.07	**	0.20	**	0.16	-0.01	**	-0.17	0.00		0.01	-0.01		-0.05	0.00		-0.01	-0.01		-0.07	0.01		0.09	0.01		0.10
Vid face	0.09	***	0.17	*	0.14	-0.01	**	-0.15	0.00		-0.03	0.00		0.01	0.00		-0.03	-0.01		-0.10	0.01	*	0.17	0.01		0.11

Note. B = standardised regression coefficients; β = standardised regression coefficients; cog = cognitive; aff = affective; U = unbiased hit rates; RT = response times; Conf = confidence ratings

A similar set of analyses using the same models was conducted with the emotion-specific scores as the DVs. Results can be found in Table 3.7. The assumptions of the 42 regressions are displayed in Appendix C.1.2.2.

Table 3.7

Multiple linear regressions models displaying the relationship between personality traits, age, gender, and emotion-specific ER measures.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

	model		predictors																							
			gender			age			PAQ			AQ-10			STAIt			STAIs-6			QCAE cog			QCAE aff		
	R^2	p	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β	B	p	β
U																										
body ang	0.05	*	-3.55%		-0.09	-0.08%		-0.07	-0.01%		-0.01	-1.04%		-0.13	0.33%	**	0.22	-0.54%		-0.12	-0.12%		-0.06	0.08%		0.02
body dis	0.11	***	1.09%		0.03	-0.26%	***	-0.20	-0.02%		-0.03	-0.60%		-0.07	0.38%	***	0.25	-0.40%		-0.09	-0.10%		-0.05	0.35%		0.10
body fea	0.06	**	-2.40%		-0.07	-0.14%	*	-0.12	-0.08%	*	-0.15	0.05%		0.01	0.21%	*	0.15	-0.10%		-0.02	-0.04%		-0.02	0.12%		0.04
body joy	0.02		-1.31%		-0.04	0.07%		0.08	-0.01%		-0.02	-0.01%		0.00	0.12%		0.11	-0.18%		-0.05	-0.04%		-0.02	0.16%		0.07
body neu	0.05	*	-2.01%		-0.04	-0.26%	**	-0.18	-0.02%		-0.02	-1.53%	*	-0.16	-0.06%		-0.03	-0.18%		-0.03	-0.30%		-0.12	0.33%		0.08
body sad	0.04		3.76%		0.09	-0.10%		-0.08	-0.06%		-0.09	-0.83%		-0.09	0.23%		0.14	-0.60%		-0.12	-0.17%		-0.07	0.44%		0.12
body sur	0.02		-0.51%		-0.01	-0.14%	*	-0.12	-0.04%		-0.07	0.31%		0.04	0.06%		0.04	0.06%		0.01	0.07%		0.04	-0.15%		-0.05
face ang	0.08	***	2.32%		0.05	-0.28%	***	-0.21	-0.04%		-0.06	-0.71%		-0.08	0.29%	*	0.18	-0.50%		-0.10	0.07%		0.03	0.36%		0.10
face dis	0.06	**	2.73%		0.08	-0.13%	*	-0.12	-0.06%		-0.10	-0.42%		-0.06	0.19%	*	0.15	-0.23%		-0.06	-0.14%		-0.08	0.48%	**	0.17
face fea	0.03		1.61%		0.04	-0.08%		-0.05	-0.07%		-0.09	-0.79%		-0.09	0.02%		0.01	0.12%		0.02	-0.18%		-0.08	0.60%	*	0.16
face joy	0.02		-1.41%		-0.05	-0.03%		-0.04	0.01%		0.02	-0.06%		-0.01	0.03%		0.03	-0.13%		-0.04	0.02%		0.01	0.18%		0.08
face neu	0.02		1.25%		0.03	-0.08%		-0.05	-0.06%		-0.08	0.36%		0.04	-0.08%		-0.04	-0.10%		-0.02	0.20%		0.08	-0.20%		-0.05
face sad	0.10	***	-0.91%		-0.02	-0.23%	**	-0.17	-0.03%		-0.05	0.24%		0.03	0.19%		0.12	-0.17%		-0.03	0.21%		0.09	0.53%	*	0.15
face sur	0.05	*	-3.26%	*	-0.11	0.06%		0.07	-0.04%		-0.08	-0.53%		-0.09	-0.01%		-0.01	0.16%		0.05	-0.23%	*	-0.15	0.31%	*	0.13
RT																										
body ang	0.11	***	13.69		0.02	6.98	***	0.28	0.99		0.08	6.83		0.04	-6.61	**	-0.22	12.59	*	0.14	0.65		0.02	0.75		0.01
body dis	0.10	***	-17.08		-0.02	6.91	***	0.25	0.53		0.04	-0.39		0.00	-7.16	**	-0.22	21.98	***	0.22	-1.66		-0.04	-2.08		-0.03
body fea	0.14	***	69.92		0.08	7.25	***	0.28	2.05	*	0.15	-10.43		-0.06	-6.65	**	-0.21	17.01	**	0.18	-1.41		-0.03	-3.51		-0.05
body joy	0.10	***	-108.51	*	-0.14	6.50	***	0.27	1.48	*	0.12	3.59		0.02	-4.44	*	-0.16	15.19	**	0.17	0.32		0.01	-4.21		-0.07
body neu	0.05	*	-41.37		-0.05	3.60	**	0.15	0.76		0.06	15.10		0.10	-3.39		-0.12	12.01	*	0.13	8.17	**	0.20	-4.40		-0.07
body sad	0.10	***	-65.82		-0.07	8.21	***	0.28	1.74		0.12	-8.58		-0.05	-6.52	**	-0.19	21.90	***	0.20	-0.74		-0.02	-0.05		0.00
body sur	0.12	***	-12.14		-0.01	9.25	***	0.32	1.17		0.08	-0.71		0.00	-7.22	**	-0.21	16.89	**	0.16	-3.36		-0.07	3.31		0.04
face ang	0.10	***	-79.63		-0.09	6.85	***	0.26	0.72		0.05	20.95		0.12	-6.76	**	-0.21	14.43	*	0.15	-0.57		-0.01	-5.07		-0.07
face dis	0.09	***	-46.68		-0.06	6.30	***	0.25	2.08	**	0.16	-3.36		-0.02	-5.36	*	-0.18	12.17	*	0.13	-2.56		-0.06	-1.29		-0.02
face fea	0.05	*	-63.79		-0.08	4.66	**	0.19	1.44		0.11	-11.87		-0.07	-2.48		-0.08	6.83		0.07	-1.16		-0.03	-4.73		-0.07
face joy	0.10	***	-40.54		-0.05	6.92	***	0.25	1.52		0.11	-10.80		-0.06	-6.50	**	-0.20	18.51	**	0.18	-3.41		-0.07	-3.41		-0.05
face neu	0.02		-81.17		-0.09	3.20	*	0.12	0.62		0.04	3.62		0.02	-2.14		-0.07	5.69		0.06	1.91		0.04	2.90		0.04
face sad	0.11	***	-38.01		-0.04	7.91	***	0.28	1.57		0.11	6.75		0.04	-6.71	**	-0.20	14.61	*	0.14	-2.03		-0.04	-3.97		-0.05
face sur	0.07	**	-6.64		-0.01	4.77	***	0.20	1.35		0.11	1.45		0.01	-6.20	**	-0.22	13.46	*	0.15	-1.76		-0.04	-0.47		-0.01
Conf																										
body ang	0.06	**	0.17	*	0.13	-0.01	***	-0.19	0.00		-0.03	0.00		0.00	0.00		-0.04	0.00		-0.01	0.01		0.10	0.01		0.09
body dis	0.05	*	0.15		0.10	-0.01	*	-0.14	0.00		0.10	0.00		-0.01	0.00		-0.06	0.00		0.01	0.01		0.13	0.01		0.08
body fea	0.05	*	0.16	*	0.11	-0.01	**	-0.17	0.00		-0.05	0.01		0.02	0.00		-0.04	0.00		-0.02	0.01		0.08	0.01		0.07
body joy	0.08	***	0.22	**	0.17	0.00		-0.07	0.00		-0.10	0.02		0.08	0.00		-0.06	-0.02	*	-0.13	0.00		0.06	0.01		0.11
body neu	0.04		0.13		0.08	-0.01	***	-0.19	0.00		0.04	-0.02		-0.06	0.00		-0.03	-0.01		-0.05	0.00		0.00	0.01		0.08
body sad	0.05	*	0.16		0.11	-0.01	**	-0.18	0.00		0.00	-0.02		-0.08	0.00		0.02	0.00		0.02	0.00		0.06	0.01		0.06
body sur	0.07	**	0.17	*	0.12	-0.01	***	-0.24	0.00		0.03	-0.01		-0.04	0.00		-0.03	0.00		-0.02	0.01		0.08	0.01		0.06
face ang	0.09	***	0.16	*	0.12	-0.01	***	-0.24	0.00		-0.02	-0.01		-0.05	0.00		-0.03	0.00		-0.03	0.01		0.13	0.01		0.11
face dis	0.07	***	0.18	*	0.13	-0.01	*	-0.13	0.00		-0.04	0.02		0.07	0.00		-0.04	-0.01		-0.07	0.01	*	0.18	0.01		0.09
face fea	0.07	**	0.16	*	0.12	0.00	*	-0.11	0.00		-0.01	0.02		0.06	0.00		-0.04	-0.01		-0.07	0.01	*	0.15	0.01	*	0.13
face joy	0.10	***	0.18	*	0.14	0.00		-0.10	0.00		-0.10	0.03		0.14	0.00		-0.04	-0.02	*	-0.12	0.01	*	0.14	0.02	*	0.16
face neu	0.05	*	0.22	**	0.15	-0.01	*	-0.11	0.00		-0.01	0.01		0.02	0.00		-0.08	-0.01		-0.05	0.01		0.12	0.01		0.05
face sad	0.09	***	0.14		0.10	-0.01	***	-0.21	0.00		-0.03	0.00		-0.02	0.00		0.00	-0.01		-0.08	0.01	*	0.17	0.01		0.10
face sur	0.06	**	0.12		0.09	0.00		-0.08	0.00		-0.06	0.01		0.05	0.00		-0.04	-0.01		-0.09	0.01		0.14	0.01		0.07

Note. B = unstandardised regression coefficients; β = standardised regression coefficients; cog = cognitive; aff = affective; U = unbiased hit rates; RT = response times; Conf = confidence ratings; ang = anger, dis = disgust, fea = fear, neu = neutral, sad = sadness, sur = surprise.

The regression analyses (Table 3.6) revealed a suppression effect of STAIt on the relationship between STAIs-6 and RT – that is, there is a significant effect of STAIs-6 on RT only when controlling for STAIt.

3.3.3 Actor differences

To explore if actors expressed via body and face differently, as well as if motion impacts such differences, three 2x2x4 RM ANOVAs were conducted, one for each task measure. Results can be found in Table 3.8 and Figure 3.6.

Table 3.8

2x2x4 RM ANOVAs comparing accuracy, speed and confidence between actors by modality and motion

	Accuracy (U)				Speed (RT)				Confidence			
effect	df	F	η_p^2	p	df	F	η_p^2	p	df	F	η_p^2	p
Modality	1, 390	2.79	0.01	.096	1, 390	38.98	0.09	<.001	1, 390	166.47	0.30	<.001
Motion	1, 390	285.85	0.42	<.001	1, 390	22.87	0.06	<.001	1, 390	144.79	0.27	<.001
Actor	2.99, 1166.60	307.61	0.44	<.001	2.97, 1160.12	102.96	0.21	<.001	2.77, 1081.52	279.18	0.42	<.001
Modality x Motion	1, 390	49.21	0.11	<.001	1, 390	7.17	0.02	.008	1, 390	12.54	0.03	<.001
Modality x Actor	2.93, 1142.33	230.2	0.37	<.001	2.99, 1164.87	111.63	0.22	<.001	2.73, 1064.33	254.32	0.40	<.001
Motion x Actor	2.99, 1167.39	9.24	0.02	<.001	2.99, 1167.55	17.19	0.04	<.001	2.97, 1157.15	11.97	0.03	<.001
Modality x Motion x Actor	2.96, 1156.34	26.19	0.06	<.001	2.93, 1144.40	6.02	0.02	<.001	2.96, 1155.53	10.88	0.03	<.001

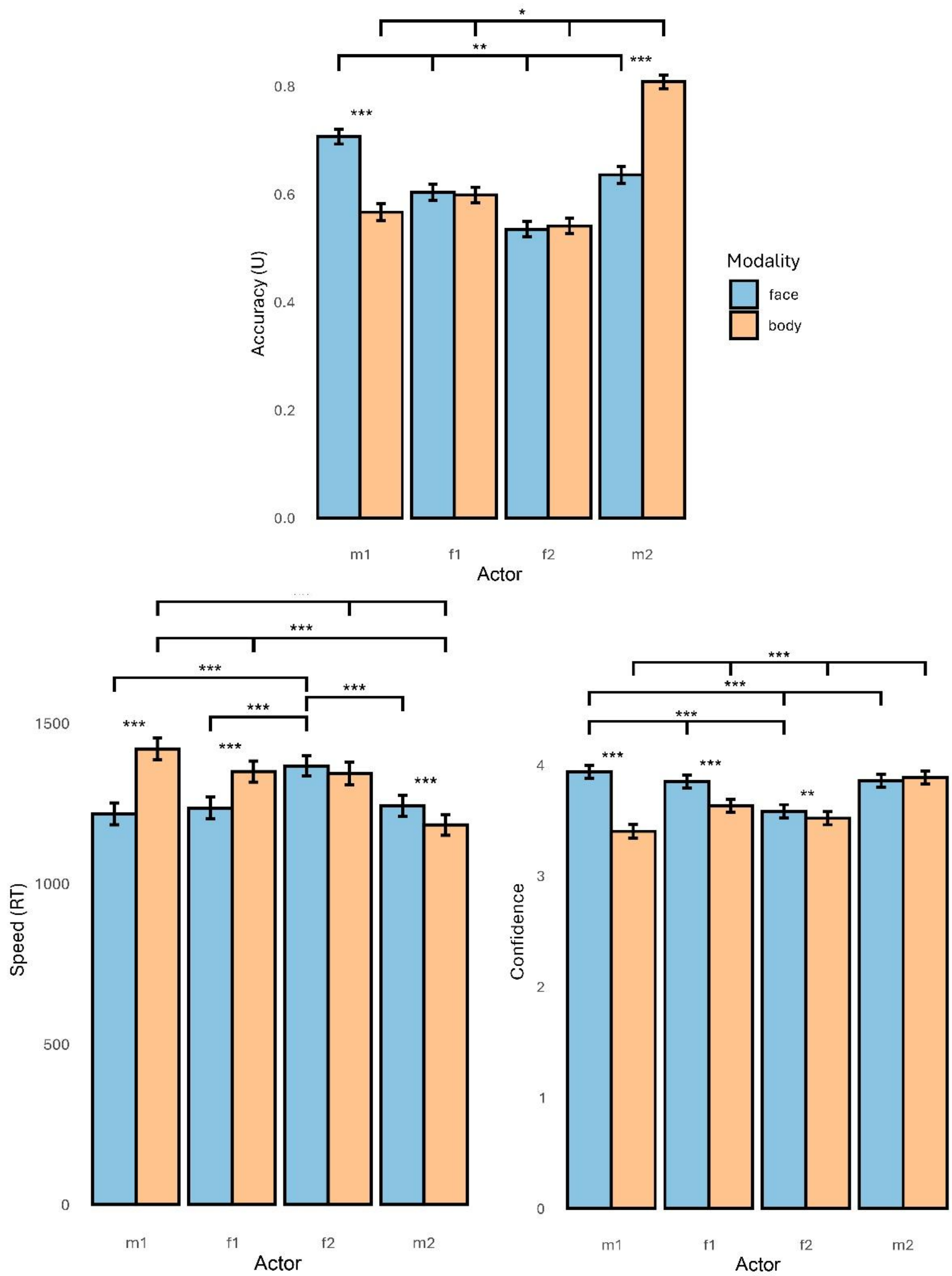
Note. Effects with non-integer degrees of freedom have been Greenhouse-Geisser corrected for sphericity.

Emotion-specific differences between actors were investigated using three 4x7 RM ANOVAs, results are displayed in Table 3.9 and in Figure 3.7. Any degrees of freedom that are not integers have been Greenhouse-Geisser corrected for sphericity violations.

Figure 3.6

Estimated Marginal Means of the 2x4 interaction of modality and actor for accuracy, speed and confidence

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

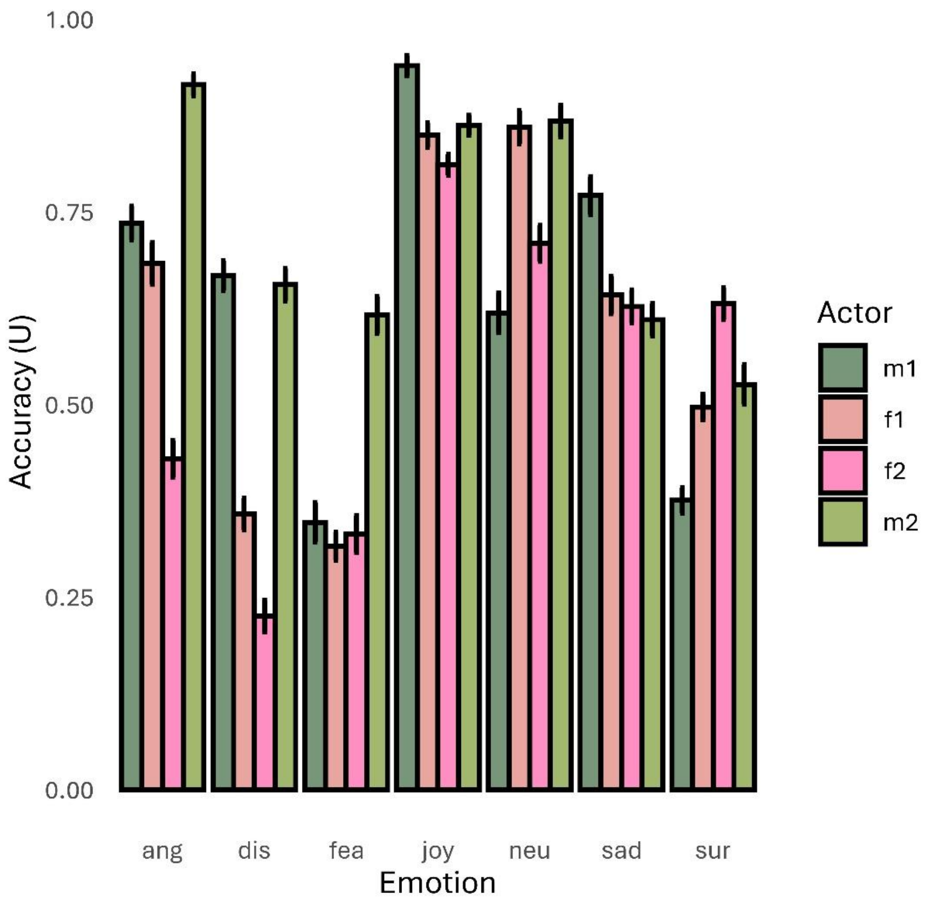


Note. m1 = male 1, f1 = female 1, f2 = female 2, m2 = male 2; U = unbiased hit rates, RT = response times; Error bars represent 95% CIs. {RT graph missing some ***}

Figure 3.7

Estimated Marginal Means of the 4x7 interaction of actor and emotion for accuracy

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display



Note. ang = anger, dis = disgust, fea = fear, neu = neutral, sad = sadness, sur = surprise; img = images, vid = videos; m1 = male 1, f1 = female 1, f2 = female 2, m2 = male 2;

Error bars represent 95% CIs.

Table 3.9

4x7 RM ANOVAs comparing accuracy, speed and confidence between actors by modality and motion

	Accuracy (U)				Speed (RT)				Confidence			
effect	df	F	η_p^2	p	df	F	η_p^2	p	df	F	η_p^2	p
Emotion	4.97, 1938.80	813.01	0.68	<.001	5.52, 2152.01	185.61	0.32	<.001	4.40, 545.68	93.77	0.43	<.001
Actor	2.99, 1166.60	307.61	0.44	<.001	2.97, 1157.37	102.11	0.21	<.001	2.61, 323.14	90.72	0.42	<.001
Emotion x Actor	15.00, 5849.77	216.97	0.36	<.001	16.16, 6302.35	83.38	0.18	<.001	13.34, 1654.08	40.83	0.25	<.001

Note. U = unbiased hit rates, RT = response times; effects with non-integer degrees of freedom have been Greenhouse-Geisser corrected for sphericity.

The scores of the two male actors and two female actors were averaged to obtain a total male score and a total female score. Three 2x2x2 Mixed ANOVAs with the factors actor gender (male, female), participant gender (male, female), and modality (face, body) were conducted on the three task measures in order to verify if there are cross-gender or own-gender preferences in face and body expressions. The participant gender by modality main effects and interaction effect have been reported previously in 3.3.1 (t-tests) and will not be repeated for this part of the analysis.

The ANOVA on **accuracy (U)** revealed significant differences between the different genders of actors, ($F(1,355) = 495.04$, $p < .001$, $\eta_p^2 = 0.58$). There were no other significant main effects or interaction effects. The analysis of **speed (RT)** revealed a significant effect of actor gender, ($F(1,355) = 73.67$, $p < .001$, $\eta_p^2 = 0.17$), and a significant modality x actor gender interaction, ($F(1,355) = 4.11$, $p = .043$, $\eta_p^2 = 0.01$). There were no significant participant gender x actor gender interaction (including the three-way interaction). Finally, the analysis on **confidence** resulted in a similar pattern of findings to speed, with a significant main effect of actor gender, ($F(1,355) = 211.19$, $p < .001$, $\eta_p^2 = 0.37$), and a significant modality x actor gender effect, ($F(1,355) = 63.60$, $p < .001$, $\eta_p^2 = 0.15$), with no other significant interaction effects. Means and post-hoc tests can be found in Appendix C.1.3.3.

In order to explore participant gender x actor gender effects on emotion-specific scores, three 2x2x7 Mixed ANOVAs were conducted in a similar fashion to the ones in the previous paragraph, but with emotion as the last factor. The results revealed an identical pattern of effects involving actor gender as the previous ANOVAs conducted with the modality factor. There were no participant gender x actor gender interactions at the emotion-specific level (see Appendix C.1.3.4).

3.4 Discussion

The study uncovered a dynamic advantage in both fER and bER, but the advantage was substantially larger for bER. All individual differences (demographics and personality traits) were related to at least one of the ER measures (accuracy, speed,

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

or confidence). When modelled together, only some specific relationships remained significant, such as anxiety with ERA and ERS, alexithymia with ERS, and cognitive empathy with ERC. Age was the only variable related to all ER measures, whilst gender was not related to any measure. Differences between fER and bER have not been found when averaging across the four actors. Two actors had equal recognisability for bodies and faces, one actor expressed better via bodies, and another actor was more proficient in facial expressions.

3.4.1 Task characteristics

Regarding task characteristics, differences in **overall** measures, the findings using static stimuli are in line with previous research, with faces being easier to recognise than bodies (Li, 2021; Ren et al., 2023). When using dynamic stimuli, however, faces were harder to recognise than bodies, contradicting past research using PLDs (Lott et al., 2022; Pavlova et al., 2022). There was an advantage for dynamic stimuli for both faces and bodies; however, the advantage of dynamic stimuli for body EEs was higher than for face EEs, and this advantage difference applied to accuracy, speed, and confidence. When averaging across images and videos, there was no difference between face and body stimuli in accuracy, but speed and confidence were reduced for body EEs.

At the **emotion-specific** level, joy was recognised at ceiling accuracy for both body and faces when examining raw (biased) hit rates, but measured substantially less after the unbiased hit rate calculation. After joy, the most recognised emotion categories were neutral, anger, sadness, surprise, disgust, and fear, in that order. Recognition of fearful facial expression constituted the lowest accuracy, but still placed twice above chance level. There was a variety of different patterns of modality by motion effects for each emotion.

Modality differences: Anger and joy were as easily recognised from bodies as from faces, whereas fear, neutral, and sadness were more easily recognised from bodies, with disgust and surprise favouring facial EEs. The patterns are different for speed and confidence. Participants were equally fast in recognising faces and bodies of anger and joy, similarly to the accuracy pattern, but were slower in responding to

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

disgusted, sad, and surprised bodies, and faster in recognising fearful, joyful, and neutral bodies. Participants were equally confident in their recognition of neutral and joyful faces and bodies, and more confident in recognising all other emotions from faces than bodies, with a particularly high difference in confidence (half a point on a 5-point Likert scale) for disgust and surprise. It is important to note that there were ceiling effects for the accuracy of recognising joy expressions, likely due to joy being the only positive emotion among the basic emotions. Fear and surprise were often confounded with one another.

Motion differences: For body expressions, there was a dynamic stimulus accuracy advantage for all emotions except neutral. For facial expressions, videos were more easily recognised for anger, disgust, fear, and neutral. Confidence was higher for videos in all emotion categories, for both faces and bodies.

This is the first work that investigated and found a differential advantage for dynamic stimuli depending on modality. This is in line with predictions derived from embodied simulation theory (Niedenthal et al., 2010), albeit with speculation on the part of body expressions. The speculation was that body expressions would lend themselves to simulationist emotion processing due to the involvement of more movement in body expressions compared to facial expressions. Given that dynamic stimuli are processed in the MNS more than static stimuli (Van der Gaag et al., 2007), it is possible that dynamic body stimuli facilitate simulation more, whereas static bodies do not benefit from simulation as much. Future neuroimaging studies could consider measuring activity in the MNS in all four conditions of the modality by motion interaction and verify this possibility. Additionally, bodies might contain more information from neutral to peak emotion (Pollux et al., 2019), as body expressions contain information about posture changing and movement in space, not just direct communicative gestures. This consideration of the configural complexity of body expressions fits the current findings, where body expressions were as easy to recognise as faces, but led to longer response times and less confidence. Future studies could explore if videos of bodies are as recognisable as seeing the first and last frames of a body expression video, as has been demonstrated previously for facial expressions (Ambadar et al., 2005).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

The findings also suggest that people underestimate their ability to recognise emotions from bodies, possibly due to the unnatural masked-face body expression paradigm. Pollux et al. (2019) investigated the confidence of recognisers viewing body EEs and face-body EEs. Using dynamic stimuli, they found that confidence was lower when faces were not visible, even if the participants had comparable accuracy, with the exception of sadness, where there was a large difference in accuracy between body EEs and face-body EEs. However, when using static stimuli, the confidence drop matched the accuracy on fear, joy, and sadness, but not anger. Future studies could explore differences between masked-face body expressions and other types format types, such as computer generated body expressions (see Metcalfe, 2019, for an example), to verify if some formats are more ecological.

There is high variability between how different emotions are being processed and categorised depending on modality. This is possibly due to the unecological nature of separating faces from bodies, that was necessary for the comparisons between modalities to be made. In natural social situations, people communicate at least bimodal expressions. What these findings tend to suggest is that it is likely that bodily expressions are more useful for some emotions, and facial expressions for others, which is in line with previous findings (Aviezer et al., 2012; Pollux et al., 2019). To give a simple and subjective example, it is probably more salient to walk towards someone pointing a finger at them (body anger) than frowning at them (face anger), or more obvious to grimace at something disgusting (face disgust) than it is to turn your head and walk away (body disgust). Future studies should address the implications of intensity of expressions on the pattern of differences between face and body expressions. To continue with the previous example, gagging and bending over at something disgusting (high intensity body expression) might be more obvious than turning and walking (low intensity body expression). The next study (Study 2) in this project will briefly explore such differences in intensity.

Specific advantages of dynamic stimuli hypothesised did not match the prediction. For both bodies and faces, most emotions demonstrated a dynamic stimulus advantage, with no decreases in accuracy or confidence for any of the emotions. It is difficult to compare the pattern of findings for each emotion with previous findings, as every other study that involved FLDs of face and body expressions has measured fewer than the full range of basic emotions, with most studies using at most one positive and one negative emotion (Zhang et al., 2015; Li, 2021; Ren et al., 2023). This study serves as the first full comparison of fER and bER across the entire range of classical basic emotions. One possibility for the mixed findings is the idea mentioned in the general introduction - that actors express emotions differently when asked to freely express emotions due to individual differences, and this can lead to unaccounted mixed findings across studies, as ER studies do not record actor individual differences beyond gender, ethnicity, and age. The differences between actors in this study are discussed below, with a more in-depth investigation of actor individual differences being undertaken in Study 3 of this thesis.

3.4.2 Individual differences

All individual differences, both personality traits and demographics, that were related to the task measures (accuracy, speed, and confidence) at modality, motion, or emotion levels were small to very small. Relationships between some of the personality traits and demographics were larger than the associations with the ER measures. Due to these relationships between the individual differences constructs themselves, when modelling all traits and demographics, some relationships observed in zero-order correlations (or t-tests for gender) became non-significant.

Age was negatively related to ERA, ERC, and ERS (high ERS reflects lower RTs), both in the face and body conditions. The ERA and ERS findings are in line with past findings on fERA (Richter et al., 2011; Wieck & Kunzmann, 2017) and bERA (Ruffman & Jenkin, 2009; Insch et al., 2015; Spencer et al., 2016; Pollux et al., 2016), whereas the negative relationship with ERC was a novel finding. The findings indicate that older people are slightly less accurate and quick, and they are aware of this. This is in line with neuropsychological decline explanations (Hayes et al., 2020), and in contradiction with studies finding that older people are unaware of cognitive decline (Mazzonna & Peracchi, 2024). However, the impact of these findings is limited by the sample being heavily skewed towards young adults. Whist age was related to ERS and ERC on most emotions, it was only related to ERA on half of the modality x emotion conditions. The

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

emotions match some of those observed in previous studies (Richter et al., 2011; Spencer et al., 2016; Pollux et al., 2016), with the other emotion-specific relationships possibly being explained by the difficulty of those specific stimuli (disgust and surprise body).

When looking at gender differences in ER in isolation, there were differences in total and body ERA, but not ERS or ERC. However, when controlling for all other individual differences, there were no ERA differences, but some significant differences in ERC. It is likely that these initial ERA differences were driven by age, empathy, and anxiety differences between the genders, with females being younger, more empathetic, and more anxious in this sample. The findings are in contradiction to previous meta-analytic findings showing small gender differences in ERA, likely due to most studies conducted on the matter not controlling for personality differences such as empathy or trait anxiety, and focusing more on demographics (Hall et al., 2025).

Empathy demonstrated a complex (but small) positive relationship with ER. Affective empathy was related to total ERA and face ERA, but not body ERA (no relationships with ERS or ERC), whilst cognitive empathy was related only to fERC. The ERA findings are in line with previous literature on both fER (Besel & Yuille, 2010; Israelashvili et al., 2020) and bER (Martin et al., 2019). A possible explanation for the lack of relationship between affective empathy and bERA is the unecological nature of the digitally masked body expressions, making the stimuli look more digital than human. Future studies should attempt more quotidian masking of faces during body expressions, using accessories such as masks (Grundmann et al., 2021), instead of digital manipulations. The relationship between ERC and cognitive empathy is not surprising, given the fact that questions that form the cognitive dimension of the QCAE directly ask if one believes they are good at telling what other people feel (Reniers et al., 2011). To draw a parallel to state – trait anxiety, cognitive empathy self-report measures would reflect the trait construct, whereas confidence ratings on an ER test can be thought of as a form of state cognitive empathy.

Alexithymia was negatively related only to the recognition of images of facial EEs, to a small degree. This is in line with past research, as most studies have preponderantly used pictures of faces (Di Tella et al., 2024). The findings demonstrate how generalising static fERA to reflect overall ERA, as most of the literature on ER has done historically, can lead to erroneous conclusions. If static fERA is related to alexithymia, but dynamic fERA, static bERA, and dynamic bERA are not related to it, concluding that alexithymia is related to ER appears to be an overreach. Moreover, the effect size of the relationship with static fERA is very small and should be interpreted cautiously. Nevertheless, the findings are in line with every previous study that has investigated alexithymia and bERA (Berenbaum & Prince, 1994; Cecchetto et al., 2014; Borhani et al., 2016). This is a novel finding that suggests that alexithymia might just impair the speed of emotion processing, not the ability to do so. The findings do not confirm relationships with ERC observed by past research (Lorey et al., 2012; Torunsky & Vilares, 2020). Taken together with the accuracy findings, it seems that more alexithymia individuals are not worse at ER overall, and they know that they are not. Alexithymia was not related to the ER of many specific emotions, suggesting a more global association with ER.

ALTs were not associated with any ER measures. Given that many traits associated with them, such as anxiety, empathy, and alexithymia, are controlled for, it is likely that those traits explained the variance in ER that is usually associated with autism. Past studies have shown similar results when controlling for alexithymia (Bird & Cook, 2013; Cook et al., 2013). However, the current sample has a small number of Ps with diagnosed autism (3.6%), with an AQ score distribution on the lower end of the scale (Allison et al., 2012). The lack of variability and the range restriction can lead to missing a possible relationship (Cohen et al., 2013). Studies 2 and 3 in this thesis address this issue by recruiting more autistic participants.

Anxiety also demonstrated complex relationships with ER. Trait anxiety was positively related to total ERA and bERA, but not fERA. Moreover, this relationship mostly stemmed from the dynamic body condition with no relationships to static EEs and no relationship to the dynamic facial EEs. This finding is in line with attentional threat bias perspectives (Cisler & Koster, 2010), suggesting that bodies might appear more threatening than faces, making anxious individuals more accurate in categorising bodies. Indeed, at the emotion-specific level there were relationships with anger and fear preponderantly, similar to previous research (Robinson et al, 2011; Brüne et al., 2013), but disgust ERA was also related to trait anxiety. State anxiety was not related to overall ERA, in contradiction to some previous findings (Dyer et al., 2022), but had a small negative relationship with video body expressions. Giving that both trait and state anxiety are particularly related to ERA on video bodies, it is likely that the combination of bodies and motion draws the attention of individuals that are hypervigilant to threat. When examining ERS, a suppression effect was observed between trait and state anxiety in relation to ERS: state anxiety was unrelated to speed when modelled alone, but showed a significant negative relationship when trait anxiety was controlled. Conversely, trait anxiety was positively associated with faster performance. This pattern suggests that the shared variance between state and trait anxiety obscures their distinct roles until they are modelled simultaneously. This unexpected pattern of findings can be explained by the attentional control theory (Eysenck et al., 2007). Trait anxiety impairs cognitive efficiency but enhances attentional vigilance, which may facilitate performance on emotionally salient tasks. This explains the slight increase in ERA and ERS of high trait anxiety individuals. In contrast, momentary state anxiety may introduce cognitive noise or distraction, slowing responses. The suppression effect therefore aligns with the theory's proposal that anxious individuals can show both facilitative and disruptive attentional patterns, depending on whether anxiety is chronic (trait) or transient (state). The explanation is also supported by the fact that ERS was related to state and trait anxiety across emotions, suggesting a general pattern during the task, whereas ERA was more emotion-specific, given the theory's incorporation of attentional threat bias perspectives.

3.4.3 Actor differences

The examination of differences between the four actors by modality revealed complex patterns for accuracy, speed, and confidence. In terms of accuracy, the expressions of the two male actors were more recognisable on average. However, male actor m1 portrayed better facial expressions, whilst actor m2 had more recognisable body expressions, with more than 10% accuracy difference between modalities. Conversely, the female actors depicted equally recognisable body and facial expressions.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

All actors had significant differences between each other on face and body EEs. ERS overall mapped onto the ERA scores by actor, with the exception of actor f1, where participants were faster in recognising her facial expressions. Confidence did not correspond to the patterns in accuracy and speed. Participants were more confident in the facial expressions of all actors except actor {m4}. When looking at emotion-specific differences, the pattern becomes even more varied, with different actors expressing different emotions better than others. These differences are difficult to explain, as no additional information about the volunteer actors was recorded outside of their gender. One possible explanation is that there is individual variability in how actors express when given any degree of freedom to express (as observed in validation data of other stimulus sets; Lundqvist et al., 1988; Tottenham et al., 2009; Conley et al., 2018; Benda & Scherf, 2020). This variability between actors could be due to personal life experiences, personality traits, or demographics (Zuckerman et al., 1975; Coats & Feldman, 1996; Kring & Gordon, 1998; Volker et al., 2009; Chaplin et al., 2013; Trevisan et al., 2018). The classical solution for this problem is the use of a set of actors that is as large as possible without compromising on the duration of an ER test (Ekman, 1976), assuming that individual differences between actors will be averaged out when calculating total accuracy scores. For the present study, it is impossible to make inferences about gender differences on EEA between actors from a pool of four actors. Future studies should consider measuring the emotion expression ability of a larger set of actors. Study 3 of this project will aim to explore actor differences in a larger actor pool.

There were no overall or emotion-specific significant interactions between gender of participant and gender of actor, suggesting no own-gender or cross-gender effects on ER. This is in line with repeated failures to replicate a bER cross-gender effect found by Kurger et al. (2013) using PLDs (He et al., 2018; Isernia et al., 2020; Pavlova et al., 2022). Study 3 will also re-examine possible participant gender by actor gender interactions, using a larger pool of actors.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

3.4.4 Limitations and future directions

The study has a number of limitations: (1) the main limitation of the study is the lack of repetitions of stimuli from the same 2x2x4x7 conditions; having a longer task with more repetitions can result in more robust measures of accuracy and allow for more complex repeated measures ANOVAs; increasing the number of trials, however, can lead to cognitive tiredness, loss of interest, and more expensive recruitment; (2) the age distribution being skewed towards younger adults makes conclusions about the role of age weaker; (3) despite the study having a considerable sample size, a larger sample size would have allowed even more complex analyses, such as 2x2x7 ANCOVAs with a larger number of predictors; (4) the opportunity sampling led to a preponderantly student sample; given that students have recruited data for this study, it is likely that they recruited family members to participate; thus, there is a possibility that assumption of independence of observations for some participants is uncertain at best; (5) the measure of state and trait anxiety (STAI) has been criticised on the basis of discriminant validity issues, particularly for the trait anxiety scale measuring depression to some extent (Knowles & Olatunji, 2020; Tindall et al., 2021); future research should consider exploring other measures of anxiety for confirmation of the effects revealed by the present study; (6) although online studies can may many limitations at a first glance: lack of control of the participant's immediate environment, distractibility, and hardware differences, research has shown that the most sensitive measure to hardware differences – response time – can be virtually indistinguishable from lab-based experiments, especially when employing preloaded JavaScript experiments, such as the present study (Hilbig, 2016); still, future studies should attempt replicating the present study in-lab in order to remove any doubts.

Future studies could attempt to address some of the aforementioned limitations, with the age limitation being the most prescient. Whilst the findings on the dynamic advantage being larger for body expressions do support simulationist models, knowing directly that the reason for the advantage is increased simulation can only be achieved through neuroimaging studies. Future research should consider replicating the present design, static x dynamic and face x body, in fMRI studies exploring brain activity in the MNS. Complex emotions are always the next step after establishing solid patterns in basic emotion recognition. The same design can be applied to a study containing both basic and complex emotions in order to establish motion by modality interactions.

3.4.5 Conclusion

To briefly recapitulate the findings, faces and bodies are on average equally recognisable, but with complex differences at the emotion-specific level. This is particularly important given the unnatural presentation of body expressions with digitally covered faces. There is a dynamic advantage in ERA, ERS and ERC, with the advantage being larger for body stimuli. Given the more ecological nature of videos, and the clear advantage in accuracy, the use of dynamic stimuli should become more commonplace in ER research and practice than static stimuli. State and trait anxiety and affective empathy are related to ERA; state and trait anxiety, and alexithymia are related to ERS; gender and cognitive empathy are related to ERC; age is related to all three measures. Gender is not related to ERA when controlling for personality traits such as anxiety and empathy, and there are no own-gender or cross-gender preferences. Actors express each emotion in varied ways, and some actors can produce more recognisable expressions using their bodies, others using their faces.

Chapter 4 – Study 2: ER and autism in children and adults

4.1 Introduction

The present study continues the individual differences – ER investigation, focusing on differences between diagnosed autistic and non-autistic individuals. The main aim is to address some gaps in the autism – ER literature, mainly exploring if individual differences explain the expected differences between autistic and non-autistic people. The study also examines the effect of age on face and body ER in more detail, exploring differences between children, young adults, and older adults.

4.1.1 Age differences in ER

Preschool children can recognise some of the basic emotions, but tend to struggle with disgust, fear, and surprise, with authors concluding that their emotion category concepts diversify over development after starting with just two opposite-valence categories (e.g., happy and upset; Widen & Russel, 2008). Facial ER is not fully developed by the time children enter their school-age years (Vicari et al., 2000). A recent meta-analysis of children's (2-12 years old) ERA confirmed that it steadily develops over time, with the recognition of different basic emotions developing at similar rates, with the following accuracy pattern: joy > anger > surprise > sadness > disgust > fear (Riddell et al., 2024). However, out of the 174 samples included in the visual studies analysis, 93% were from fER studies, with the remaining 7% being from bER and fbER studies. The bER of children is under-researched, but some studies have investigated the bER of children at various ages. A study using a non-traditional ER paradigm (emotional dancing stimuli) found that children as young as four years old can only recognise sadness, whereas eight-year-olds can recognise anger, fear, joy, and sadness (Boone & Cunningham, 1998). Some researchers have investigated incongruency effects in children, showing a large difference in incongruent ER between children and adults, with more substantial improvement as the children develop (from 3 to 6 years; Mondloch et al., 2013). A larger study using static body EEs found that

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

children aged under 3 only recognise sadness (above chance), 4-5-year olds recognise sadness and fear, and 6-8-year olds recognise sadness, fear, and anger (all emotions used in the study; Witkower et al., 2021). A recent meta-analysis of studies investigating bER in infancy and early childhood has found that there are no overall ER differences between different emotion categories (anger, fear, joy, sadness) over development, but did not have enough data to draw comparisons with neutral conditions, as not many studies have used one (Vuong & Geangu, 2023). Somewhat less research has been conducted on older children's bER. Studies using PLDs find that children (between 6 and 10 years old) perform worse than young adults, but have comparable bER to older adults (over 70 years old; Pollux et al., 2016). Studies tend to find that, towards late childhood or early adolescence (9-11 years old), children tend to reach ERAs comparable to adults when using FLDs (Pollux, 2021), but when using PLDs, even late adolescents tend to score lower than adults (Ross et al., 2012). Body ER does tend to continue developing through adolescence (Herba & Phillips, 2004), but not as rapidly as during childhood (Ross et al., 2019), and ERA tends to approach adult levels when using ecological stimuli (Ross et al., 2012). Understanding the ER of infants and children is important for parenting, but also for implementing ER interventions in populations of children with ER impairments (e.g., Wells et al., 2021).

Very few studies have investigated the differences between fERA and bERA in children. Ren et al. (2023) briefly validated a combination of face and body EEs (from different stimulus sets) and found that preschoolers recognised the faces better than the bodies; the face EEs were blurred to make them more difficult to perceive. The fERA of joy EEs was substantially higher than bERA, but the study only used joy, anger, and neutral stimuli. Another study measured fERA and bERA of preschool children using custom stimuli and found that faces were easier to recognise than bodies (Parker et al., 2013). Neither study directly compared fERA and bERA. Only one study to date compared the two abilities directly. Nelson & Russel (2011) measured ERA of children (3 – 5 years of age) and adults, using EEs from faces, bodies, voices, and a combination of all three. Children performed best on facial EEs and multimodal EEs, worse on bodies, and the worst on voices. Five-year-olds (oldest group) were close to adults in fERA, but not multimodal ERA, bERA, and vERA. One limitation of the study is the use of

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

a single actor to create custom (unvalidated) stimuli to be used for the purposes of one study alone, making it hard to compare the study with other research that used established stimuli. Indeed, the literature on children's bERA has less methodological integration than even the research on adults. More research is required to understand the direct differences between children's bERA and fERA. The present study aims to address this gap in the literature and will constitute the first exploration of bERA and fERA differences in school and pre-school children.

Although ER tends to be fully developed by very late adolescence and adulthood, emotion recognition also tends to decline in older adults. Studies consistently find lower ERA in older adults compared to younger adults, but the differences are emotion-specific (predominantly in anger, fear, and sadness; Richter et al., 2011) and modality-specific (no differences in multimodal ER; Wieck & Kunzmann, 2017). One study comparing static vs. dynamic fERA found an improvement in dynamic fERA only for low-intensity expressions (Grainger et al., 2017). A recent meta-analysis found that motion (static vs. dynamic) is not a unique moderator of fERA, but accounts for some variance in fERA along with other moderators; the authors concluded that the methodological differences in the literature account for many of the differences between young and older adults (Hayes et al., 2020). Nonetheless, studies tend to consistently find differences between young and older adults, with many authors attributing the findings largely to neuropsychological aging (Hayes et al., 2020). Some studies find reductions in ERA beginning as early as 30 years of age (Mill et al., 2009). Regardless of mechanisms, ER studies should, at best, control for age effects. Surprisingly, bER studies tend to replicate the effects observed in fER research despite task heterogeneity – older adults have lower bERA mostly specific to anger, fear and sadness (Insch et al., 2015; Spencer et al., 2016; Pollux et al., 2016). However, all three studies mentioned used PLDs, with one study using emotional walking stimuli (e.g., angry vs. happy walking PLDs). Moreover, no studies have directly compared fERA and bERA between younger and older adults using the same task and actors. The present study aims to investigate any differential age effects on fERA vs. bERA.

Age differences, whether between young adults and children or older adults, can have an effect on, or interact with, the individual differences discussed earlier in this

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

chapter (Chapter 1.4). Gender differences in facial emotion recognition ability (fERA), typically favouring females, are most pronounced in childhood and adolescence (McClure, 2000), become least apparent in young adulthood (Thompson & Voyer, 2014), and show a slight increase again in older age (Sullivan et al., 2017; Abbruzzese et al., 2019). There is little research examining the effect of age on the relationship between fER and empathy. Studies in children show that both empathy and ERA increase with age, and age is a better predictor of ER and empathy differences than gender (Schwenck et al., 2014). In children, complex relationships between empathy and brain anatomy have been observed (Bray et al., 2022). The empathy increase continues into old age (Richter & Kunzmann, 2011), but fER starts declining (Khanjani et al., 2015), demonstrating a complex developmental pathway for the two constructs. Older adults report less anxiety than younger adults (Villaume et al., 2023), or similar levels of anxiety (Stoner & Spencer, 1986), with worrying trends of increased anxiety in children and adolescents compared to previous generations (Booth et al., 2016; Durbeej et al., 2019). Little is known about whether age plays a role in the relationship between anxiety and ER, but one study found anxiety not predicting fER when controlling for age, gender, depression, alexithymia, and intelligence (Murphy et al., 2019), with alexithymia not being a significant predictor either. Large-sample studies find positive associations between age and alexithymia in adults (Mattila et al., 2006). It is difficult to measure children's anxiety due to the introspective complexity of the construct, and due to other-report measures having low validity (Lampi et al., 2021). Research mentioned in this paragraph was conducted on fER, with little to no research being conducted on the impact of individual differences on the relationships between age and bER. The present study aims to investigate ER differences between different age groups, including preschool children, whilst accounting for the aforementioned traits and demographics.

4.1.2 ER in autism

The findings of studies on ER in autism are mixed, at best. Evidence from electrophysiology, neuroimaging, and eye-tracking studies suggest that autistic individuals process EEs differently, but almost half of behavioural studies find no differences in ERA (Harms et al., 2010). Researchers concluded that the mixed findings

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

may be explained by some autistic people learning to use compensatory behavioural and neural mechanisms to recognise emotions, emphasizing that there is deficit that becomes corrected (Black et al., 2017; Subbaraju et al., 2018). Conversely, proponents of the neurodiversity paradigm (Dwyer, 2022) would consider the aforementioned mechanisms that “compensate for deficits” as natural variations of the human brain that achieve similar functions in different ways (Kapp et al., 2013; Grummt, 2024). Regardless of perspective, both tend to accept that the negative findings are the anomaly, one seeking to cure the deficits (Jaarsma & Welin, 2012) and the other seeking to celebrate the differences (Chapman, 2020). A recent meta-analysis of behavioural ER studies (N = 146) of adults and children showed similar results – medium-sized overall differences between autistic and non-autistic people, but 47% of studies found no differences between them in ERA (Yeung, 2022). The authors also found publication bias in favour of small studies with positive findings, making it more likely that more than half of studies ever conducted would have found no differences. Moreover, many studies included in the meta-analysis of overall ERA used the scores of two or three emotions to calculate a total score, with a small minority of studies including all basic emotions and even fewer studies including a neutral stimulus. Similarly, another meta-analysis that focused on vERA reported inconsistent findings and a large publication bias (Zhang et al., 2022). While there is a need for more neuroimaging and eye-tracking studies to establish the specificities of “compensatory mechanisms” (Black et al., 2017; Livingston & Happé, 2017; Subbaraju et al., 2018), more behavioural studies are also needed to clarify and understand ER differences in autism, especially ones exploring task characteristics (Yeung, 2022) and individual differences (Harms et al., 2010). On the other hand, the research is somewhat more consistent in finding negative relationships between ERA and ALTs (McKenzie et al., 2018; Bertrams & Schlegel, 2020), including in non-autistic populations (Poljac et al., 2013). The present study aims to assess fERA of autistic and non-autistic individuals on all basic emotions (plus neutral), address a few other relevant task characteristics (discussed below), and explore the role of individual differences.

ERS and ERC are also important constructs for autism research, but are often not included in meta-analyses. Very recently, one meta-analysis focusing on children

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

and adolescents identified slower fERS in autistic, compared to non-autistic, individuals (Masoomi et al., 2025). Rigorous research with adults tends to find similar patterns, along with decreased fERC (Georgopoulos et al., 2022). A follow-up study found that the reduced fERS in autistic people may not be due to emotion processing speed issues, but a strategy employed by autistic individuals (Brewer et al., 2022). This research also confirmed the positive relationship between ERA and ERC found in earlier studies (Lausen & Hammerschmidt, 2020). Whilst fERS in autism is somewhat well-understood in comparison to bERS, the impact of other individual differences is not very well-known. More research is required to understand fERC in autism.

In contrast, much less is known about differences in bERA between autistic and non-autistic people. In the meta-analysis by Yeung et al. (2022) discussed above, only five studies out of 146 used body EEs. Studies examining differences in bER between autistic and non-autistic people have produced mixed findings, similarly to the fER literature. Some studies find lower bERA for autistic people (Philip et al., 2010; Fridenson-Hayo et al., 2016; Metcalfe et al., 2019; Mazzoni et al., 2020), whilst others find no differences (Prior et al., 1990; Doody & Bull, 2013; Peterson et al., 2015). Studies that did not find a general bERA difference found differences in specific emotions (Hadjikhani et al., 2009; Losh et al., 2009; Actis-Grosso et al., 2015; Lott-Sandkamp et al., 2023). Moreover, a few of the aforementioned studies have found ALTs to be associated negatively with bERA (Losh et al., 2009; Metcalfe et al., 2019; Lott-Sandkamp et al., 2023). Most of the studies did not use the full range of basic emotions, more research with a full set of emotions is required to understand the differences in bERA between autistic and non-autistic individuals. Of the few studies that compared fERA and bERA in autism, one found no differences between the ER of faces and bodies (Fridenson-Hayo et al., 2016). However, the study by Fridenson-Hayo et al. (2016) used body expressions from the EU-Emotion stimulus set (O'Reilly et al., 2016), a stimulus set that contains standard facial expressions but body expressions with contextual information, such as a person getting angry after they discover a broken disc that falls out of a case. The context introduces confounding variance that is possibly due to deductive reasoning and Theory of Mind, making the body EEs difficult to compare to context-free face EEs. Some studies that measure ER using both modalities did not

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

compare them directly (Losh et al., 2009). Some studies used incomparable faces and bodies, such as PLDs of bodies and FLDs of faces (Actis-Grosso et al., 2015), or static faces and dynamic bodies, each obtained from different stimulus sets with actors (Philip et al., 2010). Given these limitations, differences between fER and bER remain unclear. More research is necessary in order to understand the differences between autistic and non-autistic people in bERA and fERA using EEs from the same actors on all basic emotions. More importantly, most of the studies discussed in this paragraph were conducted with children or adolescents, less is known about the bERA of autistic adults. The present study will use EEs of all basic emotions, faces, and bodies from the same actors in order the assess the influence of these task characteristics on ER in autistic adults.

Due to the inconsistent findings described above, researchers have begun to explore if other traits that are comorbid with autism can explain the differences between autistic and non-autistic people. Alexithymia, anxiety, and empathy are all related to ER (see Chapters 1.4 and 3.1), and are also highly related to autism. A very recent meta-analysis involving autistic children and adolescents found that one in three youths qualify for clinical levels of anxiety symptoms, with the prevalence of a formal diagnosis being one in five (Thiele-Swift & Dorstyn, 2024). Similar prevalence is observed in adults (Uljarević et al., 2021). This number is two to four times higher than the prevalence in the general population, which includes autistic and non-autistic individuals (Centers for Disease Control and Prevention, 2022; Koet et al., 2022). Moreover, a recent review found a negative relationship between trait anxiety and ER in autistic samples, but there were only two studies that investigated this relationship (Jolliffe et al., 2023). Co-occurring high trait anxiety and diagnosed anxiety could account for some ER difficulties in autism. Research tends to find negative associations between autism and cognitive empathy (Gleichgerrcht et al., 2013; Metcalfe et al., 2019), but not affective empathy (Baron-Cohen, 2013), with some inconsistencies (Donaldson et al., 2022). One recent large-sample study found that empathy and empathic disequilibrium (an imbalance in cognitive and affective empathy, with one substantially larger or smaller than the other) are associated with autism (trait and diagnosis; Shalev et al., 2022). Empathy can constitute another explanation for the

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

relationship between autism and ER. Alexithymia is another candidate for a confounder, as the prevalence in the autistic population is estimated to be around 50%, but only about 5% in the non-autistic population (Kinnaird et al., 2019). Authors have formulated the alexithymia hypothesis of autism, suggesting that comorbid alexithymia explains lower ERA and other social difficulties in autism (Bird & Cook, 2013). Some initial studies do seem to find that alexithymia accounts for ERA difficulties more than autism diagnosis (Cook et al., 2013; Ketelaars et al., 2016; Butera et al., 2023) and ALTs (Ola & Gullon-Scott, 2020; Moraitopoulou et al., 2024), with one study finding contradictory evidence (Keating et al., 2022). Despite alexithymia being difficult to measure in children, one study has found evidence for the alexithymia hypothesis in autistic children (Griffin et al., 2016). Moreover, research tends to converge on the existence of an alexithymic subgroup in the autistic population that has lower cognitive empathy (Mul et al., 2018), suggesting that this group might account for mixed findings in the ER literature. However, the research discussed in this paragraph almost exclusively describes findings on fER. This study, as well as Study 3, will investigate whether alexithymia, anxiety, and empathy explain the differences observed previously between autistic and non-autistic people in ER. Research tends to find no gender differences in ER in autistic populations (Philip et al., 2010; Mazzoni et al., 2020; Yeung, 2022), but little to nothing is known about gender differences in ERC. The present study will attempt to replicate these findings and explore gender differences in ERC.

Moreover, in autism studies, alexithymia, anxiety, and empathy vary by demographics such as age and gender, as they do in the general population (see Chapters 1.4 and 3.1). Studies find gender differences (Schneider et al., 2013) and age differences (Song et al., 2019) in empathy in autistic populations. Also, empathic disequilibrium associated with autism is more prevalent in females (Shalev et al., 2022). Despite some initial mixed findings (Levant et al., 2009), more recent research suggests that alexithymia is more common in males (Mendia et al., 2024). In autistic populations, gender differences in alexithymia are still largely unknown (Vaiouli et al, 2021; Livingston et al., 2022; Cargill et al., 2024). Controlling for age is necessary in alexithymia studies (Kinnaird et al., 2019), but differences between age groups within autism are largely unknown. Anxiety also presents differently between genders in

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

autistic children (May et al., 2014) and adults (Sedgewick et al., 2020; Sáez-Suanes et al., 2023), but with some mixed findings in young people (Magiati et al., 2016). In the autistic population, anxiety increases until middle age, then slowly decreases (Uljarević et al., 2021), with the highest prevalence in adolescents (Vasa et al., 2013). Demographic factors should be accounted for when looking at the relationship between individual personality differences and ER.

4.1.2 Aims and research questions

The second study of the project aims to explore differences between autistic and non-autistic children and adults. It is comprised of three parts separated by methodology and analysis: Part A explored autism differences in an adult sample, Part B in a sample comprised of children, and Part C compared the ER of the two samples from Part A and B in order to explore age differences between children, adults, and older adults. Due to the study being conducted with a sample of children, the ER task needed shortening in order to avoid dropouts and cognitive tiredness in children (described further in the Methods). Based on the findings from Study 1, with dynamic stimuli being easier to recognise, only videos were used in Study 2, effectively halving the length of the task from Study 1. Relationships between the personality traits (alexithymia, anxiety, ALTs, empathy, age) and ER were explored. The study aimed to investigate the following research questions, mapping onto each part of the study:

(A1) Are there differences in fER and bER between autistic and non-autistic **adults**? Given previous findings, it is only slightly more likely that differences will be found for both faces (Harms et al., 2010; Yeung, 2022) and bodies (Prior et al., 1990; Philip et al., 2010; Doody & Bull, 2013; Peterson et al., 2015; Fridenson-Hayo et al., 2016; Metcalfe et al., 2019; Mazzoni et al., 2020). Most studies have not used the full range of basic emotions, making emotion-specific differences a novel exploration. Given the consistent findings of reduced ERA on disgust EEs, it is hypothesised that autistic individuals will score lower on disgust trials (Smith et al., 2010; Jayashankar & Aziz-Zadeh, 2023).

(A2) Are differences between autistic and non-autistic **adults** explained by differences in personality traits (anxiety, alexithymia, empathy)? There is evidence to

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

suggest that alexithymia might explain fER differences between autistic and non-autistic individuals (Cook et al., 2013; Ketelaars et al., 2016; Ola & Gullon-Scott, 2020; Butera et al., 2023; Moraitopoulou et al., 2024). Exploring anxiety and empathy as confounders is a novel endeavour. Possible gender interactions will also be explored in order to verify previous non-findings on ERA, and explore ERC gender differences in an autistic sample.

(B1) Are there differences in fER and bER between autistic and non-autistic **children**? Most of the research discussed in the introduction that has found differences between autistic and non-autistic individuals has been conducted on children or adolescents, suggesting that it is more likely to find differences in children than adults (Yeung, 2022). It is hypothesised that differences will be found in children. There is little to no evidence about differences in fER compared to bER in children, especially school children. This study will undertake this novel exploration.

(B2) Are the differences between autistic and non-autistic **children** explained by differences in personality traits (anxiety, empathy)? Given that studies have found age differences in empathy and anxiety (Song et al., 2019; May et al., 2014), it is possible that these traits will impact the difference between autistic and non-autistic children. However, no studies to date have explored if personality covariates explain ER differences between autistic and non-autistic children, making this research question a novel exploration. Alexithymia has been omitted as a confounder mainly due to methodological issues (described further in the Methods), but also due to the existence of no substantial evidence for alexithymia differences in autistic and non-autistic children (Kinnaird et al., 2019).

(C) Are there differences in fER and bER between children, young adults and older adults? Research consistently finds a maturation of ERA from childhood to adulthood, followed by a decline in ERA towards older adulthood; however, most research has focused on fER (Hayes et al., 2020) or bER measured using PLD stimuli (Insch et al., 2015; Spencer et al., 2016; Pollux et al., 2016). It is expected that a similar trend will be replicated, but the present study aims to investigate the novel avenue of exploring fER vs. bER across ages. In addition, age differences within a child sample will

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

be explored in order to observe the trajectory of ER in preschool and school children, and if there is a differential trajectory of fER and bER.

Part A – Autism and ER in adults

4.2A Methods

4.2A.1 Participants

Data was collected via opportunity sampling at the University of Lincoln, between 2021 and 2024, in a similar fashion to Study 1: student collected data from volunteers (n = 238), student for-credit participation (n = 176), and non-student paid participation on Prolific.co (n = 107), for a total of N = 521 participants.

Participants entered their own gender identities in the demographics sections, resulting in a sample of 348 females, 138 males, 26 non-binary people, and nine people entering other gender identities. The age range of the sample was 18 to 76, with more of a skew towards young adults than the sample in Study 1 (M = 26.77, Mdn = 20, SD = 12.37). 58.5% of the sample were students, with 95.8% of the students being undergraduates. 93.5% of the samples was comprised of native English speakers. 78 participants reported having an autism diagnosis, 16 were in the process of receiving a diagnosis, 422 had no diagnosis, and five did not wish to disclose. The 16 participants who were in the process of receiving a diagnosis were added to the autistic group along with the diagnosed participants. Participants who did not fully complete more than 75% of the ER task were removed before any data cleaning and analysis.

Part of student data collection conducted for this study was by dissertation students, who incorporated the present study into their own research questions by adding questionnaires and sometimes slightly changing the make-up of the study. As a result, there is some missing data for alexithymia (n = 123 missing PAQ data) and anxiety (n = 123 STAIs-6 and STAIt missing data, for different participants than for PAQ), with all other measures being present in the full data set. In order to avoid a reduction in sample size by excluding the missing data from both measures, two samples will be formed: an anxiety sample where alexithymia will be ignored, and an alexithymia sample where anxiety will not be analysed.

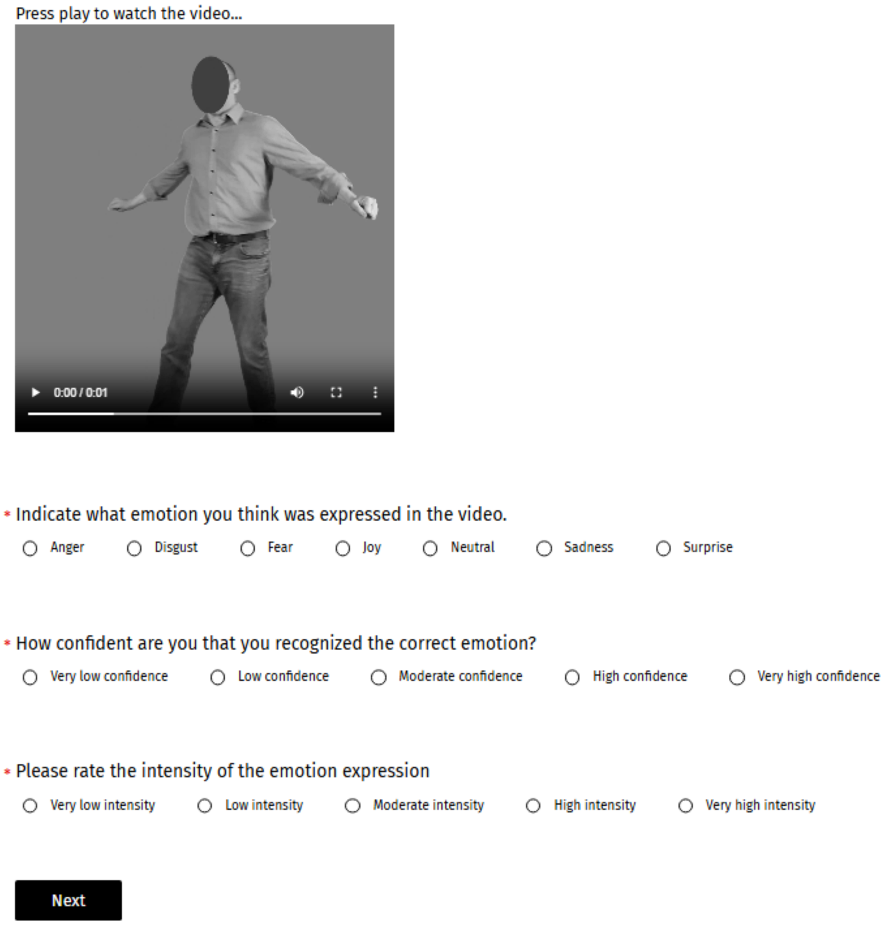
4.2A.2 Measures

Participants completed the same personality-style questionnaires described in Study 1: STAIs-6, STAIt, QCAE, AQ-10 and PAQ; along with some demographic information. All questionnaire measures showed good to excellent internal consistency (α = .80-.95). For the ER task, two of the actors from Study were used (male 1 and female 1), with only the video stimuli being used for each emotion (28 total trials); actors male 1 and female 1 were chosen due to time pressure, the filming of the other two actors being not complete at the time of starting this study. The reason for keeping the study shorter was the intention to apply the same task with children for age comparisons (Part C). The task was embedded in a survey format in Qualtrics and QuestionPro (Qualtrics, 2022; QuestionPro, 2024), with each trial being displayed on a single page. Participants saw a HTML5 video with controls (for playing the video), and had the option to replay the video as many times as they wanted, with no time constraints. This was also intentional to make the task easier for children (Part B and C). Under the video, there were three multiple choice items: a list of the seven emotion categories, a confidence rating, and an intensity rating, both on a 5-point Likert scale (Figure 4.1). The videos were bounded at 500 pixels height, with varied width depending on the size of the video (all videos were cropped at different sizes based on the distance of the actor to the camera, described in Chapter 2). The videos were fully randomised and only presented once.

Figure 4.1

Example of a trial in the ER task (Part A)

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display


Press play to watch the video...

0:00 / 0:01

* Indicate what emotion you think was expressed in the video.

○ Anger ○ Disgust ○ Fear ○ Joy ○ Neutral ○ Sadness ○ Surprise

* How confident are you that you recognized the correct emotion?

○ Very low confidence ○ Low confidence ○ Moderate confidence ○ High confidence ○ Very high confidence

* Please rate the intensity of the emotion expression

○ Very low intensity ○ Low intensity ○ Moderate intensity ○ High intensity ○ Very high intensity

Next

4.2A.3 Procedure

The study was conducted entirely online, with participants having no time constraints. Similar to Study 1, participants first gave consent and demographic information, followed by the STAIs-6, the ER task, and the rest of the questionnaires. Participants were asked to prioritise speed and not spend too much time thinking about the EE videos or questionnaire personality statements, but to feel free to take breaks whenever they needed. The median completion time for the study was approximately 18 minutes. The study could only be run on computers (not on mobile devices), and the videos did not work on Safari. The study was approved by the University of Lincoln Research Ethics Committee (reference code: 2022_8946).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

4.2A.4 Statistical analysis

Stimuli in each trial varied by actor (male or female), modality (face or body), and emotion (six basic emotions plus neutral), for a 2x2x7 repeated-measures design (N = 28 trials).

Unbiased hit rates (U) were calculated as in Study 1. Similar methodological checks to Study 1 were performed, with the addition of a t-test comparing the AQ scores of the autistic and non-autistic groups. The overlap of autism diagnosis and self-diagnosis will be investigated using a 2x2 χ^2 test of independence. If the groups do not significantly overlap, the main analysis will be conducted twice, separately for each grouping variable. No tests for mouse or touchpad were necessary due to no RTs being measured.

In order to investigate if there are **differences between autistic and non-autistic** people in ER, a series of 2x2 mixed ANOVAs were conducted to investigate the interaction of autism and modality for each measure: accuracy (U), confidence (conf), and intensity (int). The ANOVAs were conducted separately for the alexithymia and the anxiety samples (see 4.2A.1). If there was a significant main effect of autism or an interaction effect, the analyses were followed up with a set of ANCOVAs to investigate if covariates explain differences between autistic and non-autistic people. Covariates that were considered were the same demographics and traits investigated in Study 1, but only if they were related to the outcome ER measures in this study. If there was no interaction between modality and autism, ANCOVAs were computed for face and body trials separately. If the assumption of homogeneity of variances was not met for a given ANOVA, a Welch ANOVA was conducted instead. If there was a significant robust effect of autism, a robust regression (Huber, 1981) using the "lmrob" function from the "robustbase" package (Rousseeuw et al., 2024) in RStudio was conducted to investigate if covariates explain the effect of autism.

To investigate **emotion-specific differences**, ANOVAs could not be computed neither for accuracy scores, nor for confidence or intensity ratings. The accuracy scores at the emotion-specific level, for each modality, are an average of just two repetitions (the two actors). As such, the scores are likely on a small, discrete, and bounded scale

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

(minimum 0 – .5 – 1; the unbiased hit rate transformation can slightly increase the scale), and are not suited for parametric analysis. The confidence and intensity ratings are an average of two ordinal variables (Likert scale ratings), making them technically quasi-interval variable, but bounded on a 1 to 10 discrete scale. For the sake of caution, non-parametric analyses for every emotion, for both modalities, will be run instead of the aforementioned ANOVA approaches.

4.3A Results

Data cleaning consisted of the removal of five participants who did not state their autism diagnosis status, and the removal of 27 participants who reported having participated in a study using the same videos previously (likely Study 1 or students participating in the same study twice via the different collection methods). An exploration of the three main accuracy variables (total, face, and body) revealed 10 outliers who were removed from the final analysis. The removal is justified by the lack of control over participation environment and some methods of data collection not having any reward. Only outliers that scored significantly lower were removed, with outliers on the high end of accuracy being retained. The cleaning resulted in a final sample of N = 479.

As was found in Study 1, the main variables were normally distributed, but age was positively skewed.

Table 4.0

Descriptive statistics and CIs of total sample, and separated by autism group

Variable	N	M	SD	95% M CI LL	95% M CI UL	N		M		SD		95% M CI LL		95% M CI UL	
			Total			nA	A	nA	A	nA	A	nA	A	nA	A
age	479	27.30	12.70	26.10	28.40	389	90	27.50	26.30	13.40	9.02	26.20	24.40	28.80	28.20
PAQ	364	86.80	29.60	83.70	89.80	279	85	81.30	105.00	26.50	32.20	78.10	97.90	84.40	112.00
STAIs-6	406	11.90	3.84	11.50	12.30	339	67	11.70	13.00	3.69	4.40	11.30	12.00	12.10	14.10
STAIt	368	50.40	11.50	49.20	51.60	302	66	48.80	57.60	10.80	11.90	47.60	54.70	50.10	60.50
AQ-10	479	4.27	2.55	4.04	4.50	389	90	3.62	7.10	2.14	2.24	3.40	6.63	3.83	7.57

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

QCAE cognitive	479	55.70	10.30	54.80	56.70	389	90	58.00	46.00	8.65	11.20	57.10	43.70	58.90	48.30
QCAE affective	479	35.30	6.19	34.80	35.90	389	90	35.70	33.70	6.00	6.77	35.10	32.30	36.30	35.10
QCAE total	479	91.10	13.70	89.90	92.30	389	90	93.70	79.70	11.90	15.30	92.50	76.50	94.90	82.90
U total	479	0.57	0.11	0.56	0.57	389	90	0.57	0.54	0.11	0.11	0.56	0.51	0.58	0.56
U body	479	0.55	0.14	0.54	0.56	389	90	0.55	0.52	0.14	0.16	0.54	0.49	0.57	0.56
U face	479	0.63	0.13	0.62	0.64	389	90	0.64	0.61	0.13	0.14	0.63	0.58	0.65	0.64
Conf total	479	3.49	0.47	3.45	3.53	389	90	3.52	3.36	0.45	0.55	3.48	3.25	3.57	3.47
Conf body	479	3.26	0.52	3.22	3.31	389	90	3.29	3.14	0.50	0.58	3.24	3.01	3.34	3.26
Conf face	479	3.72	0.50	3.67	3.76	389	90	3.75	3.58	0.47	0.58	3.70	3.46	3.80	3.70
Int total	479	3.16	0.37	3.13	3.19	389	90	3.16	3.14	0.36	0.42	3.13	3.05	3.20	3.22
Int body	479	3.26	0.39	3.23	3.30	389	90	3.26	3.25	0.37	0.44	3.23	3.16	3.30	3.35
Int face	479	3.06	0.44	3.02	3.10	389	90	3.07	3.02	0.44	0.47	3.02	2.92	3.11	3.12

Note. M = mean; SD = standard deviation; 95% M CI LL = Lower limit of the 95% confidence interval of the mean; UL = upper limit; nA = non-autistic group, A = autistic group; U = unbiased hit rates; Int = intensity ratings; Con = confidence ratings.

4.3A.0 Methodological checks

Three one-way ANOVA were conducted to verify if there were differences between the data collection methods. There were no significant differences for total (p = .122), body (p = .106), and face (p = .724) accuracy (U).

Analogously, three one-way ANOVAs revealed no significant differences between students and non-students on total (p = .058) and face (p = .836) accuracy, but a significant difference on body accuracy (p = .037). A further ANCOVA demonstrated that age explained the effect of student status, (F(1,476) = 3.51, p = .061, $\eta_p^2 < .01$).

An independent samples t-test revealed a significant large difference in ALTs (AQ-10) between the autistic and non-autistic groups, t(477) = -13.8, p < .001, d = -1.61. The autism sample scored on average (M = 7.1) higher than the cut-off point outlined by the authors of the AQ-10 (larger than 6; Allison et al., 2012), strengthening the argument for combining the self-reported autistic people with people reporting that they are in the process of receiving a diagnosis.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

A χ^2 test of independence showed an overlap between autism diagnosis and self-diagnosis, $\chi^2(1, N = 290) = 155$, $p < .001$. The main analysis will be conducted only for the autism diagnosis grouping variable. Full results can be found in Appendix C.2A.0.1.

4.3A.1 Individual differences in autism

In order to explore individual differences in ER, zero-order correlations were computed for the main ER measures (Table 4.1.1). Correlations between the questionnaire measures can be found in Table 4.1.2. Additionally, differences in questionnaire measures and age between autistics and non-autistics were investigated (Table 4.2). Full results can be found in Appendix C.2A.1.1

Table 4.1.1

Correlations between the main ER task measures and questionnaire measures (and age) for the total sample and separated by autism group

		Total			Body			Face		
		U	Conf	Int	U	Conf	Int	U	Conf	Int
Total sample										
Conf	r	.12**			.12*			.09		
	N	479			479			479		
Int	r	.01	.45***		.05	.47***		-.07	.35***	
	N	479	479		479	479		479	479	
age [a]	ρ	.02	-.1*	-.12**	-.05	-.19***	-.21***	.08	-.05	-.08
	N	479	479	479	479	479	479	479	479	479
PAQ	r	-.14**	-.29***	-.07	-.12*	-.19***	-.06	-.1	-.36***	-.05
	N	364	364	364	364	364	364	364	364	364
STAIs-6	r	-.05	-.18***	-.07	-.04	-.17***	-.06	-.04	-.18***	-.06
	N	406	406	406	406	406	406	406	406	406
STAIt	r	-.01	-.21***	-.11*	.02	-.16**	-.08	-.05	-.23***	-.11*
	N	368	368	368	368	368	368	368	368	368
AQ-10	r	-.14**	-.27***	-.08	-.11*	-.21***	-.07	-.10*	-.29***	-.07
	N	479	479	479	479	479	479	479	479	479
QCAE	r	.14**	.32***	.12**	.16***	.26***	.11*	.05	.33***	.11*
cognitive	N	479	479	479	479	479	479	479	479	479
	r	.12*	.02	.02	.16***	0	0	.01	.03	.03

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

QCAE affective	N	479	479	479	479	479	479	479	479	479
			Total			Body			Face	
		U	Conf	Int	U	Conf	Int	U	Conf	Int
Autistic group										
Conf	r	-.02			-.07			.12		
	N	90			90			90		
Int	r	-.08	.47***		0	.44***		-.16	.41***	
	N	90	90		90	90		90	90	
age [a]	ρ	.23*	.02	-.13	.08	0	-.13	.27*	.01	-.14
	N	90	90	90	90	90	90	90	90	90
PAQ	r	-.12	-.36***	-.08	-.15	-.27*	-.04	-.05	-.41***	-.1
	N	85	85	85	85	85	85	85	85	85
STAIs-6	r	.02	-.27*	-.07	.06	-.23	-.02	-.04	-.28*	-.11
	N	67	67	67	67	67	67	67	67	67
STAIt	r	-.18	-.30*	-.12	-.15	-.29*	-.13	-.13	-.28*	-.09
	N	66	66	66	66	66	66	66	66	66
AQ-10	r	.05	-.36***	-.01	.06	-.29**	.01	-.01	-.39***	-.03
	N	90	90	90	90	90	90	90	90	90
QCAE	r	.16	.40***	.2	.11	.36***	.15	.15	.38***	.2
cognitive	N	90	90	90	90	90	90	90	90	90
QCAE	r	.14	.02	.05	.17	.03	.04	.02	.01	.05
affective	N	90	90	90	90	90	90	90	90	90
			Total			Body			Face	
		U	Conf	Int	U	Conf	Int	U	Conf	Int
Non-autistic group										
Conf	r	.14**			.16**			.06		
	N	389			389			389		
Int	r	.03	.45***		.06	.48***		-.06	.33***	
	N	389	389		389	389		389	389	
age [a]	ρ	-.01	-.09	-.10*	-.03	-.14**	-.11*	.04	-.04	-.06
	N	389	389	389	389	389	389	389	389	389
PAQ	r	-.08	-.22***	-.04	-.06	-.1	-.06	-.09	-.30***	-.01
	N	279	279	279	279	279	279	279	279	279
STAIs-6	r	-.06	-.14**	-.06	-.07	-.13*	-.07	-.03	-.13*	-.04
	N	339	339	339	339	339	339	339	339	339
STAIt	r	.06	-.14*	-.09	.1	-.09	-.06	-.02	-.17**	-.1
	N	302	302	302	302	302	302	302	302	302
AQ-10	r	-.12*	-.20***	-.09	-.12*	-.14**	-.11*	-.08	-.22***	-.06
	N	389	389	389	389	389	389	389	389	389
	r	.08	.25***	.1	.14**	.19***	.11*	-.03	.28***	.07

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

QCAE cognitive	N	389	389	389	389	389	389	389	389	389
QCAE	r	.09	0	.01	.15**	-.03	-.01	-.01	.02	.02
affective	N	389	389	389	389	389	389	389	389	389

Notes. correlations on the first three rows are between the task variables on the columns and other task variables from the same condition (total, face or body); U = unbiased hit rates; Int = intensity ratings; Con = confidence ratings; ρ = Spearman's Rho correlation coefficient

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

[a] correlations with age are non-parametric (Spearman's rank coefficients).

Table 4.1.2

Correlations between questionnaire measure (total sample)

		PAQ	STAIs-6	STAIt	AQ-10	QCAE cognitive	QCAE affective
STAIs-6	r	0.30***					
	N	291					
STAIt	r	0.50***	0.56***				
	N	291	368				
AQ-10	r	0.58***	0.19***	0.44***			
	N	364	406	368			
QCAE cognitive	r	-0.53***	-0.13**	-0.33***	-0.67***		
	N	364	406	368	479		
QCAE affective	r	-0.18***	0.08	0.23***	-0.10*	0.35***	
	N	364	406	368	479	479	
QCAE total	r	-0.48***	-0.06	-0.14**	-0.54***	0.91***	0.71***
	N	364	406	368	479	479	479

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

Table 4.2

T-tests comparing the questionnaire measures and age between the autism groups

	t	df	p	d̄	Cohen's d	95% CI d̄ LL	95% CI d̄ UL
PAQ[a]	-6.16	121	<.001	-24	-0.8	-31.2	-16
STAIs-6	-2.69	404	0.01	-1.4	-0.36	-2.37	-0.37
STAIt	-5.86	366	<.001	-8.8	-0.8	-11.7	-5.83
AQ-10	-13.8	477	<.001	-3.5	-1.61	-3.98	-2.99
QCAE cognitive[a]	9.55	115	<.001	12	1.2	9.51	14.49

QCAE affective	2.78	477	0.01	2	0.33	0.59	3.41
QCAE total[a]	8.13	115	<.001	14	1.02	10.59	17.41
age [b]	14897	-	0.03	-1	0.15	-2	0

Notes. df = degrees of freedom, d̄ = mean difference, CI d̄ = confidence interval of the mean difference, LL = lower limit, UL = upper limit;

[a] Welch's t-tests (non-homogenous variance)

[b] for age, a Mann-Whitney U test was conducted instead, due to the non-normal distribution of age (Appendix C.2A.0.0); the test statistic for age is a Mann-Whitney U statistic instead of a t statistic, and the effect size is a rank-biserial correlation coefficient instead of Cohen's d.

To explore if ER scores of autistic and non-autistic participants interacted with gender, three sets (for accuracy, confidence, and intensity) of two 2x2 between-subjects ANOVAs (one for each modality) were conducted with the factors gender (male, female) and autism (autistic, non-autistic). There were no significant interaction effects of gender x autism on ER measures, with the exception of body accuracy where there was a marginally significant interaction effect, $F(1,442) = 3.89$, $p = .049$, $\eta_p^2 = .01$). However, Bonferroni-corrected post-hoc tests showed no significant differences between male autistic, female autistic, male non-autistic, and female non-autistic participants (See Appendix C.2A.1.2).

4.3A.2 ER differences in autism: adults

For the **anxiety** data, three 2x2 mixed ANOVAs were conducted on each ER measure, with the repeated measures factor modality (face, body) and the between-subjects factor autism (autistic, non-autistic). There were no significant main effects of autism or interaction effect on accuracy and intensity, but there was a significant effect of autism on confidence, $F(1,366) = 5.91$, $p = .016$, $\eta_p^2 = .02$. The assumption of homogeneity of variances was met for both the face and body measures (Appendix C.2A.2.1). Two separate ANOVAs revealed no effect of autism on body confidence ($p = .066$), but a significant effect of autism on face confidence, $F(1,366) = 7.23$, $p = .008$, $\eta_p^2 = .02$. Controlling for state and trait anxiety, and cognitive and affective empathy (ANCOVA) rendered the effect of autism non-significant, $F(1,362) = 0.33$, $p = .567$, $\eta_p^2 <$

.01, with only cognitive empathy being a significant predictor in the model, $F(1,362) = 25.11$, $p < .001$, $\eta_p^2 = .06$.

For the **alexithymia** data, a similar set of 2x2 ANOVAs were conducted (Table 4.3). There was a significant difference between the autistic and non-autistic group in accuracy ($F(1,362) = 7.19$, $p = .008$, $\eta_p^2 = .02$) and confidence, $F(1,362) = 7.75$, $p = .006$, $\eta_p^2 = .02$), with no interaction effects between autism and modality for either measure. There were no significant autism or interaction effects on intensity. On the confidence measures, and on body accuracy, there was heterogeneity of variances (Appendix C.2A.2.1).

Table 4.3

One-way ANOVAs for accuracy and confidence

	type	F	df1	df2	p	effect size
U body	Welch's	4.43	1	120	.037	.01
U face	Fisher's	3.12	1	362	.078	.01
Conf body	Welch's	4.93	1	120.6	.028	.01
Conf face	Welch's	5.8	1	118.1	.018	.02

Notes. effects sizes are η_p^2 for the Fisher's ANOVA, and ω^2 for the Welch's ANOVAs.

To investigate the effect of covariates on the relationship between autism and accuracy and confidence, robust regressions with MM-estimation (Rousseeuw et al., 2024) were conducted using the autism grouping variable and covariates (alexithymia, cognitive empathy, affective empathy). To verify the results of the robust Welch's ANOVAs presented above, robust regression analyses were conducted with just autism as a predictor before the multiple regressions that included the covariates. Autism was significant as a single predictor of body accuracy, $B = -.048$, $p = .026$. When adding alexithymia, cognitive empathy, and affective empathy, the effect of autism became non-significant, $B = -.026$, $p = .271$. Predicting body confidence accuracy, autism was a significant single predictor, $B = -.167$, $p = .023$, but became non-significant after controlling for the covariates, $B = .012$, $p = .876$. In this model, cognitive empathy was a significant predictor, $B = -.014$, $p < .001$. With face confidence as an outcome, autism was a significant predictor, $B = -.181$, $p = .012$, and became non-significant when modelled alongside alexithymia and empathy, $B = .088$, $p = .216$. Alexithymia ($B = -.004$,

$p < .001$) and cognitive empathy ($B = -.015$, $p < .001$) were significant predictors of face confidence. Full results of the regression can be found in Appendix C.2A.2.2.

For each of the three ER measures, a set of seven (for each emotion) Mann-Whitney U tests with a Bonferroni correction (for a family of seven tests) were conducted once for the body and once for the face conditions. None of the tests were statistically significant (see Appendix C.2A.2.3).

Part B – Autism and ER in children

4.2B Methods

4.2B.1 Participants

Data was collected from children and guardians (parents or other relatives) participating in the Summer Scientist Week event at the University of Lincoln. The event involves participants bringing their children to the university to participate in research studies and to play games. Children would receive reward tokens for participating, spending them on available games and activities. Guardians would complete personality questionnaires about the children; if the children were at the event with a family friend, the friend would be given a link to the questionnaires to give to the child's parents. Participation was entirely voluntary, for both children and guardians. Data collection took place in August of 2022, 2023 and 2024. Data was collected from a total sample of N = 249 children, after the removal of participants who dropped out of the ER task with less than 75% completion. Data from participants who took part multiple times across the years, and from children who were younger than 5 and older than 11, was removed from the Qualtrics/QuestionPro database after each data collection day.

An additional method of recruitment was attempted – recruiting children from mainstream schools and SEN schools, by asking teachers to collect ER data as experimenters. This method was unsuccessful due to difficulties related to availability

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

of schools staff to assist with data collection. Most mainstream schools contacted did not reply to the research invitation, and the ones who did were unable to dedicate staff time eventually, due to understaffing and school administration issues. In total, data from n = 7 children was collected from Gosberton Academy, an SEN school in Lincolnshire. Teachers were trained to be experimenters and collect data on behalf of the researchers using the ER task. Teachers also completed other-report questionnaires about the children, similar to how parents did in Summer Scientist Week. Questionnaires were completed before conducting the ER task with children.

The intention was to collect data from a substantial sample of autistic children to compare to non-autistic children; however, only a small sample of n = 20 autistic children were recruited by the end of the project. Out of the total sample (N = 49), parents of 36 children did not complete the questionnaire measures; these participants were excluded from the main analysis of this study, but some of the participants will be included in the age analysis at part C, as demographic data was also collected by the Summer Scientist Week organisers when parents signed up for the event.

The total sample was comprised of 5 to 11 year-olds (*M* = 7.93, *SD* = 1.72); 95 (44%) were females, and 120 were males (56%). Only one child was not a native English speaker.

4.2B.2 Measures

Similar measures were adapted for other-report about children, with the exception of the PAQ. One of the main objectives of Study 2 was to compare adults and children (Part C, described later on in this chapter). Whilst tools exist to measure alexithymia in children (Rieffe et al., 2006; Way et al., 2010), their use is accompanied by significant challenges related to developmental appropriateness (Parker et al., 2010; Brown et al., 2021), validity concerns (children and parent discrepancies; Griffin et al., 2016), and measurement reliability (Loas et al., 2017; Brown et al., 2021). Due to these difficulties, and in order to facilitate the use with children and parents in a chaotic environment (see Part B) by reducing the size of the study, measurement of alexithymia was removed from the study. The **QCAE** was adapted for parent-report similar to Metclafe et al. (2019). The child version of the **AQ-10** was used (Allison et al., 2012). The

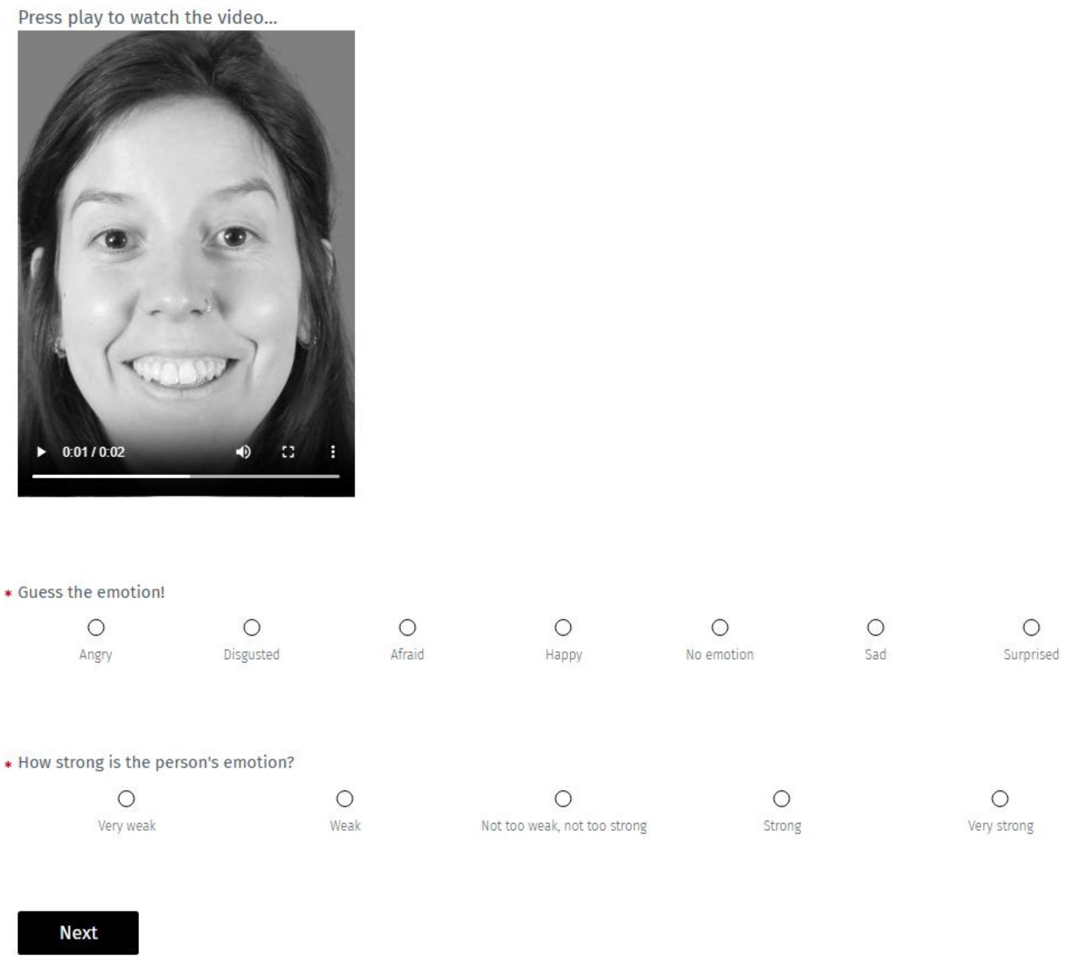
QCAE had good to excellent internal consistency (α = .86-.95), but the AQ-10 was minimally reliable (α = .66).

Instead of the STAI (as in Part A), a brief, 8-item children's anxiety scale was used: **Spence Children's Anxiety Scale – Brief version** (SCAS-8; Reardon et al., 2018). Guardians at Summer Scientist Week completed the parent-report version (SCAS-8-P), whilst teachers at Gosberton Academy completed the teacher-report version (SCAS-8-T). The two versions differ in only two of the eight items. The items query the frequency of behaviours exhibited by the child on a 4-point Likert scale (0 – Never to 3 – Always), with items such as "The child worries about being away from his/her parents" and "The child worries what other people think of him/her". The scale demonstrated good internal consistency in general population samples (α = .80-.87; Reardon et al., 2018), as well as in the present sample (α = .82).

The ER task was structured in a similar way as in Part A, with the exception of removing the confidence ratings (Figure 4.2). This decision was motivated by differences in meta-cognition between adults and children, with children often having lower meta-cognitive ability (Filippi et al., 2020; Baer et al., 2021) which could lead to confidence differences due to general meta-cognition ability, not ER differences. Additionally, the task was required to be simpler and shorter for children, in order to avoid cognitive tiredness and drop-outs. Children were asked if they would like the experimenter to facilitate their task participation (i.e., click for them) or if they would like to complete it by themselves. Children who required help, usually younger children (described further in the results section), were played the videos by the experimenters and were asked to pick an emotion out of the list; the list was often read to children who could not read. Experimenters also queried the perceived intensity of the EEs, replaying the videos a number of times until the children decided on an answer. The emotion choices question ("Guess the emotion!") used different labels than the adults' task in part A, replacing nouns with adjectives for most categories: "anger" -> "angry", "fear" -> "afraid", "disgust" -> "disgusted", "joy" -> "happy", "neutral" -> "no emotion", "sadness" -> "sad", "surprise" -> "surprised". The replacement was an attempt to simplify the task for children. Children were told that they could pick "no emotion" if they "think the person is not feeling anything". The labels of the intensity question ("How strong is the person's emotion?") were also simplified: "very low intensity" -> "very weak", "low intensity" -> "weak", "moderate intensity" -> "not too weak, not too strong", "high intensity" -> "strong", "very high" -> "very strong". After conducting pilot testing in the first day of Summer Scientist Week 2022, it was observed that some younger children did not know the word "disgusted". Subsequent testing involved asking children if they know what disgust is, followed by an explanation about how disgust is the "reaction to something yucky – eww, that's disgusting!".

Figure 4.2

Example of a trial in the ER task (Part B)



Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

4.2B.2 Procedure

Guardians saw a summary of the study before attending the event, giving formal consent for the children to participate. Any particular needs or requirements that the child might have would be communicated to the experimenter on a printed table with all the children attending an event. No requirements were of relevance to the present study, as they mostly involved food allergies or children not wanting to be photographed. Children were recruited from a play area – a large room where children would play games, interact with volunteers, or engage in other activities such as face painting. Experimenters would approach the children and ask if they would like to participate in a study to earn tokens (that could be spent on activities), or children would queue up at the entrance to the play area to ask to be taken to a study. After assent was obtained from children, they would be asked to bring their guardians along, if the guardian wasn't already with a child. If the guardian was not able to come with the child (e.g., having toddlers to look after), they would be given either a link on a piece of paper or a tablet (depending on availability) to complete the questionnaires about their child. The child would then be taken to an experiment room to complete the ER task. The room varied between and within years, depending on availability of rooms at the University of Lincoln. All rooms contained at least one computer and a desk, which were all the materials required for the task. If the parent accompanied the child, they would be asked not to aid the child with the task, often being given the personality questionnaires to complete on a tablet or computer. The context of testing varied depending on the family, with parents sometimes asking for multiple children to be tested at the same time, to bring toddlers along, or to have children tested one after another if multiple computers were not available. If multiple computers were available (IT rooms/computer labs), children would sometimes get tested simultaneously. Children would be seated at a distance from one another and asked not to interfere with each other's tasks. Up to four children have been tested at the simultaneously. After completing the study, children would be awarded tokens, regardless of whether they completed the study or dropped out. They would then be returned to the play area by the experimenters. They ER task took approximately 10 minutes on average. The study was under an umbrella application with the study described in Part A, approved by the University of Lincoln Research Ethics Committee (reference code: 2022_8946).

4.2B.3 Statistical analysis

Results were analysed similarly to part A, exploring descriptives by autism group, and correlations between age, personality traits, and ER task measures. Methodological checks were largely similar, with the addition of exploring if there are ER differences between children that asked for help to complete the task and those who did not (controlling for age), and if the presence of parents had an effect on ER.

4.3B Results

Similarly to Study 1 and Part A of the present study, ER task variables and most of the questionnaire variables were normally distributed both in the total sample and when separated by autism group, with the exception of trait anxiety (SCAS-8) having a non-normal distribution, and AQ-10 having a slightly skewed distribution (skewness = -1.08) in the autistic sample (see Appendix C.2B.0.0).

Table 4.4

Descriptive statistics and CIs of total sample, and separated by autism group

Variables	M	SD	95% CI M LL	95% CI M UL	M		SD		95% CI M LL		95% CI M UL	
	Total				nA	A	nA	A	nA	A	nA	A
age	7.89	1.72	7.66	8.12	7.82	8.55	1.75	1.36	7.57	7.92	8.07	9.18
SCAS-8	7.38	4	6.84	7.92	6.91	11.9	3.68	4.24	6.38	9.91	7.43	13.89
AQ-10	2.85	2.41	2.52	3.18	2.39	7.3	1.95	1.87	2.11	6.43	2.67	8.17
QCAE cognitive	48.32	12.56	46.63	50.02	50.4	28.25	10.87	9.94	48.86	23.6	51.95	32.9
QCAE affective	33.41	5.33	32.69	34.13	33.81	29.55	5.09	6.12	33.09	26.69	34.54	32.41

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

QCAE total	81.74	15.82	79.6	83.87	84.22	57.8	13.84	13.89	82.25	51.3	86.18	64.3
U total	0.42	0.12	0.4	0.44	0.43	0.36	0.12	0.1	0.41	0.32	0.44	0.41
U body	0.39	0.14	0.37	0.41	0.4	0.3	0.15	0.11	0.37	0.25	0.42	0.34
U face	0.51	0.14	0.5	0.53	0.52	0.49	0.14	0.13	0.5	0.44	0.54	0.55
Int total	3.39	0.54	3.32	3.46	3.38	3.44	0.54	0.57	3.31	3.17	3.46	3.71
Int body	3.44	0.53	3.37	3.51	3.43	3.51	0.53	0.5	3.36	3.28	3.51	3.75
Int face	3.34	0.63	3.25	3.42	3.33	3.37	0.62	0.71	3.25	3.04	3.42	3.71

Note. M = mean; SD = standard deviation; 95% M CI LL = lower limit of the 95% confidence interval of the mean; UL = upper limit; nA = non-autistic group, A = autistic group; U = unbiased hit rates; Int = intensity ratings.

4.3B.0 Methodological checks

An independent-samples t-test indicated a large significant difference between the autistic and non-autistic groups on ALTs levels (homogeneity of variances assumed), $t(211) = -10.78$, $p < .001$, $d = -2.53$.

There was a significant difference between the children that were helped (by the experimenter clicking for them and asking the emotion and intensity questions) and children that completed the task on their own in the overall ER measures: total accuracy ($p <.001$), body accuracy ($p <.001$), and face accuracy ($p = .004$). When controlling for age, these differences became non-significant for all measures ($p = .584$-.837). This suggests that the help was largely for younger children, and this grouping does not need to be accounted for as a covariate when age is accounted for. There were no significant differences in accuracy between children who had parents present compared to children whose parents were not present ($p = .143$-.540). Full results can be found in Appendix C.2B.0.1.

4.3B.1 Individual differences in autism

Correlations were computed for the main ER measures, age, and personality traits in order to explore individual differences (Table 4.5). Correlations within the two autism groups were not computed due to the small sample size (n = 20) of the autistic sample. Differences in questionnaire measures and age between autistics and non-

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

autistics were also investigated (Table 4.6). Full results can be found in Appendix C.2B.1.1.

Table 4.6

Correlations between the main ER task measures and questionnaire measures (and age) for the total sample

	U total	Int total	U body	Int body	U face	Int face
Int total	-0.14*		-0.08		-0.11	
age	0.51***	-0.25***	0.39***	-0.15*	0.42***	-0.30***
SCAS-8	-0.02	-0.02	-0.06	-0.02	0.02	-0.03
AQ-10	-0.19**	-0.07	-0.21**	-0.06	-0.12	-0.07
QCAE cognitive	0.19**	-0.01	0.18**	-0.02	0.15*	0
QCAE affective	0.13	0.07	0.11	0.06	0.09	0.06
QCAE total	0.20**	0.01	0.18**	0.01	0.15*	0.02

Note. U = unbiased hit rates, Int = intensity ratings; if = image faces, ib = image bodies, vf = video faces, vb = video bodies.

Table 4.7

T-tests comparing the questionnaire measures and age between the autism groups

	t	p	d̄	d	95% CI d̄ LL	95% CI d̄ UL
SCAS-8	-5.7	<.001	-4.99	-1.34	-6.72	-3.27
AQ-10	-10.78	<.001	-4.91	-2.53	-5.81	-4.01
QCAE cognitive	8.74	<.001	22.15	2.05	17.16	27.15
QCAE affective	3.49	<.001	4.26	0.82	1.86	6.67
QCAE total	8.13	<.001	26.42	1.91	20.01	32.83

Notes. d̄ = mean difference, CI d̄ = confidence interval of the mean difference, LL = lower limit, UL = upper limit;

Degrees of freedom for each test are 211.

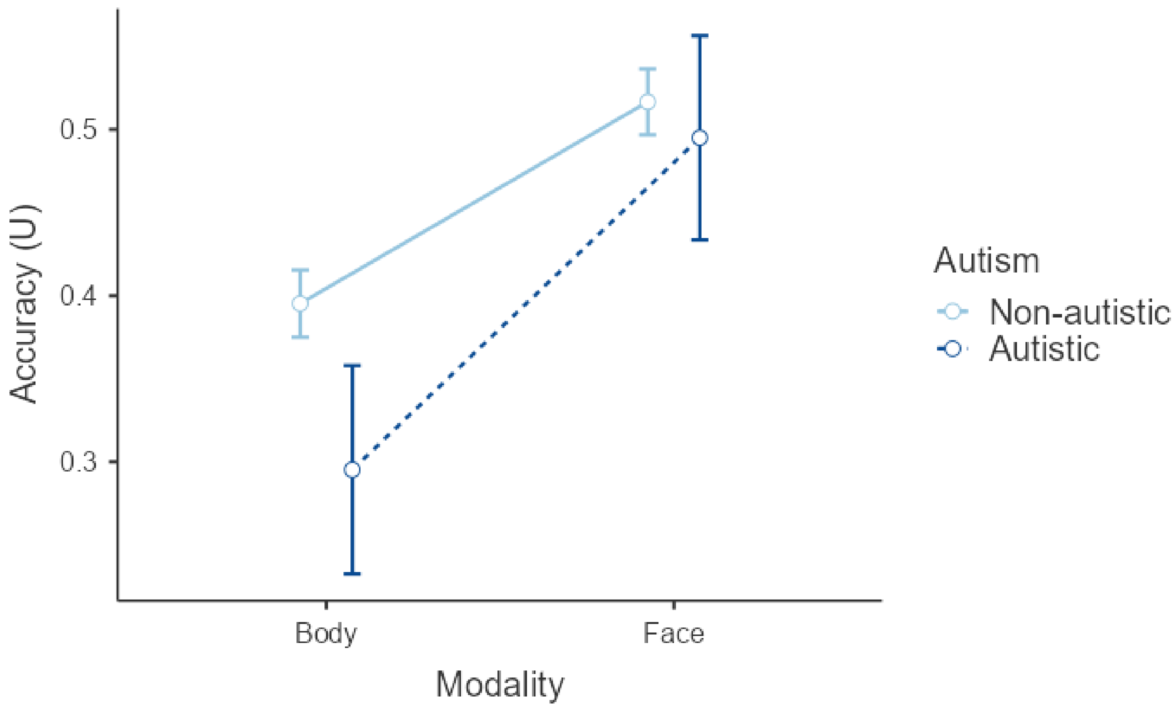
4.3B.2 ER differences in autism: children

Two 2x2 mixed ANOVAs were conducted on accuracy and intensity, with the repeated-measures factor modality (face, body) and the between-subjects factor autism (autistic, non-autistic). Assumptions were met for all analyses in this section (see Appendix C.2B.2.1).

The ANOVA on accuracy revealed a significant main effect of autism (F(1,211) = 5.15, p = .024, η_p^2 = .02) and a significant interaction effect (F(1,211) = 4.09, p = .044, η_p^2 = .02). Post-hoc analyses (Bonferroni corrected) showed a significant difference between the autistic and non-autistic groups on body accuracy ($\bar{d}$ = .10, t(211) = 2.99, p = .019), but not on face accuracy ($\bar{d}$ = .02, t(211) = 0.66, p = 1).

Figure 4.2

Accuracy interaction plot of modality by autism



Note. Error bars represent 95% CIs.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

An ANCOVA was conducted on body accuracy in order to investigate whether the differences between the autism groups are explained by personality covariates. A one-way ANOVA preceded the ANCOVA in order to establish the direct effect of autism on body accuracy. The ANOVA showed a significant effect of autism, an effect that remained significant after controlling for age, cognitive empathy, affective empathy, and anxiety, with age having the strongest effect on body accuracy (Table 4.5).

Table 4.8

ANOVA and ANCOVA assessing the effect of autism and autism with covariates on body accuracy

	SS	df	F	p	η_p^2
Autism	0.18	1	8.96	0.003	0.04
Residuals	4.27	211			
Autism	0.17	1	9.97	0.002	0.05
age	0.79	1	47	<.001	0.19
QCAE cognitive	0.01	1	0.39	0.531	0
SCAS-8	0.02	1	1.24	0.267	0.01
QCAE affective	0.01	1	0.88	0.348	0
Residuals	3.44	206			

Note. SS = sum of squares

The ANOVA on intensity revealed no main effect of autism or interaction effect.

For both ER measures, seven (per emotion) Bonferroni-corrected Mann-Whitney U tests were conducted for body and face trials. There were no significant emotion-specific differences (see Appendix C.2B.2.2).

To investigate possible gender effects, a 2 x 2 mixed ANOVA with the factors gender (male, female) and modality (face, body) was conducted on accuracy scores. No significant gender effects were found.

{Part C – Age differences in ER}

4.2C Methods

4.2C.1 Participants

The two samples described in Part A and B were merged for a combined dataset of children and adults (N = 728). It is important to consider that the children sample is technically an in-lab sample, whereas the adults sample is an online one.

4.2C.2 Measures

The data obtained from the QCAE and AQ can be combined without any transformations, as the adult and children versions both used the same scales. The children's SCAS and adults' STAI required transformation in order to be comparable. The STAI was converted from a 1-4 Likert scale to a 0-3 scale to match the SCAS. Both measures were averaged across items. Confidence data was not analysed due to confidence ratings not being taken from children (Part B).

4.2C.3 Statistical analysis

In order to compare children, young adults, and older adults, the adult sample was split at 30 years of age between younger and older adults. The number was chosen based on past research finding ERA beginning to decline at 30 (Mill et al., 2009).

The main objective of the analysis was to investigate differences between age groups in accuracy and intensity, but a secondary analysis will also explore the exact trajectory of accuracy differences in children.

4.3C Results

Splitting the sample into age groups resulted in three samples: 34% children (n = 246), 48% young adults (n = 348), and 18% older adults (n = 131).

A 2x3 Mixed ANOVA was conducted on accuracy scores with the factors modality (body, face) and age group (children, young adults, older adults). There was a significant effect of age group ($F(2,688) = 123.99$, $p < .001$, $\eta_p^2 = .26$), a significant main effect of modality ($F(1,688) = 215.21$, $p < .001$, $\eta_p^2 = .24$), and a significant interaction effect

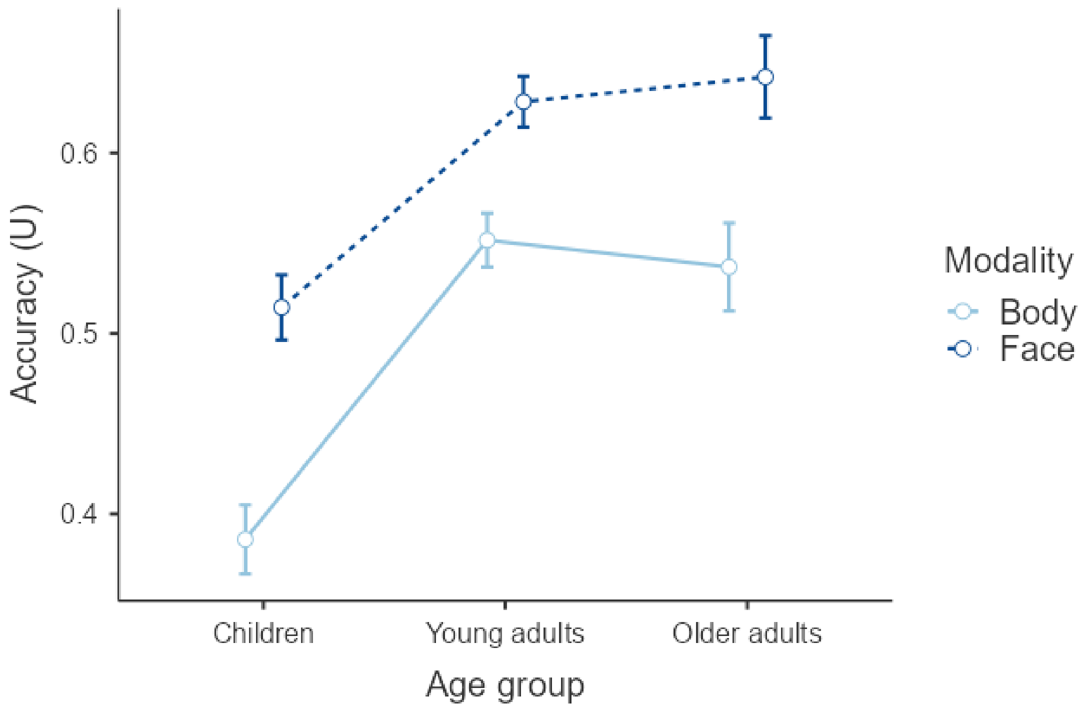
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

(F(2,688) = 6.17, p = .002, η_p^2 = .02). Bonferroni post-hoc tests for the interaction effect showed a larger difference between children and young adults on body accuracy ($\bar{d}$ = -.17, t(688) = -13.42, p < .001) than face accuracy ($\bar{d}$ = -.11, t(688) = -9.82, p < .001), with no differences between young adults and older adults on either body ($\bar{d}$ = .01, t(688) = 1.02, p = 1) or face ($\bar{d}$ = -.01, t(688) = -1, p = 1) accuracy. Adding anxiety (trait only), cognitive empathy, affective empathy, and ALTs as covariates in the model substantially reduced the main effect of modality (F(1,573) = 8.98, p = .003, η_p^2 = .02), only slightly reduced the effect of age group (F(2,573) = 123.99, p < .001, η_p^2 = .18), and resulted in the interaction between modality and age group becoming not significant (F(2, 573) = 2.35, p - .096, η_p^2 = .01).

To investigate differences across ages between autistic individuals, a 2x3x2 Mixed ANOVA was conducted on accuracy scores with the factors modality (body, face), age group (children, young adults, older adults), and autism (autistic, non-autistic). There were no significant two-way or three-way interactions with autism. Full results can be found in Appendix C.2C.

Figure 4.3

Accuracy interaction plot of modality by age group



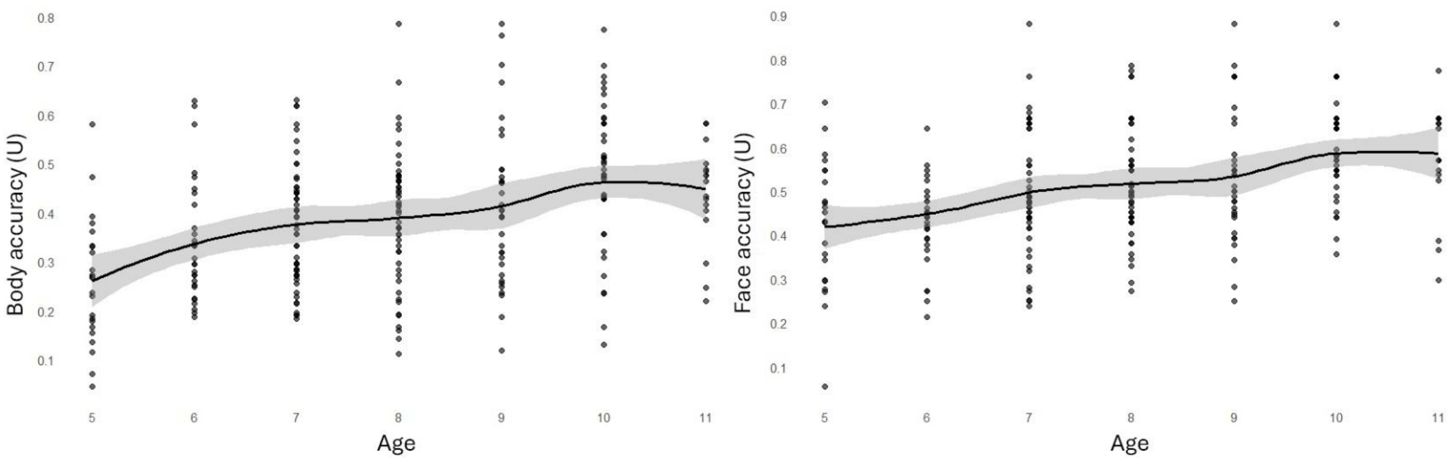
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Note. Error bars represent 95% CIs.

A relationship between age and accuracy was observed in children in Study B. Scatterplots were used to explore age patterns of ER accuracy in children. The plots revealed a generally positive trend, with accuracy increasing with age. However, the trend was not strictly linear; a slight plateau was visible around ages 7–8, and 10–11. A LOESS smooth line was added to better capture the non-linear pattern (Cleveland, 1979). {add line spacing}

Figure 4.4

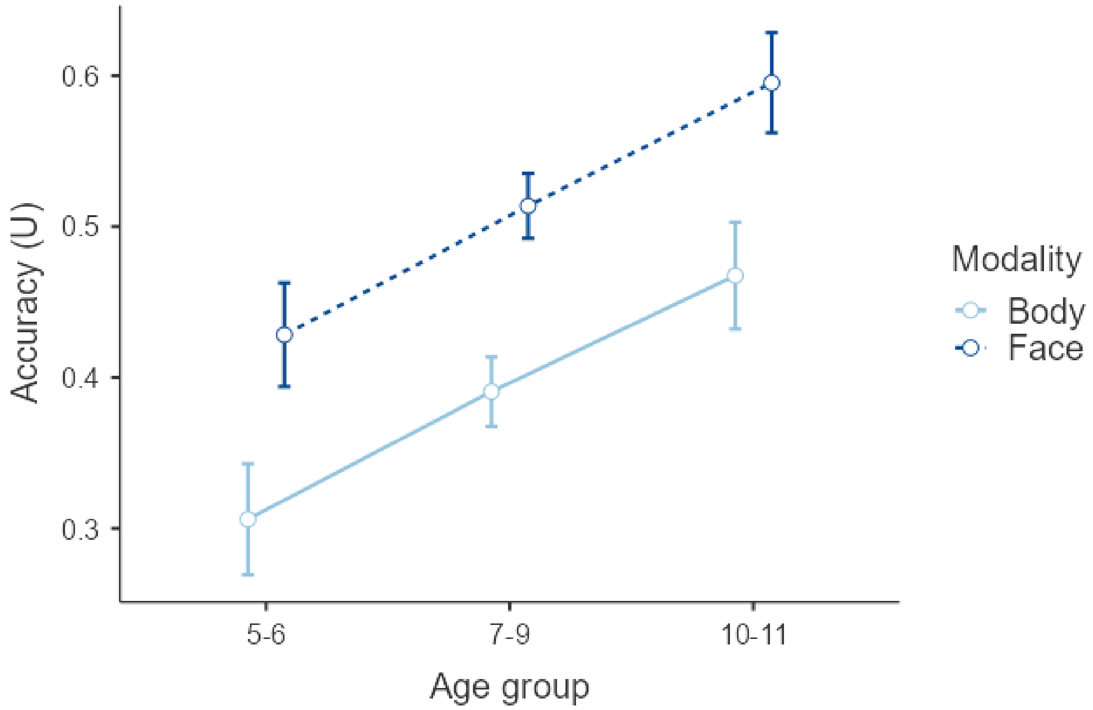
Scatterplots of body and face accuracy by age with LOESS smoothing lines



Based on the observed plateaus, participants were grouped into age groups 7-9 and 10-11. The 5-6 year olds appeared different on body accuracy, but similar in face accuracy, and were grouped together for an age comparison analysis. A 2x3 was conducted on accuracy with the repeated measures factor modality (body, face) and the between-subjects factor age group (5-6, 7-9, 10-11). There was a significant main effect of modality (F(1,243) = 109.41, p < .001, η_p^2 = .31), and a significant main effect of age group (F(2,243) = 36.89, p < .001, η_p^2 = .23), but no interaction effect (p = .981; see Appendix C.2C).

Figure 4.5

Accuracy interaction plot of modality by age group (children only)



Note. Error bars represent 95% CIs.

Although the split between young and older adults is based on previous evidence, the spread of age in the older adult group (over 30) is rather large. To verify finer differences within that group, a similar approach as the one conducted above for children was employed for older adults: correlational exploration followed by a split into smaller groups and an ANOVA. However, there were no relationships between age and accuracy in the older adult groups on either body accuracy ($\rho(129) = -.07$, $p = .449$), or face accuracy ($\rho(129) = .02$, $p = .853$).

4.4 Discussion

In part A of the present study, it was found that there are small differences between autistic and non-autistic adults in fERC, but not bERC, ERA, and ERI. The differences in fERC were explained by differences in state and trait anxiety. The analysis focusing on anxiety had a smaller sample of autistic participants than the total sample (n = 66 out of 90) due to missing anxiety data. In the analysis focusing on alexithymia (n = 85 autistic participants), there were small differences between the autistic and non-

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

autistic groups on bERA, bERC, and fERC, but not fERA, fERI, or bERI. Differences were explained by alexithymia, cognitive empathy, and affective empathy. No emotion-specific differences were found. In part B, differences between autistic and non-autistic children were found on bERA, but not fERA, with no ERI differences. The differences in bERA were not explained by anxiety, affective and cognitive empathy, or age. In part C, young adults had higher ERA than children, but equivalent ERA to older adults, with no interactions with autism. The difference between bERA and fERA was larger for children than adults. Children's ERA increases during preschool and school ages in a non-linear fashion, with growth "spurts" between ages 5 and 7, and between 9 and 10. fERA and bERA increase in a similar fashion.

4.4.1 ER differences in autism: adults

The double analysis that had to be undertaken, analysing anxiety and alexithymia separately due to imbalanced missing data issues, revealed a difference in accuracy between autistic and non-autistic people in the alexithymia sample, but not in the anxiety one (smaller sample of autistic people). These seemingly different findings need to be interpreted carefully, as the effect size of the difference in the alexithymia sample was very small. The findings are in line with the trend of mixed findings observed in the literature (Prior et al., 1990; Philip et al., 2010; Doody & Bull, 2013; Peterson et al., 2015; Fridenson-Hayo et al., 2016; Metcalfe et al., 2019; Mazzoni et al., 2020; Yeung, 2022), however, the present study finds that when there are differences in ERA, they are explained by differences in alexithymia or empathy. The results support the alexithymia hypothesis of autism (Cook et al., 2013; Ketelaars et al., 2016; Ola & Gullon-Scott, 2020; Butera et al., 2023; Moraitopoulou et al., 2024) and, given that empathy also explains differences between autistic and non-autistic individuals, there is support for extending the alexithymia hypothesis to a wider personality hypothesis of autism that includes multiple explanatory traits.

The differences between fER and bER are difficult to interpret given the findings in Study 1. More specifically, of the two actors used in this study, one actor was more proficient at expressing via faces than bodies, likely artificially raising the accuracy scores on faces in Study 2, considering that the second (female) actor expressed emotions to a similar recognisability via faces and bodies. This finding brings into question most previous findings that compared different modalities in autistic populations, but also in general: if the EEA of actors is not known to be similar, it becomes unknown if recognisers have a preference for one modality over the other. Study 3 will further investigate actor ability, and whether actor individual differences play any role in it.

Confidence findings suggest that autistic individuals are overall less confident in their ability, despite their ERA being on par with non-autistic individuals. This reflects a negative self-stereotype in autistic people about their own ERA, and confirms some previous findings (Georgopoulos et al., 2022). However, the differences in ERC are explained by differences in anxiety, alexithymia, and empathy, with cognitive empathy accounting for most variance in ERC. The cognitive empathy – ERC relationship is in line with the findings of Study 1, supporting the idea that confidence rating given during a task are similar to a measurement of state cognitive empathy, whereas the questionnaire measure reflects trait empathy. Also, total ERC was related to each of the personality traits, including state anxiety. This suggests that confidence is a complex construct that requires more attention from future research. The idea of manipulating confidence experimentally, elaborated in the discussion of Study 1, is further supported by the present findings.

When looking at correlations between alexithymia and ERA, there were no correlations in the non-autistic sample, with correlations (some non-significant, {potentially} due to the smaller sample size and small effect size) in the autistic sample. This finding is a confirmation of the finding in Study 1, where the sample was also comprised of non-autistic individuals. There was also a large difference in alexithymia between the autistic and non-autistic sample, in line with previous findings (Kinnaird et al., 2019). Overall, this suggests that variation on the higher end of the alexithymia continuum is related to ERA, with lower to medium alexithymia not being related to ERA. Future research should attempt to integrate advancements in alexithymia measurement and discern a confident cut-off point for categorising people as alexithymic and non-alexithymic.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

4.4.2 ER differences in autism: children

In contrast, the findings in the child sample (Part B) demonstrated a larger effect of autism on ERA, an effect that was not explained by controlling for age, anxiety, and empathy. This suggests that in children, differences are more likely to be due to autism per se, not due to personality differences. It is important to discern that differences were present only for bERA, not for fERA, in contrast to previous studies finding impaired fERA in children (Yeung, 2022). Due to the issue uncovered in Study 1 (actor male 1 having facial expressions more recognisable than body expressions), it is uncertain whether autistic children have a particular difficulty in recognising body expressions, or whether the body expressions are more difficult than the facial expressions. Future studies should use expressions of overall similar recognisability in order to correctly interpret fERA and bERA differences. Regardless of the reason for differences in bERA, they were not explained by personality traits, suggesting that a personality hypothesis of autism might apply only to adults. However, caution is warranted in interpreting these results given the other-reported nature of children's personality traits.

Given that personality traits explain differences in adults, but not in children, it might suggest the acquisition of personality differences from childhood to adulthood in autistic individuals. Future research should consider a longitudinal exploration of how children's ER and related personality traits found in this thesis change over time, in order to investigate if anxiety, alexithymia, and cognitive empathy differences are acquired over time in autistic populations, possibly due to social factors (Woods, 2017).

No differences in disgust, or any other specific emotions, have been found in the present study between autistic and non-autistic people. This is likely due to methodological limitations (i.e., a small pool of actors with no repetitions) not allowing more appropriate and powerful parametric tests to be conducted. Study 3 will attempt to redress this issue by using expressions from 16 actors.

4.4.3 Age differences in ER

The analysis at Part C revealed a substantial difference in ERA between children and adults, with children initially having slightly worse bERA compared to fERA than adults, but this did not withstand after controlling for anxiety, cognitive and affective empathy, and ALTs. A follow-up analysis found no interaction of age and autism on ERA. The findings contradict previous research that found differences between young and older adults on fERA (Mill et al., 2009; Hayes et al., 2020). It is likely that no differences were found due to the task being less difficult (i.e., lack of a time constraint and the ability to replay videos), given that past research has found that older adults tend to have lower accuracy on more difficult stimuli (Grainger et al., 2017). The findings also contradict previous bER research that used exclusively PLDs (Insch et al., 2015; Spencer et al., 2016; Pollux et al., 2016), suggesting that ecological FLDs are likely more recognisable for older adults. Future research should explore differences between young and older adults on difficult FLD body and face EEs, to verify if there are differential patterns for bodies and faces.

Focusing on the developmental trajectory of ERA in 5- to 11-year-olds, the results demonstrated a non-linear development, with substantial ERA increases at 5-7 and 9-10 years of age. The first increase corresponds with cognitive development of children and is in line with past research showing increased emotion concept acquisition at that age (Witkower et al., 2021). The second increase corresponds with the increase in social interactions and pressures that preadolescents undergo at that age (Chaplin & Aldao, 2013). At the neural level, these developmental spurts in fERA and bERA may reflect non-linear maturation of the social brain, particularly in regions such as the mPFC, ACC, and pSTS that are central to emotion and mental state processing (Blakemore, 2008; Crone & Dahl, 2012). Non-linear ER development has been noted in previous longitudinal fER studies (Poenitz & Román, 2020; Watling & Damaskinou, 2020); the present study demonstrates a very novel finding: that bER development follows a similar trajectory to fER, suggesting domain-general mechanisms of emotional development.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

4.4.4 Limitations and future directions

The present study has a number of methodological limitations: (1) ERC and alexithymia were not measured for children due to methodological reasons explained in sections 4.2A.2 and 4.2B.2; (2) although other-report for the AQ and SCAS-8 has evidence supporting relationships with self-report in children (Loas et al., 2017; Reardon et al., 2018; Brown et al., 2021), the QCAE does not (Metcalfe et al., 2019); (3) there was a small sample size of autistic children due to difficulties in recruitment, and a small sample size of autistic older adults due to opportunity sampling involving student data collection, with the age distribution being heavily skewed towards young adults; (4) the male actor had imbalanced face-body EEA (see 4.4.1 above); (5) the ER task was very short, with only two actors and no repetitions, making comparisons on specific emotions very difficult statistically; (6) there was missing data in part A, reducing the power of some comparisons; (7) in every age group, the autistic and non-autistic sample sizes were unbalanced, with a ratio of roughly 10:1 in children and older adults, and 3:1 in young adults; (8) most importantly, there were no time constraints on the task in order to facilitate the participation of young children, alongside allowing participants to replay videos, and this might result in both artificially increased performance that is not comparable to real-life transient EE recognition, as well as in unsystematic variance related to the choice of some participants, but not others, to replay videos. For the same reason, autism-related differences in ERS could not be investigated, but Study 3 addresses this measure of ER. Nonetheless, some important and novel findings have been brought forward by the present study. Future research should attempt to replicate some of the findings whilst addressing the methodological limitations.

4.4.5 Conclusion

The present study was unable to confidently infer conclusions about differences in emotion categorisation measures from bodies vs. faces due to methodological limitations. There were some differences in body ER between autistic and non-autistic adults, but they were explained by differences in empathy and alexithymia. More substantial differences were uncovered in ERC, and they were also explained by

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

empathy, alexithymia, and anxiety. In children, differences in ERA were uncovered only with boy expressions, and the differences were not explained by the personality traits or age. Children develop body and face ER in a similar fashion, with non-linear growth periods between 5-7 and 9-10 years of age. Older adults do not demonstrate impaired ER, but the study used a less difficult task due to comparisons with children.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Chapter 5 – Study 3: FaBLE and the double empathy hypothesis of ER

The third and final study in this project aims to investigate the double empathy hypothesis of ER: are autistic people better at recognising autistic actors (own-neurotype preference) and worse at recognising non-autistic actors, and vice versa for non-autistic recognisers? The study was also intended to address some of the questions that remained unanswered after Study 1 and Study 2. Outside of the present thesis, the study was also intended to serve as an initial validation study for a new stimulus set that includes autistic actors and has the actors' personalities measured: Face and Body Lincoln Expressions (FaBLE). However, the discussion of the validity of the stimulus set is outside the scope of the present project.

5.1 Introduction

5.1.1 Individual differences in EEA

EEA variability can cause unaccounted systematic variance in ERA (see Chapter 1.7). Researchers in the field of fER have attempted to circumvent the problem by having actors involved in the creation of fER stimuli pose prototypical, standardised expressions (Scherer & Bänziger, 2010). When constructing facial expressions stimulus sets, actors are sometimes instructed to pose facial EEs (e.g., FEEST, ADFES; Young et al., 2002; Van Der Schalk et al., 2011) based on prototypical combinations of action units guided by the Facial Action Coding System (FACS; Ekman, 1982). Other stimulus sets make use of standardised instructions created by the authors (e.g., KDEF, RADIATE; Lundqvist et al., 1988; Conley et al., 2018), intending for the final products to result in a similar configuration to the prototypical, universal basic expressions. Some authors create stimulus sets by asking actors to freely pose facial EEs as they see appropriate (e.g., NimStim; Tottenham et al., 2009), or using method acting based on example expressions (CEED; Benda & Scherf, 2020), allowing individual differences in EEA to influence the way the emotion is expressed. Although controlling for individual differences in actors appears desirable, it seems that even when having detailed

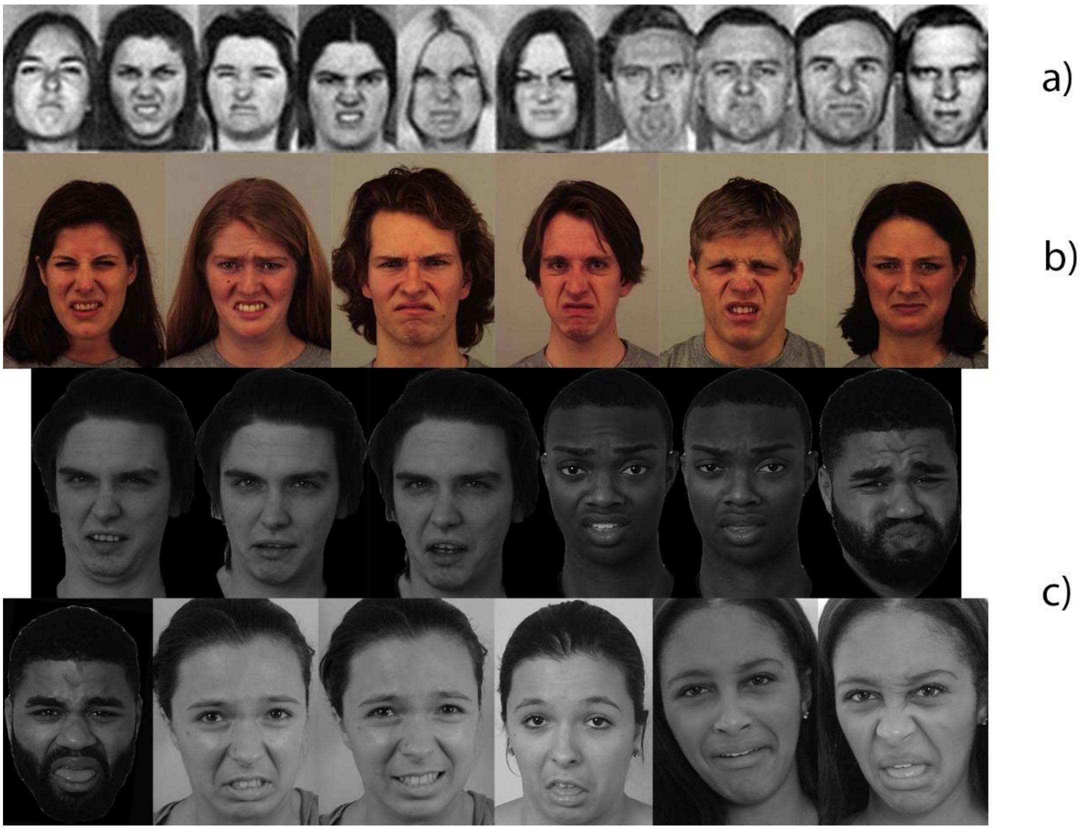
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

instructions on what muscles to move, actors produce qualitatively different expressions. As an example of the heterogeneity, Figure 5.1 illustrates facial expressions of disgust from three different stimulus sets, each with a different degree of freedom to express. It is apparent that individual differences play a role in emotion expressions even when heavily instructed, noticeable from actors' choice to express disgust with an open or closed mouth, for example. A recent study has explored the variability of facial EEs directly, and found that even professional actors produce highly variable expressions (Le Mau et al., 2021). Moreover, another study asked participants to generate their prototypical facial expressions by using computer software to modify 3D faces. The authors found that people have vastly different prototypes of the same types of facial EEs, and this accounts for variation in EEs (Binetti et al., 2022). It is possible that personality factors could lead to such individual differences. For example, a person who is more confident, less anxious, and less alexithymic, might be more likely to show their teeth when photographed for an anger expression. This could probably influence how, for example, anxious observers recognise different expressions, given their attentional biases to threat (Cisler & Koster, 2010). The age (Hauschild et al., 2020), gender (Rehnman & Herlitz, 2006; Lambrecht et al., 2014), ethnicity (Bonassi et al., 2021), and culture (Javanbakht et al., 2018; Cooper et al., 2022) of actors can all affect the fER of the observer. However, the effect of personality differences of actors on the fER of the observer, and how the traits of the observer play into this possible relationship, has not been investigated directly, to the best knowledge of the author.

Figure 5.1

Qualitative individual differences between and withing actors in facial expressions

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display



Note: This figure illustrates how actors in three different stimulus sets express disgust, aiming to show how different actors, and even the same actors, express an emotion in different ways regardless of the instructions they are given. a) between-actor differences in the POFA (Ekman, 1976), actors were instructed to express based on FACS action units; b) between-actor differences in the KDEF (Lundqvist et al., 1988), actors were given standardised instructions not based on FACS; c) between-actor and within-actor differences in the CEED (Benda & Scherf, 2020), actors were allowed to freely express emotions using method acting.

In the recognition of body expressions, there are no prototypes of universal basic expressions to rely on, as research on body expressions is still in the incipient phase. Some authors have attempted to create body action coding systems (Dael et al., 2012; Huis In 't Veld et al., 2014), but they do not benefit from the years of testing and the widespread acceptance that the FACS benefits from. Moreover, there is no agreement on body EEs prototypes, with the authors of the most popular action coding system (BAP; Dael et al., 2012) recognising the high complexity of body expressions and the difficulty of describing all possible gesture motions. Given a likely larger number of possible ways to express an emotion using the body, at least for some emotions,

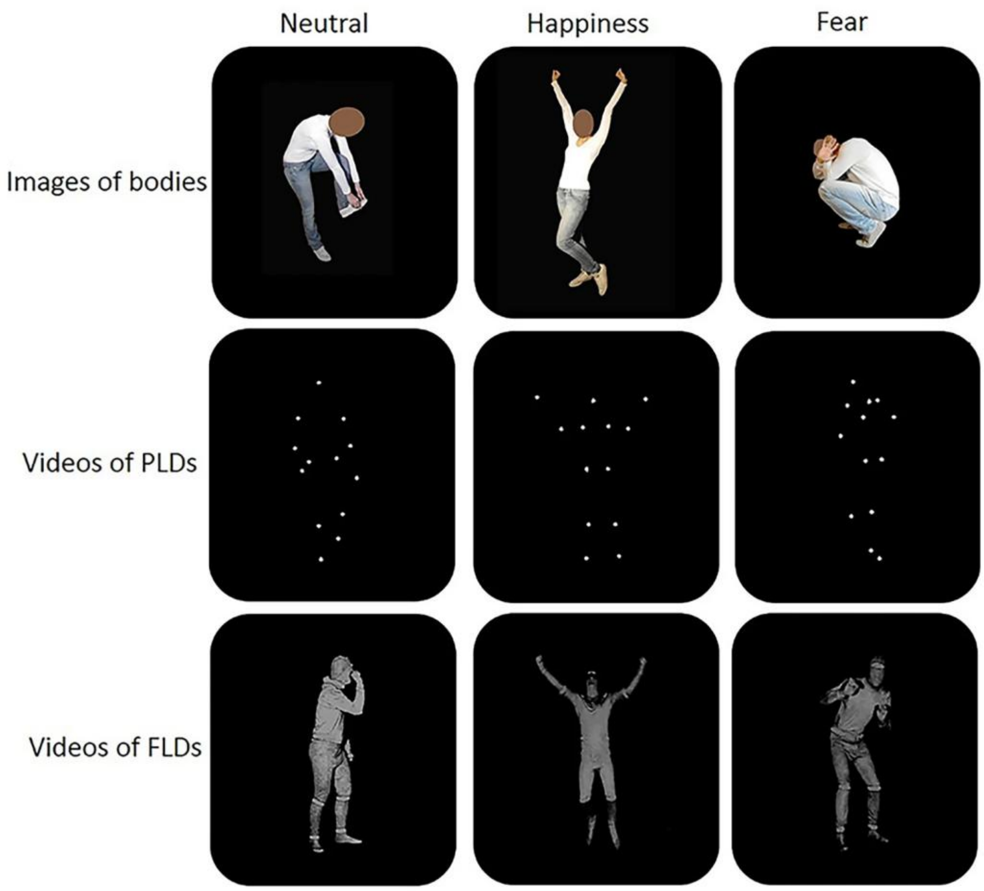
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

individual differences should affect even more what expression a person chooses to use to convey their emotion. However, very few studies have explored the impact of actor individual differences in bER. A study by Krüger et al. (2013) identified a cross-gender effect in bER, where females had an advantage in recognising male angry walking PLDs, and men had an advantage in recognising female joyful walking PLDs. Concerning age effects, children exhibit an own-age preference, recognising body expressions from children better than those from young or old adults (Pollux, 2021). Ethnicity of the actors has been found to affect emotion perception in an fMRI study (Watson & De Gelder, 2017). Ethnic differences have been found in children, but only for some specific emotions and in some ethnic groups (Tuminello & Davidson, 2011). However, in another study focusing on face-body expressions, no gender or ethnicity differences have been found, but differences in social class emerged, with lower classes having better EEA and ERA (Monroy et al., 2022). When considering qualitative differences between body expressions, varied postures and gestures can be observed between any two stimulus sets, or even different actors within the same set. For example, in the study conducted by Mazzoni et al,. (2022), where they explored differences between static FLDs, dynamic PLDs and dynamic FLDs, the static FLDs were from a different stimulus set than the other dynamic stimuli, and were posed by different actors. It can be noted in the figure the authors presented to exemplify the stimuli that fear is expressed in markedly different ways between the two sets of stimuli (Figure 5.2), whilst joy is more similar. A stimulus set that constitutes an exception to this observed variability in body expressions is the BEAST (De Gelder & Van den Stock, 2011). In the creation of the stimuli, the authors instructed the actors to express emotions by doing specific movements, standardised across actors. This resulted in more uniform gestures, although postural variations between actors can be observed. Results from the validation data, however, show differences between actors in recognition accuracy, despite the desired uniformity of gestures and posture (De Gelder & Van den Stock, 2011). It is necessary that such differences between how actors decide to pose emotions are influenced by individual differences in actors (i.e., personality, life experiences, demographics), otherwise most actors would enact body expressions using largely similar gestures and postural changes.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Figure 5.2

Individual differences in body expressions



Note: Taken from Mazzoni et al. (2022), this figure illustrates individual differences in body expressions used in the same study to compare different stimulus formats. Videos of FLDs and Images of bodies contain stimuli from different sets with different actors.

5.1.2 The double empathy hypothesis of autism

As described previously in Chapter 1 and Chapter 4.1, autistic people might express emotions differently to non-autistic people (Yirmiya et al., 1989; Macdonald et al., 1989; Loveland et al., 1994; Volker et al., 2009; Trevisan et al., 2018). Autistic people also perceive and recognise emotions differently from non-autistic people (see Chapter 1.6 and Chapter 4). As an explanation for these differences, as well as for other differences in social communication, Milton (2012) has proposed the double empathy

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

hypothesis. It posits that autistic people have difficulties understanding non-autistic people, but that non-autistic individuals also struggle with understanding autistic individuals. Coming from a neurodiversity perspective, the argument suggests that different neurotypes communicate differently, resulting in cross-neurotype misunderstanding, and intra-neurotype preferences. The theory encompasses many aspects of social cognition, attitudes. and communication. In ToM, studies tend to support the hypothesis (Sheppard et al., 2016), sometimes only partially (Edey et al., 2016). Research on social attitudes demonstrates that autistic individuals are misunderstood by non-autistic individuals (Heasman & Gillespie, 2018), and non-autistic people form negative first impressions of autistic people (Sasson et al., 2017). Social communication and cooperation studies demonstrate within-neurotype advantage and cross-neurotype disadvantages (Crompton et al., 2020; Chen et al., 2021). However, double empathy ER research is still scarce. Faso et al. (2015) found that non-autistic people rate autistic people's facial EEs as less natural and more intense, but still have increased ERA when viewing autistic people's anger expressions compared to non-autistic expressions; this effect was observed for both posed and spontaneous expressions. Non-autistic participants had better accuracy on posed joy expressions of non-autistic people. Another study examined the empathic accuracy of non-autistic people when watching an audio-visual emotional narration of both autistic and non-autistic individuals (Cheang et al., 2024). It found that non-autistic people have better accuracy when listening to non-autistic narrations in comparison to the autistic narrations. However, the task measured ER as how close the observer rated the intensity of the narration in comparison to the narrator's own rating. This essentially combines ERA and ERI into a single measure, making the results hard to compare with regular ER studies. Brewer et al. (2016) found evidence against the double empathy hypothesis using facial expressions: both autistic and non-autistic individuals recognised non-autistic expressions better than autistic expressions. Possible mechanisms underpinning double empathy in ER have been investigated using facial expressions. Research tends to find that fEEs of autistic individuals use the same action units (e.g., brow raise, open mouth) as non-autistic individuals, but differ in kinematics: shorter expressions in autistic people (Keating & Cook, 2020), asymmetry in expressions of autistic individuals (Guha et al., 2015; Witherow et al., 2024), different

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

temporal activation of action units (Ji et al., 2025), or differences in micro expressions (Torres et al., 2025). However, in autistic children, researchers have found evidence for the use of different facial action units (Ji et al., 2025) or fewer action units (Yirmiya et al., 1989). Kinematic differences between autistic and non-autistic people in body expressions are largely unknown. Research on body emotional movements (not emotion expressions) has uncovered atypical kinematics in autistic people, but only in social contexts (Di Cesare et al., 2024). More research is necessary to understand whether the double empathy hypothesis applies to bER in autism. Particularly, there is no research examining bER using autistic and non-autistic actors to film expressions of emotion. The present study aims to address the double empathy hypothesis in the field of ER, comparing how autistic and non-autistic individuals recognise facial and bodily expressions of emotion posed by autistic and non-autistic actors.

5.1.3 Static vs. dynamic ER in autism

The relationship between facial expression motion (static vs. dynamic) and autism has not received a great deal of attention. A review by Kashlak (2014) did not find differences between the fER of static and dynamic stimuli in autistic people. More recent studies that did find reduced fERA in autistic people found no differential pattern between static and dynamic stimuli (Jelili et al., 2021). Kashlak (2014) noted limitations in sample size, participant age, and incomplete emotion sets of static vs. dynamic studies, suggesting that more studies are needed to understand the possible differences. Of note is the finding by Yeung et al. (2022) that motion does not significantly moderate the meta-analytic differences between autistic and non-autistic people in ERA. Refocusing on body expressions, there is little research looking at static vs, dynamic bER in autistic vs. non-autistic people. A recent study by Mazzoni et al. (2022) found no bERA differences in autistic adolescents and adults between static and dynamic EEs, but autistic people had slower bERS for dynamic stimuli. The authors interpreted this findings as autistic people needing more time to recognise emotions due to the use of compensatory mechanisms. It is important to note that the sample sizes were small; more research is necessary to establish differences between static and dynamic bERA. Additionally, Mazzoni et al. (2022) used only two emotions (fear and joy) and a neutral condition. Moreover, the static stimuli and the dynamic stimuli were

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

drawn from two different datasets, instead of using still drawn from the videos to have comparable pairs of stimuli. In order to address all the gaps identified, the present study aims to compare static vs. dynamic, fERA and bERA of autistic and non-autistic individuals using matching static and dynamic stimuli of the same actors expressing all basic emotions.

5.1.4 Aims and research questions

Studies 1 and 2 were unable to address a few issues of interest due to methodological limitations. Study 1 did not measure the effect of actor individual differences beyond gender. Study 2 was unable to assess differences between ER from static vs. dynamic stimuli in autism due to the use of dynamic stimuli only for methodological reasons. The study also did not have a large enough number of trials in the ER task to explore emotion-specific differences between autistic and non-autistic individuals. Additionally, the comparison between fERA and bERA in Study 2 was not precise due to one actor being more proficient than the other in expressing using one modality. Study 3 aims to address these questions as a secondary research aim, with the main aim to explore the double empathy hypothesis in ER. The study will compare the interaction between participant autism diagnosis and actor autism diagnosis. Additionally, this study employed a collection method that ensured that a large sample is comprised of an equal number of autistic and non-autistic people, allowing for more powerful parametric comparisons. The study aims to explore the following research questions:

(A) Do autistic people identify emotions expressed by other autistic people better? Does the same own-group preference occur in non-autistic people? Whilst there is some evidence that autistic people may struggle with recognising expression of non-autistic individuals (Yeung, 2022), and that non-autistic individuals have trouble reading the emotions of autistic expressers (Faso et al., 2015; Cheang et al., 2024), no research has tested this cross-group effect in a single study using the same stimuli. In addition, there is no research to date that has investigated the ER of autistic people when viewing autistic actors.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

(B) Is there a dynamic stimulus advantage in autism? Though some studies have found a disadvantage in, or differential processing of, dynamic stimuli for autistic people (Sato et al., 2012; Sato et al., 2013), most studies tend to find no differences in ERA between the two types of stimuli (Kashlak, 2014; Yeung, 2022). However, most studies, especially in bER, have not used the static and dynamic versions of the same FLD stimuli, but have done so with PLDs (Atkinson et al., 2004). This study will attempt to add to this line of research by investigating differences using FLD in a substantial sample.

(C) This study will attempt to replicate or redress some previous research questions: is there a difference in how faces and bodies are recognised by autistic people, and are there any emotion-specific differences between autistic and non-autistic people (Study 2, research question A1); are there own-gender or cross-gender preferences in ER (Study 1, research question D).

5.2 Methods

5.2.0 Creation of a new stimulus set: FaBLE

In order to investigate the research questions outlined above, a new stimulus set needed to be created containing autistic actors and measures of personality from the actors. In addition, the new stimulus set aimed to have a larger pool of actors and to address a few methodological issues observed using the stimulus set described in Chapter 2 and used in Chapters 3 and 4. Firstly, during the editing of the stimuli, actors ended up partially off-screen for some emotions and performed a more restricted emotion expression on retake. To address this, the filming of the new stimulus set used double the green-screen space compared to the previous stimuli. Secondly, when applying the stimuli in an ER task in Study 1, ceiling effects were noted for joy trials. This is an effect observed in many ER studies, with authors noting that the cause might be that joy (happiness) is the only positive emotion that tends to be studied alongside a number of negative emotions, leading to increased discrimination from the other emotions in categorisation tasks (Sauter, 2010). To address this, another emotion was added to the new stimulus set – amusement. Amusement, often referred to as mirth, is the emotion generated by the appraisal of a humorous event and is associated with the emotion expression of laughter (see Hurley et al., 2013 for a comprehensive definition of amusement). Many authors have argued that amusement is a basic emotion (Liu et al., 2014), with Paul Ekman himself arguing for the fundamental nature of amusement in some of his work (Ekman, 1992; Ekman et al., 1999). Finally, the new stimulus set intended to capture a more varied demographic profile, aiming for gender balance, including a non-binary gender identity and containing expressions from older adults. In addition, half of the actors had to be diagnosed with autism; a variety of alexithymia levels was also desired.

Actors were recruited at the University of Lincoln via leaflets and posters placed on campus, online advertisements, and word of mouth. Actors expressed interest by completing a screening where they gave demographic data and completed the PAQ and AQ-10 (screening deployed on Qualtrics/QP). N = 72 people expressed interest by completing the screening. Actors were selected on an ongoing basis with the intent to form a total set of 16 actors with the characteristics mentioned above (balanced gender, some older adults, eight autistic actors, varied alexithymia levels). For example, once an autistic female in the older age category was recruited, non-autistic females of similar ages were contacted to participate in the filming. After a filming session, actors were awarded an Amazon gift card worth £50. The final pool of actors is comprised of eight autistic actors matched to eight non-autistic actors on age and gender (see Table 5.1 in section 5.2.2).

Before the filming sessions, a set of YouTube clips of amusement were selected and edited into guide videos (n = 11). Another rating study was conducted just for the amusement clips using the same methods as the study described in Chapter 2. N = 68 participants rated each of the 11 videos on realism, stereotypicality and intensity. Seven out of the 11 videos met the criteria outlined in Chapter 2 (> 60 realism and stereotypicality, < 70 intensity). In order to match the number of videos to the guide videos obtained previously, only three videos with the highest realism and stereotypicality were selected to be used as guide videos for filming (Appendix A.3).

Figure 5.3

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Frame capture showing the double green screen set-up: actor expressing amusement

Filming was conducted using the same method as for the previous stimulus set (see Chapter 2). Due to no amusement stimuli being available in the KDEF alongside the other basic expressions, actors were shown the body expression videos of amusement again as guides for performing facial expressions only for amusement, as all three amusement guide videos had the face visible. Seminars and lecture rooms were used for filming, but due to the availability of actors and appointments being set up often on short notice, a wider variety of rooms were used at different times of day. The filming equipment configuration was the same as previously (see Figure 2.4), regardless of the room used. After finishing the filming session, the participants completed some questionnaires: demographic information, STAIt, PAQ, QCAE, AQ-10. Actor number 9 did not complete the actor questionnaire due to situational circumstances, but consented to their data from the screening being used. Videos were edited using the same procedure as previously; however, this time, colour videos with a pure green background were also created, alongside the usual greyscale videos. Only the greyscale videos were used in this study, but the colour videos are part of the stimulus set for future use.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

As in Chapter 2, an image selection study was conducted to obtain images from the videos. Three images extracted by the main author from the videos were presented to raters, and they had to select the image that best expressed the given emotion. A smaller sample of raters was used (N = 6) due to the large pool of stimuli. All raters were researchers with experience in social cues/emotion recognition research. Ties were selected at random, but this occurred mostly with images as they tended to be very similar between the three available images.

Figure 5.4

Examples of colour and greyscale face and body stimuli: actor expressing anger

Note. The frame captures above were take from videos and do not represent static stimuli used; the hand is not visible in the body expression due to motion blur.

The resulting stimulus set contained a total of 512 stimuli defined by 2 modalities (face, body) x 2 motion formats (static, dynamic) x 8 emotions (amusement, anger, disgust, fear, joy, neutral, sadness, surprise) x 16 actors.

5.2.1 Measures

Although all personality traits discussed so far in this thesis are related to ER (in Study 1 and 2), the present study had a much larger pool of trials. For this reason, only two questionnaire measures were used: the AQ-10 and PAQ. The AQ-10 was necessary to verify the ALTs of the autistic and non-autistic sample, and the PAQ was chosen out of the three remaining traits (alexithymia, anxiety, and empathy) due to alexithymia's strong overlap with autism, given that this study focuses on autism for its main analysis. The stimuli described in Section at 5.2.0 were used to create an emotion recognition task measuring the same variables as the task used in Study 1: accuracy, speed (RT), and confidence ratings, with the exception of adding amusement in the emotion choice screen. Participants could choose from all eight emotions after viewing a stimulus.

5.2.2 Participants

Participants were recruited exclusively on Prolific.co (N = 648). Male/female and autistic/non-autistic quotas were enabled on Prolific, aiming to recruit 50/50 gender and autism distributions. However, the quotas for autism were not accurate when asking participants if they were diagnosed with autism in the study, resulting in 265 (40.9%) autistic participants and 376 (58.0%) non-autistic participants, with seven refusing to disclose their diagnosis status. Out of the autistic participants, 176 were already diagnosed, and 89 were in the process of receiving a diagnosis; both groups were combined to form the autism group. The gender quotas were more accurate, with 325 (50.2%) females, 307 (47.4%) males, 11 (1.7%) non-binary people, four other identities (0.7%), and one person refusing to indicate their gender. Given the small sample of participants identifying as not male or female, they were excluded from any gender analyses. Only 89 participants were students, and 37 individuals were non-native English speakers. Participants were aged between 18 and 83 (M = 38.58, SD = 13.41).

The ER task was implemented with all stimuli created in Chapter 5.2.0, however, having participants view all stimuli would have resulted in long completion times, resulting in cognitive tiredness and dropouts. The study was split in half by actor set, then by motion format, resulting in four different studies: images of actor set 1 (FaBLE1), videos of actor set 1 (FaBLE2), images of actor set 2 (FaBLE3), and videos of actor set 2 (FaBLE4). Actor distribution between the two sets can be seen in Table 5.1. Each study's ER task contained 2 (face, body) x 8 (actors) x 8 (emotions) = 128 stimuli, resulting in a task of roughly similar size to the task in Study 1. Given the images and videos were completed by different people, there were no repetitions of the same unique stimulus in any of the studies.

Each of the four studies was completed by different groups of participants. Participants were roughly split between the four studies at random (n = 169/156/162/161). Participants were also split roughly evenly by autism group (non-autistic to autistic ratio = 1.39/1.36/1.60/1.34), and gender (female to male ratio = 1.2/1.11/0.93/1.01) inside of each study, with similar ages (M = 38.51/38.67/38.69/38.45, SD = 13.42/13.63/13.66/13.04).

Table 5.1

Characteristics of the actors in the new stimulus set

	Autism group					Non-autism group					
	Actor ID	age	gender	AQ-10	PAQ	Actor ID	age	gender	AQ-10	PAQ	age difference
Actor set 1 (FaBLE 1 & 2)	1	45	Female	5	101	14	50	Female	2	49	-4
	8	51	Male	10	153	16	53	Male	3	70	-2
	2	21	Female	8	147	5	22	Female	0	50	-1
	6	20	Male	10	139	7	23	Male	4	75	-3
Actor set 2 (FaBLE 3 & 4)	4	26	Female	7	96	12	24	Female	1	29	2
	10	24	Male	5	77	15	23	Male	2	41	1
	3	23	Non-binary	10	146	9	25	Non binary	4	65	-2
	11	27	Male	10	124	13	26	Male	2	37	1

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

5.2.3 Procedure

The study was built in QuestionPro and was conducted entirely online. Participants were asked to complete the study using a mouse, as it improves speed. Participants were paid £8.5-£9 per hour, depending on how long they took to complete the study. The study took, on average, 25 minutes, resulting in an average pay of £3.5-£3.7 per participant. The participants first gave demographic information, then completed the ER test, followed by the AQ-10 and PAQ. The ER task was deployed inside QuestionPro questions using JavaScript logic in a similar fashion to Study 1. Both the filming of the stimuli (reference code: 2023_14199) and the ER study (reference code: 2023_12553) received approval from the University of Lincoln Research Ethics Committee. Payment of actors, video editing, and participant payments were funded via University of Lincoln internal funding under the Impact Accelerator Funding (IAF), a pot stemming from the Higher Education Investment Fund (HEIF), a pot allocated to the university annually by Research England. The total amount of funding provided was £6350.

5.2.4 Statistical analysis

There were four groups of different participants that completed the four studies. Within each study, trials on the ER test varied by modality (face or body), emotion (amusement, anger, disgust, fear, joy, neutral, sadness, or surprise), and actor (eight actors), for a 2x8x8 repeated-measures design (N = 128 trials). The different studies form a 2x2 between-subjects design with differences between motion conditions (static or dynamic) and set of actors (set 1 or set 2). Given that autism group was the main factor of interest, and there was a split of autistic and non-autistic people within each study, the total design of the study was a mixed 2 (autism) x 2 (motion) x 2 (actor set) x 2 (modality) x 8 (emotion) x 8 (actor), with the first three factors being between-subjects, and the last three being repeated measures. In order to address the various research questions, different combinations of factors will be analysed.

Unbiased hit rates (U) were calculated similarly to Study 1 and 2. Methodological checks aimed to verify if the AQ-10 scores mapped onto the autistic and non-autistic sample, as in Study 2. The use of mouse vs. touchpad was compared similarly to Study

1. The relationship between accuracy and speed was also verified, to check if there is an accuracy-speed trade-off.

In order to analyse specific questions about the effect of actor individual differences, such as autism or gender, actors will be grouped by the given characteristics and the scores will be averaged to obtain, for example, one male score and one female score, or one autistic actors' score and one non-autistic actors score. Given that different participants completed the studies for each actor set, a preliminary analysis will explore if there are significant differences between the two sets at every level of interest for the research questions: overall body and face of all actors, of autistic and non-autistic actors, of male and female actors, of older and young adult actors, of high alexithymia and low alexithymia actors. If there are no significant differences, the two actor set studies will be analysed together; otherwise, two separate analyses will be conducted for each actor set. Emotion-specific differences and actor-specific differences will be explored for the two samples separately.

5.3 Results

Most of the main ER test variables (at the total ER, body ER, and face ER levels), as well as the PAQ, were largely normally distributed, with the exception of face confidence showing high kurtosis only in FaBLE 3 (see Table 5.2). Kurtosis was slightly higher for the AQ-10, but given that the samples consisted of roughly half autistic and half non-autistic participants, a somewhat bimodal distribution is expected. The deviation from a mesokurtic distribution was very small. Contrary to the previous two studies, age was normally distributed with a slight positive skew (See Appendix C.3.0.0).

Table 5.2

Descriptive statistics of the main variables for each of the four studies

	survey	Age	AQ-10	PAQ	Total U	Body U	Face U	Total RT	Body RT	Face RT	Total Con	Body Conf	Face Conf
M	FaBLE 1	38.51	4.85	87.24	0.34	0.34	0.37	1243	1242	1245	3.45	3.22	3.67
	FaBLE 2	38.67	4.63	88.27	0.47	0.55	0.41	1292	1273	1310	3.62	3.53	3.7
	FaBLE 3	38.69	4.72	88.76	0.33	0.3	0.39	1224	1252	1197	3.42	3.21	3.63
	FaBLE 4	38.45	4.85	93.64	0.46	0.5	0.45	1297	1309	1285	3.51	3.42	3.6

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

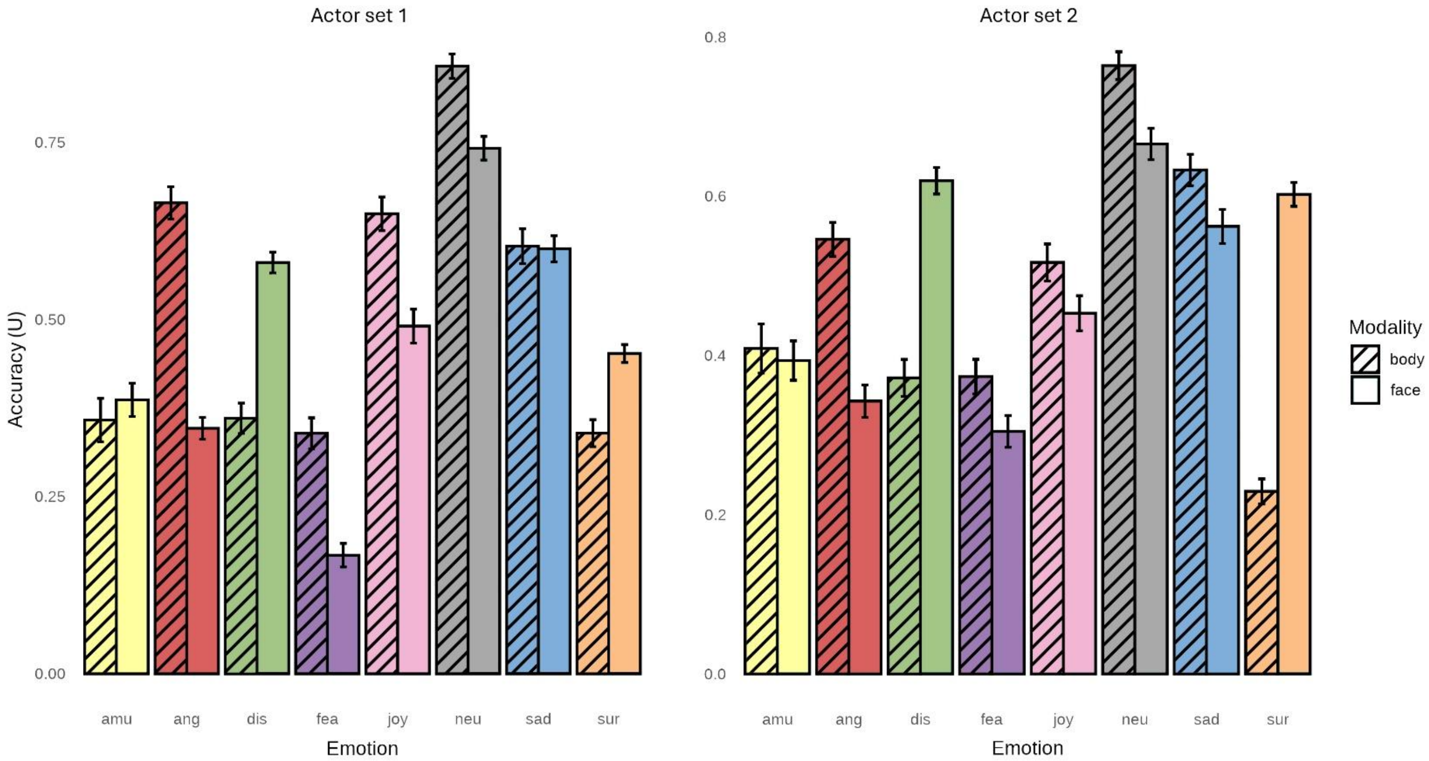
95% CI M LL	FaBLE 1	36.48	4.42	82.6	0.33	0.33	0.36	1199	1195	1201	3.36	3.11	3.6
	FaBLE 2	36.51	4.18	82.75	0.45	0.53	0.4	1243	1224	1260	3.53	3.44	3.62
	FaBLE 3	36.57	4.25	83.45	0.32	0.29	0.37	1181	1206	1153	3.32	3.1	3.54
	FaBLE 4	36.42	4.38	88.88	0.44	0.48	0.43	1253	1262	1242	3.42	3.32	3.51
95% CI M UL	FaBLE 1	40.55	5.29	91.87	0.36	0.36	0.38	1286	1288	1288	3.53	3.32	3.75
	FaBLE 2	40.82	5.08	93.79	0.48	0.57	0.43	1340	1323	1359	3.7	3.63	3.78
	FaBLE 3	40.81	5.2	94.07	0.34	0.32	0.4	1267	1298	1241	3.52	3.32	3.72
	FaBLE 4	40.48	5.32	98.4	0.47	0.51	0.47	1340	1356	1328	3.6	3.52	3.69
SD	FaBLE 1	13.42	2.87	30.51	0.07	0.09	0.08	286.2	307.4	287.9	0.56	0.69	0.5
	FaBLE 2	13.63	2.84	34.92	0.09	0.11	0.09	305	314.2	311.3	0.52	0.6	0.5
	FaBLE 3	13.66	3.05	34.21	0.08	0.08	0.1	278.8	297	284.7	0.62	0.72	0.57
	FaBLE 4	13.04	3	30.6	0.09	0.1	0.11	278.7	303.2	275.9	0.58	0.63	0.58
Skewness	FaBLE 1	0.73	0.19	0.13	0.12	-0.25	0.28	0.35	0.36	0.33	-0.02	-0.32	0.14
	FaBLE 2	0.66	0.35	0.09	-0.28	-0.34	-0.06	0.23	0.3	0.16	-0.22	-0.35	-0.14
	FaBLE 3	0.74	0.31	0.05	0.06	0.07	0.2	0.27	0.2	0.34	-0.19	0.07	-0.71
	FaBLE 4	0.83	0.12	-0.24	-0.76	-0.7	-0.1	0.28	0.19	0.36	0.23	0.18	0.28
Kurtosis	FaBLE 1	-0.36	-1.21	-0.65	-0.06	0.24	-0.04	-0.19	-0.25	-0.2	0.65	0.92	-0.08
	FaBLE 2	-0.41	-0.93	-0.84	0.1	0.11	-0.08	-0.53	-0.55	-0.46	-0.04	0.56	-0.28
	FaBLE 3	0.01	-1.26	-0.95	-0.21	-0.25	-0.44	-0.1	-0.08	0.01	0.77	0.08	2.26
	FaBLE 4	-0.09	-1.29	-0.66	1.09	1.23	-0.24	-0.51	-0.68	-0.22	0.24	0.36	-0.05

Note. M = mean; SD = standard devization; 95% M CI LL = Lower limit of the 95% confidence interval of the mean; UL = upper limit; U = unbiased hit rates; RT = response times; Conf = confidence ratings; $N_{FaBLE\ 1}$ = 169, $N_{FaBLE\ 2}$ = 156, $N_{FaBLE\ 3}$ = 162, $N_{FaBLE\ 4}$ = 161.

Figure 5.5

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Average accuracy by modality for each emotions, for both actor sets



Note. U = unbiased hit rates; amu = amusement, ang = anger, dis = disgust, fea = fear, neu = neutral, sad = sadness, sur = surprise;

Error bars represent 95% CIs. {maybe add a line at chance recognition}

5.3.0 Methodological checks

A set of one-way ANOVAs were conducted to verify differences between the two actor sets on age, ALTs, alexithymia, accuracy, speed, and confidence (total, body, and face levels). All ANOVAs were non-significant, showing similar ER results and individual differences between the two participant groups separated by actor sets, with the exception of body and face accuracy (but not total). The participants recognising the expressions of actor sample 1 (M = .44, SD = .14) were more accurate than those looking at actor sample 2 (M = .40, SD = .13) when recognising body expressions, $F(1, 646)$ = 14.92, p < .001. For faces, actor sample 1 (M = .39, SD = .09) produced less recognisable expressions than sample 2 (M = .42, SD = .11), $F(1, 646)$ = 14.92, p < .001. Based on these results, sample 1 and 2 will be analysed separately when exploring differences between face and body accuracy, but will be analysed together when looking at total speed or confidence. Full results of the methodological checks can be found in Appendix C.3.0.1.

An independent samples t-test showed a large, statistically significant difference in ALTs (AQ-10) between the autistic and non-autistic groups, $t(639) = 21.20$, $p < .001$, $d = -1.70$.

Mouse users were significantly faster ($t(642) = -2.11$, $p = .035$, $d = -.17$) and significantly more confident ($t(642) = 2.79$, $p = .005$, $d = .22$), but not more accurate ($t(642) = 0.55$, $p = .582$, $d = .04$).

There was a small negative correlation between overall accuracy and response times, $r(646) = -.12$, $p = .001$, suggesting that individuals who were more accurate were also faster. No accuracy-speed trade-off computations were required.

5.3.1 Double empathy

To investigate the double empathy hypothesis of ER, a four-way mixed ANOVA was conducted on four measures: accuracy on actor set 1, accuracy on actor set 2, {and} speed (RT), and confidence of both actor sets. The factors were participants' (P) autism (autistic, non-autistic), actors' (A) autism (autistic, non-autistic), modality (face, body), and emotion (all eight emotions). The scores for the eight actors within each set were averaged based on the autism diagnosis of the actor (4 autistic, 4 non-autistic individuals in each set). All four ANOVAs met their assumptions (Appendix C.3.1); results are displayed in Table 5.3. Group estimated marginal means, Bonferroni post-hoc tests, and plots can be found in Appendix C.3.1.1 to C.3.1.4.

Table 5.3

Four-way ANOVA results for each ER measure

	Accuracy (U) set 1				Accuracy (U) set 2			
effect	df	F	η^2_p	p	df	F	η^2_p	p
P autism	1, 321	5.9	0.02	.016	1, 316	0.34	<.01	.563
A autism	1, 321	519.51	0.62	<.001	1, 316	37	0.11	<.001
P autism x A autism	1, 321	1.98	<.01	.160	1, 316	7.43	0.02	.007
Modality	1, 321	55.45	0.15	<.001	1, 316	3.5	0.01	.062
P autism x Modality	1, 321	0.32	<.01	.573	1, 316	0.09	<.01	.766

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Emotion	5.57, 1787.20	616.05	0.66	<.001	5.77, 1823.01	298.33	0.49	<.001
P autism x Emotion	5.57, 1787.20	1.76	<.01	.110	5.77, 1823.01	2.9	<.01	.009
A autism x Modality	1, 321	84.47	0.21	<.001	1, 316	0.11	<.01	.741
P autism x A autism x Modality	1, 321	0.74	<.01	.389	1, 316	2.42	<.01	.121
A autism x Emotion	6.28, 2015.44	12.33	0.04	<.001	6.38, 2015.64	24.73	0.07	<.001
P autism x A autism x Emotion	6.28, 2015.44	2.05	<.01	.053	6.38, 2015.64	0.98	<.01	.441
Modality x Emotion	5.71, 1834.02	185.76	0.37	<.001	6.12, 1935.31	235.32	0.43	<.001
P autism x Modality x Emotion	5.71, 1834.02	0.93	<.01	.468	6.12, 1935.31	1.31	<.01	.247
A autism x Modality x Emotion	6.35, 2039.28	54.75	0.15	<.001	6.35, 2005.06	61.35	0.16	<.001
P autism x A autism x Modality x Emotion	6.35, 2039.28	1.35	<.01	.228	6.35, 2005.06	0.72	0.00	.641

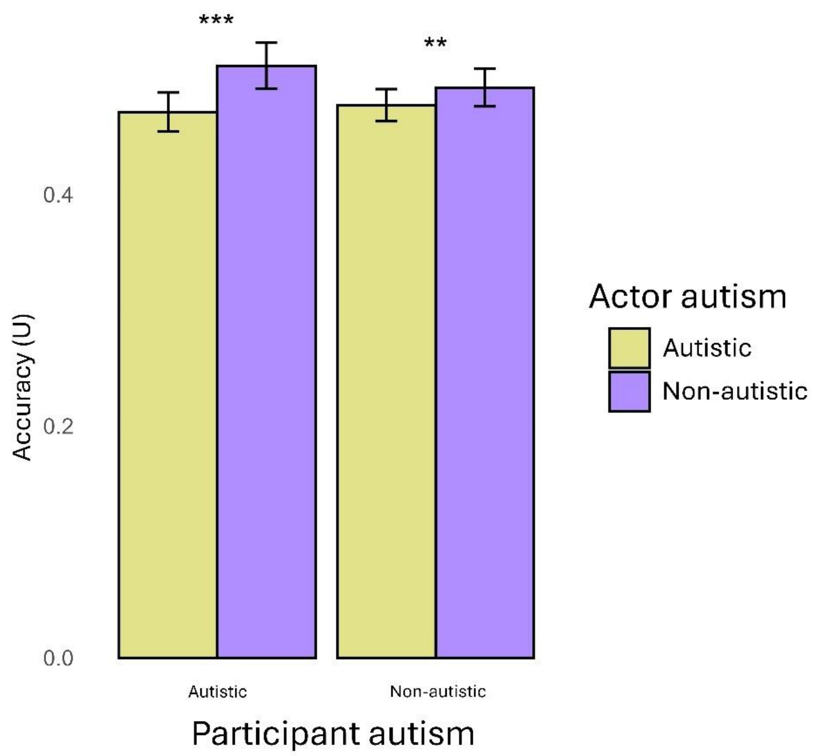
	Speed (RT)				Confidence			
effect	df	F	η^2_p	p	df	F	η^2_p	p
P autism	1, 639	5.24	<.01	.022	1, 639	15.47	0.02	<.001
A autism	1, 639	174.41	0.21	<.001	1, 639	261.54	0.29	<.001
P autism x A autism	1, 639	0.37	<.01	.541	1, 639	0.78	<.01	.378
Modality	1, 639	0.91	<.01	.340	1, 639	351.06	0.36	<.001
P autism x Modality	1, 639	7.54	0.01	.006	1, 639	3.65	<.01	.057
Emotion	6.69, 4278.06	289.27	0.31	<.001	5.88, 3755.73	238.96	0.27	<.001
P autism x Emotion	6.69, 4278.06	2.28	<.01	.028	5.88, 3755.73	1.48	<.01	.184
A autism x Modality	1, 639	195	0.23	<.001	1, 639	76.28	0.11	<.001
P autism x A autism x Modality	1, 639	0.30	<.01	.583	1, 639	0.19	<.01	.667
A autism x Emotion	6.62, 4228.11	29.16	0.04	<.001	6.53, 4172.14	18.27	0.03	<.001
P autism x A autism x Emotion	6.62, 4228.11	1.35	<.01	.224	6.53, 4172.14	1.00	<.01	.428
Modality x Emotion	6.64, 4244.93	167.29	0.21	<.001	6.26, 3999.05	341.36	0.35	<.001
P autism x Modality x Emotion	6.64, 4244.93	1.05	<.01	.392	6.26, 3999.05	1.27	<.01	.264
A autism x Modality x Emotion	6.46, 4125.64	13.86	0.02	<.001	6.46, 4129.32	22.67	0.03	<.001
P autism x A autism x Modality x Emotion	6.46, 4125.64	0.77	<.01	.605	6.46, 4129.32	0.95	<.01	.461

Note. Effects with non-integer degrees of freedom have been Greenhouse-Geisser corrected for sphericity.

Concerning the double empathy hypothesis, there were no differences in how accurately autistic participants recognised autistic actors' in the first actor set (P autism x A autism), but a significant interaction effect demonstrated such differences in the second actor set. There were no participant autism x actors autism interaction effect on speed and confidence. In none of the four ANOVAs were there any double empathy effects at the modality-specific or emotion-specific levels, and no four-way interactions, either. Figure 5.6 displays the significant interaction effect uncovered in the ANOVA on ERA in the second actor set.

Figure 5.6

Effect of the interaction between autism of participants autism of actors on accuracy in actor set 2



Note. U = Unbiased hit rates; ** p < .01, *** p < .001;
Error bars represent 95% CIs.

To investigate the pattern of autistic participants recognising different actors, a 2 x 2 x 8 ANOVA was conducted on the accuracy scores for both sets of actors, with the factors participant autism, modality, and actor (all eight actors). Results of the ANOVA are summarised in Table 5.4. Figure 5.7 shows the two-way interaction of participant autism by actor, revealing that there are significant differences between autistic and non-autistic participants only on the scores from one actor (a8). Assumptions, estimated marginal means, post-hocs, and plots can be found in Appendix C.3.2.1 and C.3.2.2.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Table 5.4

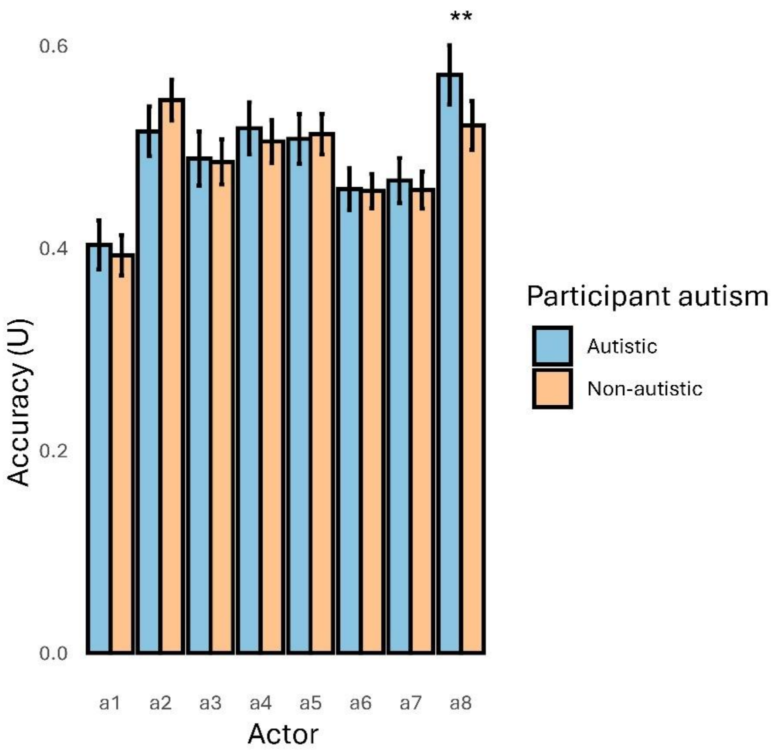
Participant autism x modality x actor ANOVA results

Effect	df	F	η^2_p	p
Autism Participants	1, 316	0.34	<0.01	.563
Actor	6.82, 2155.11	55.82	0.15	<.001
Autism Participants x Actor	6.82, 2155.11	3.06	.010	.004
Modality	1, 316	3.5	.011	.062
Autism Participants x Modality	1, 316	0.09	<0.01	.766
Actor x Modality	6.67, 2109.27	60.45	0.16	<.001
Autism Participants x Actor x Modality	6.67, 2109.27	1.74	<0.01	.099

Note. Effects with non-integer degrees of freedom have been Greenhouse-Geisser corrected for sphericity.

Figure 5.7

Participant autism x actor interaction plot



Note. U = Unbiased hit rates; ** p < .01;

Actors a1, a2, a5 and a6 were autistic, the others non-autistic;

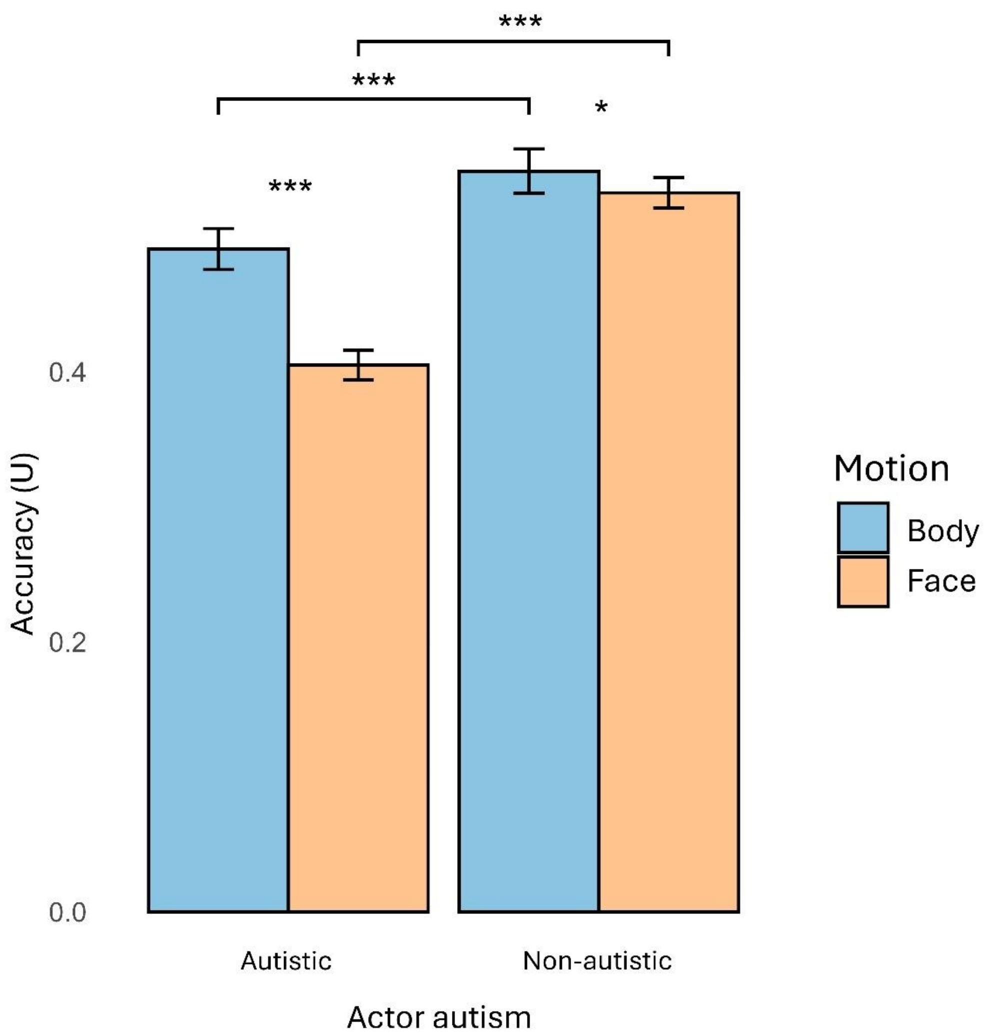
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Error bars represent 95% CIs.

There was an EEA (accuracy) difference between autistic and non-autistic actors in both actor sets (Table 5.3). In set 1, autistic actors produced EEs that were 9.26% more recognisable than non-autistic actors ($p < .001$). In set 2, the difference was smaller, $\bar{d} = 2.76\%$, $p < .001$. There was a significant modality x actor autism interaction effect in actor set 1 (Figure 5.8), but not in actor set 2. Actor-specific scores are presented below in 5.3.3.

Figure 5.8

Actor autism x modality interaction (accuracy in set 1)



Note. U = Unbiased hit rates; * p < .05, ** p < .01, *** p < .001;

Error bars represent 95% CIs.

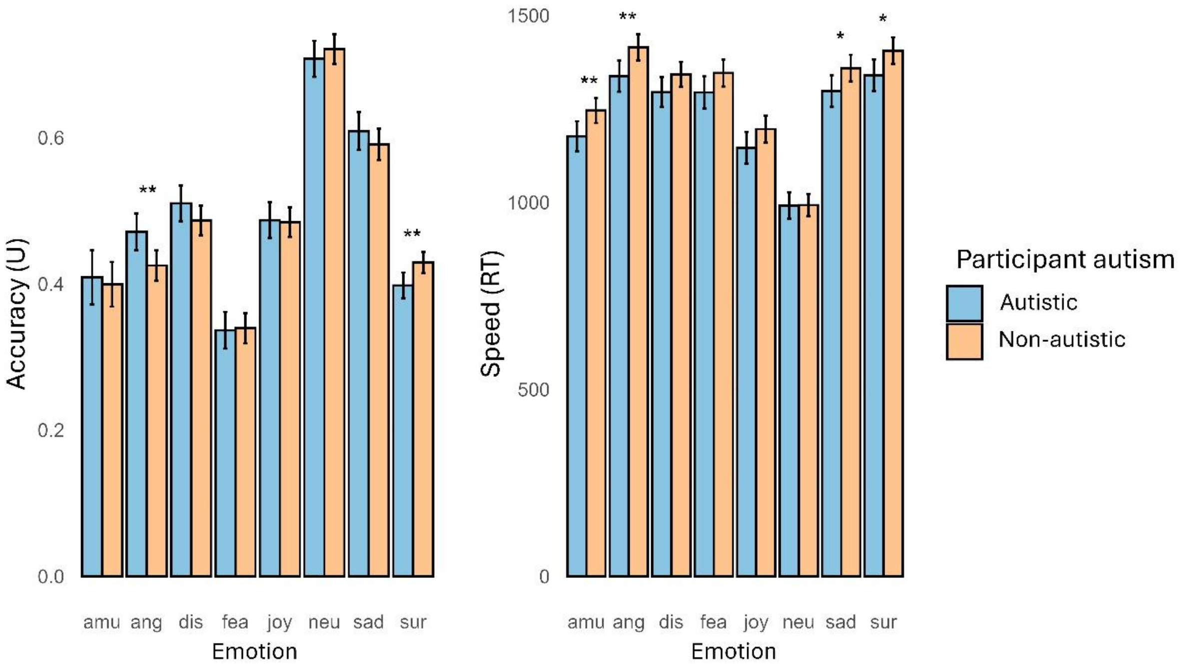
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

5.3.2 Autism differences, the alexithymia hypothesis and the dynamic advantage

This study allowed for a statistically appropriate investigation of emotion-specific differences in autism due to the larger pool of actors. When averaging across actors, there were emotion-specific differences in accuracy only in actor set 2 and in speed (Table 5.3). There were no differential patterns when accounting for modality in emotion-specific differences between autism groups. Figure 5.9 shows that there were differences only for two emotions in accuracy, and four emotions in speed.

Figure 5.9

Participant autism x emotion interaction plots



Note. U = Unbiased hit rates, RT = response times; * p < .05, ** p < .01;
Error bars represent 95% CIs.

There were significant differences between autistic and non-autistic participants on accuracy (only set 1), speed and confidence. To verify if the alexithymia hypothesis observed in Study 2 can be replicated, ANCOVAs with alexithymia as a covariate were conducted for each of these measures. For accuracy in set 1, the effect of autism was rendered non-significant (F(1,320) = 1.40, p = .238, $\eta_p^2 < 0.01$) when controlling for alexithymia, which was a significant predictor of accuracy (F(1,320) = 4.51, p = .034, η_p^2 = 0.01). Alexithymia was not a significant predictor of speed (F(1,638) = 0.17, p = .680, $\eta_p^2 < 0.01$), with autism differences remaining significant when accounting for alexithymia, F(1,638) = 5.13, p = .024, $\eta_p^2 < 0.01$. Autistic people were faster than non-autistic people by 58 ms on average (in the ANCOVA model). For confidence scores, alexithymia (F(1,638) = 10.76, p = .001, η_p^2 = .02) had a larger effect than autism group, F(1,638) = 4.49, p = .034, $\eta_p^2 < .01$.

To investigate if autistic people have different ER on static vs. dynamic stimuli, three ANOVAs were conducted (one for each ER measure) for each set of actors, first at the modality level (2x2x2), then at the emotion level (2x2x8), resulting in a total of 12 ANOVAs. There were no autism x motion interactions or three-way interactions (autism x motion on specific modalities or emotions) in any of the 12 models. ANOVA tables can be found in Appendix C.3.3.

5.3.3 Actor differences

To map out general actor variability in EEA, without accounting for any individual differences, two 2 x 8 RM ANOVAs were calculated, one for each actor set, with the factors modality and actor. Assumptions and post-hoc analyses can be found in Appendix C.3.4, C.3.4.1, and C.3.4.2. Results are summarised in Table 5.5 and in Figure 5.10.

Table 5.5

Modality x actor ANOVAs (accuracy)

	Effect	df	F	η^2_p	p
Set 1	actor	6.88, 2227.95	169.27	0.34	<.001

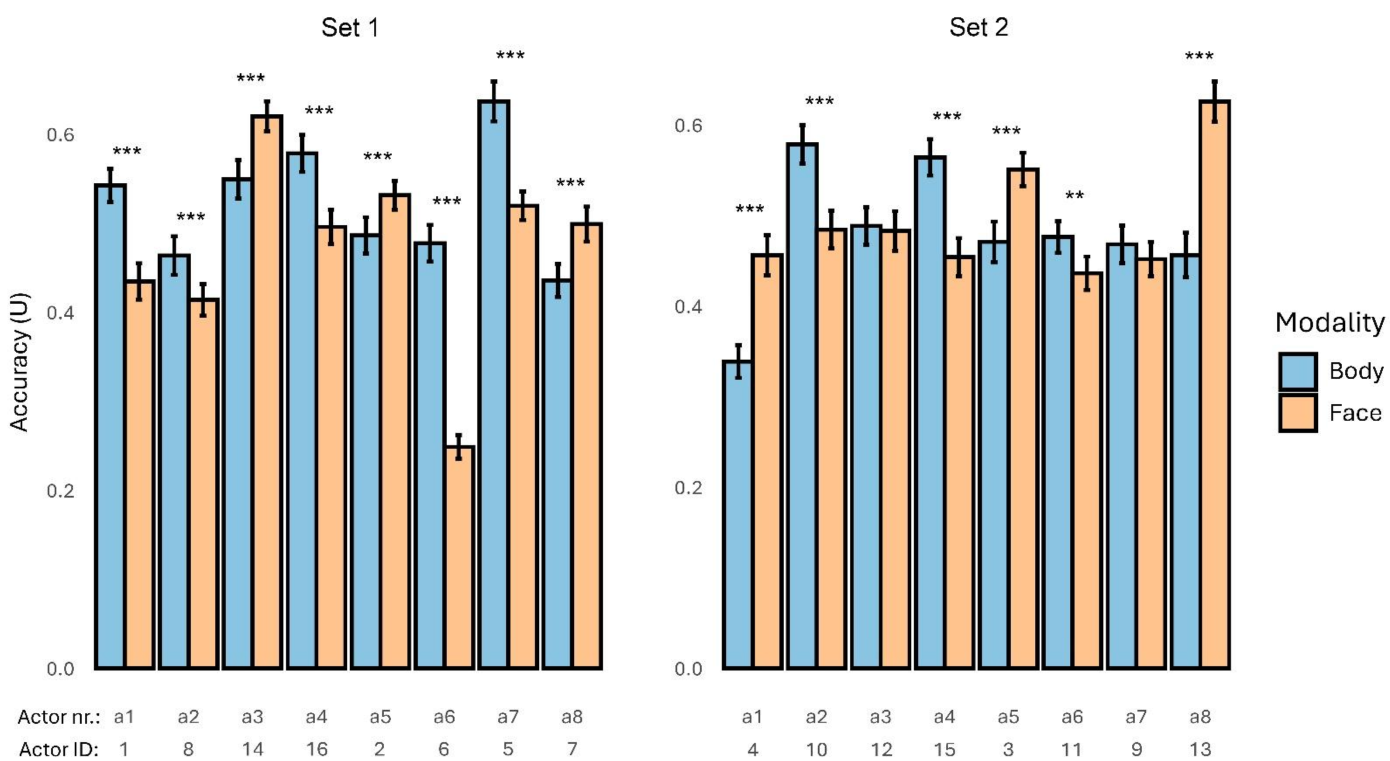
Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

	Modality	1, 324	57.51	0.15	<.001
	actor x Modality	6.74, 2183.72	88.46	0.21	<.001
Set 2	actor	6.80, 2191.18	56.83	0.15	<.001
	Modality	1, 322	3.41	0.01	.066
	actor x Modality	6.69, 2152.64	64.88	0.17	<.001

Note. Effects with non-integer degrees of freedom have been Greenhouse-Geisser corrected for sphericity.

Figure 5.10

Modality x actor interaction plots (accuracy)



Note. U = Unbiased hit rates; * p < .05, ** p < .01, *** p < .001;

Error bars represent 95% CIs.

When completing demographic questions, actors indicated whether they have no acting experience, amateur experience or professional experience. Actors (ID) 3, 5, 7, 9, 10, 11, 14 reported amateur experience, actor 4 indicated professional experience, with every other actor reporting no experience.

In order to verify if EEA of actors was related to their personality traits, non-parametric correlations were computed between the average ER scores obtained for each actor, and actors' PAQ, QCAE, STAI, and AQ-10 scores. There were significant relationships between EEA and AQ-10, STAIt, PAQ (see Table 5.6). There are some smaller relationships with the other traits as well, but the analysis is underpowered. Mann-Whitney U tests revealed that there were significant differences between autistic and non-autistic actors in alexithymia (PAQ), $U(N_{autistic} = 8, N_{non\text{-}autistic} = 7) = 3$, $p = .004$, trait anxiety (STAIt), $U(N_{autistic} = 8, N_{non\text{-}autistic} = 6) = 6$, $p = .013$, and ALTs (AQ-10), $U(N_{autistic} = 8, N_{non\text{-}autistic} = 7) = 1.5$, $p = .002$

Table 5.6

Correlations between actors' emotion expression ability and personality traits

		EEA	AQ-10	STAIs-6	STAIt	QCAE cognitive	QCAE affective
AQ-10	ρ	-0.72**					
	df	13					
	p	0.003					
STAIs-6	ρ	-0.25	0.4				
	df	13	13				
	p	0.378	0.145				
STAIt	ρ	-0.63*	0.66**	0.32			
	df	13	13	13			
	p	0.012	0.008	0.248			
QCAE cognitive	ρ	0.4	-0.84***	-0.4	-0.47		
	df	13	13	13	13		
	p	0.135	<.001	0.141	0.077		
QCAE affective	ρ	0.38	-0.60*	-0.49	-0.36	0.48	
	df	13	13	13	13	13	
	p	0.164	0.018	0.067	0.193	0.073	
PAQ	ρ	-0.64*	0.89***	0.3	0.65**	-0.85***	-0.59*
	df	13	13	13	13	13	13
	p	0.01	<.001	0.279	0.008	<.001	0.02

Note. EEA = Emotion expression ability; * p < .05, ** p < .01, *** p < .001.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

To investigate whether there are own-gender effects, three 2x2x2 Mixed ANOVAs were conducted on each ER measure with the factors participant gender (male, female), actor gender (male, female), and modality (face, body). Analyses involving non-binary participants and actors were not conducted due to the small sample size of non-binary participants. Thus, only actor set 1 was analysed, as actor set 2 contained non-binary actors. Analogously, three 2x2x2 Mixed ANOVAs were conducted on each ER measure with the factors participant age (young adults, older adults), actor age (young adults, older adults), and modality (face, body) to verify if there are any own-age effects. Participants were split into young and older adults based on the mean age of the sample (M = 38.58). None of the six ANOVAs showed any participant x actor or participant x actor x modality effects, either for gender, or for age. ANOVA results can be found in Appendix C.3.5, and the post-hoc analysis in Appendix C.3.5.1 to C.3.5.3.

Given the normal distribution of age in this study, correlations between age and ER were replicated (Table 5.7).

Table 5.7

Correlations between age and ER measures

	U total	U body	U face	RT total	RT body	RT face	Conf total	Conf body	Conf face
Age	-0.11**	-0.02	-0.19***	0.38***	0.39***	0.34***	-0.17***	-0.18***	-0.13***

Note. U = unbiased hit rates; RT = response times; Conf = confidence ratings; Sample size for all correlations was N = 646

5.4 Discussion

The present study investigated the face and body ER of autistic and non-autistic participants in a large sample size. The study used a novel set of emotion expression stimuli containing both body and face images and videos. Half of the actors from which the stimuli were obtained were autistic, and other actor individual characteristics were also measured and investigated. This is the first ER study, to the knowledge of the main author, that used body expressions obtained from autistic individuals, and

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

corresponding facial expressions from the same actors. The results were not in line with the double empathy hypothesis of autism in ER. Instead, autistic actors had lower EEA than non-autistic actors, in particular for the face modality. However, this was mostly due to one autistic actor out of eight skewing the mean of the group for face EEs. There were small differences in only one set of actors between autistic and non-autistic recognisers. The alexithymia hypothesis of autism is supported by the findings of this study, with alexithymia being a better predictor of ERA, and removing the differences between autism groups when controlled for. There were not many emotion-specific differences in ERA between autistic and non-autistic participants, with just a couple of differences on anger and surprise. There was no dynamic advantage or disadvantage for autistic people. There was high actor variability in EEA, with no discernible patterns. There were no own-gender or own-age effects on ERA, ERS, or ERC.

5.4.1 Double empathy

The present study found the opposite of the theorised double empathy problem: autistic people were more accurate in recognising non-autistic expressions than autistic expressions. Non-autistic recognisers had less of a preference for non-autistic expressions than the autistic recognisers. This is in line with evidence found by Brewer et al. (2016) using facial expressions, but the present study extends this finding to body expressions as well. Taken together with the findings of generally lower EEA in autistic actors (although influenced by very low EEA of one autistic actor and very high EEA of one non-autistic actor), the present study supports previous findings of lower EEA in autistic individuals (Yirmiya et al., 1989; Macdonald et al., 1989; Loveland et al., 1994; Volker et al., 2009; Trevisan et al., 2018), and suggests that the effect does not pertain to a double empathy explanation (Milton, 2012). One possible explanation for the EEA differences can be the high alexithymia in the autistic sample. Previous studies have found reduced fEEA in alexithymic participants (Rasting et al., 2005; Wagner & Lee, 2008). This study also found that there is a strong relationship between actors' EEA and their alexithymia, as well as significant differences between autistic and non-autistic actors in alexithymia and anxiety. These variables are potential explanatory variables for the differences in EEA between autistic and non-autistic people. Future studies could investigate if personality traits explain EEA differences between autistic and non-autistic individuals similarly to how the alexithymia hypothesis was tested for ERA in the present thesis. Nonetheless, the present study constitutes the first investigation of the double empathy hypothesis in ER where autistic and non-autistic participants and actors were compared in the same analysis.

5.4.2 Participant individual differences and motion effects

The findings suggest no differences between autistic and non-autistic people in the ERA of static vs. dynamic stimuli. This is in line with previous research mostly uncovering no effect of motion (Kashlak, 2014; Jelili et al., 2021; Yeung, 2022). The study also did not find any own-gender or own-age preferences for any modality, in line with past findings (He et al., 2018; Isernia et al., 2020; Pollux, 2021; Pavlova et al., 2022).

The study replicated the findings observed in Study 2, supporting the alexithymia hypothesis (Cook et al., 2013; Ketelaars et al., 2016; Ola & Gullon-Scott, 2020; Butera et al., 2023; Moraitopoulou et al., 2024). In a similar fashion, there were small differences between autistic and non-autistic participants, that were ultimately explained by alexithymia. Alexithymia was a better predictor of ERA than autism diagnosis, but not in predicting ERS or ERC. Moreover, alexithymia did not explain the differences between autistic and non-autistic participants in ERS. It is important to note that autistic people were faster than non-autistic people, in contradiction to some previous findings that suggested autistic people might employ a strategy of taking more time to think over the emotion choice (Brewer et al., 2022; Georgopoulos et al., 2022; Masoomi et al., 2025).

5.4.3 Actor individual differences

This study found high variability of ERA between actors. Half of the actors were better at body expressions, six actors were better at facial expressions, and two actors were equally better {at both}. Actor/individual variability in expressions is not a novel finding (Le Mau et al., 2021; Binetti et al., 2022), but it is an issue rarely discussed in ER research. The high variability in ERA between modalities is, however, a very novel finding. It poses a number of problems when interpreting past ER research. For

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

example, if a pool of actors that happen to be proficient at body expressions is recruited for a bER study, it can influence the findings via ceiling effects or lack of variability due to high body EEA across the board. Or, as observed in the present study, if an actor with very low face EEA, such as actor 6, is used in conjunction with mid-level EEA actors, it can reduce the average EEA, which can lead to interpretations of low participant ERA. Validation studies help with this issue to some extent (Bänziger & Scherer, 2010), but researchers might choose to use just some of the stimuli from a set, resulting in unsystematic error due to actor EEA. Moreover, many researchers create their own stimuli for a one-time use, without validation, leaving the research open to this possible extraneous effect. It is difficult to explain why actors vary so much by modality (and emotion, as seen in Study 1). Personal experiences, personality traits, idiosyncratic choices in expressing emotions at the time of recording, choices to imitate the guide videos or not (or interpretation of vignettes in other stimulus sets), and physical body characteristics could all be plausible explanations. Future studies focusing on why the EEA differences occur are necessary. The effect of heterogeneity in task characteristics on ERA, which is often a criticism of the ER literature (Yeung, 2022) could be reduced by controlling for inter-actor differences. The uncovered relationships between alexithymia, trait anxiety, autism and EEA (and possibly empathy and state anxiety) provide a promising starting point for future EEA research.

5.4.4 Limitations and future directions

The study has a number of limitations, mostly of the methodological kind: (1) the study had to be divided into separate surveys, removing the ability to compare all 16 actors at once, and not allowing for repeated-measures comparisons of motion conditions; (2) some personality measures investigated in Study 1 and 2 had to be removed due to the size of the study; (3) there were differences between the two actors sets in accuracy, requiring a double analysis of two similar samples; (4) the analysis of actor relationships and differences was underpowered; (6) there were no repetitions in the task, requiring averaging over various conditions (main actors or emotions); a larger task with a few repetitions could have allowed for a full investigation of all effects concomitantly using a six-way ANOVA design. Another important theoretical limitation

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

was the lack of validation of the stimuli prior to the study, especially validation involving dimensional ratings of the stimuli.

The addition of amusement to the pool of basic emotions proved useful, reducing the ceiling effect of joy. Future studies should consider including another positive emotion in addition to joy, both for theoretical (Sauter, 2010) and methodological reasons. The present study opens avenues for future research. In particular, it highlights the importance of participant and actor individual differences and how researchers should account for them when conducting ER research.

5.4.5 Conclusion

Overall, the present study found no double empathy effect, reduced EEA in autism, unimpaired ERA in autistic people when controlling for alexithymia, and no static vs. dynamic differences in autism. In addition, the study highlighted the importance of high variability in EEA between actors, with indications of relationships with anxiety, alexithymia, and autism in actors. Future research could consider EEA variability in interpretations of ERA variability.

Chapter 6 – General discussion

6.1 Summary of findings

The present thesis set out to bring the knowledge base about ER from bodies to similar levels as the face ER literature, whilst also comparing the two abilities. For this purpose, a methodologically integrative approach was adopted: using face and body, static and dynamic stimuli depicting all basic emotions, and all taken from the same pool of actors. fER and bER were compared in three studies using variations of a custom ER test, all whilst accounting for demographic factors, personality differences, autism, and actor characteristics.

Study 1 investigated ER by means of a timed test, using body and face, static and dynamic stimuli, and measured the effect of individual differences: state and trait anxiety, cognitive and affective empathy, alexithymia, ALTs, age, and gender on fER and bER. Bodies and faces were equally recognisable, with an advantage for dynamic expressions that was larger for bodies than for faces. When modelling all the individual differences together, alexithymia, {cognitive meant to be affective} empathy, and state and trait anxiety were related to ERA and ERS, whilst cognitive empathy and gender were related to ERC. Age was related to all three ER measures. There was variability in what emotions and what modalities actors were better at expressing.

Study 2 focused on ER in autism, examining differences between autistic and non-autistic people in fER and bER, and verifying if differences were explained by personality traits. Two similar studies were conducted on adults (Part A) and children (Part B), culminating in an analysis exploring age differences in ER between children and adults. The study found a small difference between autistic adults in bERA, that was explained by differences in alexithymia and empathy. Autistic adults were less confident than non-autistic adults, but this was explained by differences in alexithymia, anxiety, and empathy. Autistic children had lower body accuracy than non-autistic children, but not face accuracy; personality differences, age, and gender did not

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

account for the effect. As expected, young adults performed substantially better than school children, but had equal performance to older adults.

Study 3 shifted the focus to actor differences, and reinvestigated autism differences by measuring the ER of autistic vs. non-autistic people when observing EEs portrayed by autistic and non-autistic actors. It also investigated if autistic people recognise static and dynamic stimuli differently from non-autistic people. It was found that non-autistic actors portrayed more recognisable expressions than autistic actors. Autistic recognisers did not have better ERA when categorising EEs from autistic expressers; on the contrary, autistic recognisers had a larger advantage than non-autistic recognisers when viewing EEs from non-autistic actors. Overall, autistic individuals had slightly lower accuracy, that was explained by alexithymia.

6.2 Integration of findings and theoretical implications

When integrating the comparisons between **fER and bER in static and dynamic stimuli**, this thesis uncovered a consistent dynamic advantage for body expressions. When images are used, faces are more recognisable than bodies; when videos are used, people are more accurate in recognising body expressions. This pattern is consistent, as it surfaced in Study 1 using four actors and seven basic emotions, as well as in Study 3, using 8 actors and eight basic emotions in two separate samples of participants. In essence, this amounts to three different large-sample (N > 300) studies replicating this effect. This finding is relevant for the understanding of embodied simulation models (Goldman & Sripada, 2005; Gallese & Sinigaglia, 2011; Khosdelazad et al., 2020). Research has previously found a dynamic advantage in faces and bodies (Kilts et al., 2003; Sato et al., 2004; Van der Gaag et al., 2007), but no studies to date have explored the dynamic advantage comparatively in the two types of ER. The novel finding of an increased advantage for bodies compared to faces could suggest that bER relies more on simulation than fER, and that moving bodies might engage the MNS more than moving faces. Future directions are discussed below. A supporting mechanistic explanation is the kinematic complexity of body expressions. Body expressions can be composed of gestures, posture, posture shifts, and locomotion (Dael et al., 2012; De Gelder, 2006), whilst facial expressions are only composed of a facial equivalent of gestures – action units based on facial muscle movement (Kleinsmith & Bianchi-Berthouze, 2012; Keltner & Cordaro, 2017). Consider an example of joy and anger body expressions (Figure 6.1). Some participants expressed joy with their fists clenched, and some guide videos used in Chapter 2 involved athletes raising their fists in victory. Anger expressions can also present with similar gestures – the making of a fist. What distinguishes anger from joy, is the way the fists might move, for example, the pulling back of the fists (joy, Figure 6.1 b), or a raise followed by a sudden drop (anger, Figure 6.2 a). This dynamic nuance might not be as prominent in facial expressions, as facial muscles cannot move in 3D space as widely as body muscles can. Static stimuli can lose many components of a body expression (Giese & Poggio, 2003), with especially locomotion and postural shifts always being lost. The loss of kinematic complexity is the other side of the dynamic advantage coin – the static disadvantage of body expressions. Whilst the importance of motion in recognizing body expressions is well-established (Atkinson, Tunstall, & Dittrich, 2007), to the best of the first {delete first} author's knowledge, this thesis presents the first direct behavioural comparison of the dynamic advantage across both face and body emotion recognition within the same experimental framework. Whilst previous research has explored static and dynamic fER and bER, it has only measured each type of ER separately, using varied stimuli and other task characteristics. The present thesis has demonstrated how task characteristics may influence the results of emotion recognition studies above and beyond the ability of the recognisers: actor individual differences (i.e., some actors perform better than others), task difficulty (i.e., the presence of time restrictions and unlimited stimulus presentation), and the number of emotion categories (i.e., introducing amusement reduced the accuracy of joy). As such, comparisons across papers using different tests cannot be confidently interpreted. The present thesis conducted comparisons of face and body, static and dynamic EEs from the same actors, all integrated into the same task designed to be fully within-subjects.

Figure 6.1

Examples of anger and joy static body expressions

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

a b

Note. a = anger, b = joy;

The findings on the relationship between **individual differences and ER** have numerous theoretical implications.

Whilst evidence for the relationship between **alexithymia** and ERA has been found in studies 2 and 3, there was less evidence for this relationship in Study 1. Study 1 did not have a substantial group of autistic individuals, with no relationship being found between alexithymia and ER. Additionally, this was replicated in Study 2, where correlations were computed separately for the total sample, and for the non-autistic and autistic groups separately: alexithymia was related to ER only in the autistic sample. Study 2 also found large differences in alexithymia between autistic and non-autistic people, supporting previous findings (Kinnaird et al., 2019). The findings suggest that variation on the high end of alexithymia (i.e., in autistic samples) is related to ER deficits, but not on the lower levels (i.e., in non-autistic samples). Future studies should aim to target the recruitment of non-autistic individuals with high alexithymia and autistic individuals with low alexithymia, and explore the interaction of alexithymia and autism on ER. Studies 2 and 3 also found that differences between autistic and non-autistic people in ER became non-significant when alexithymia was controlled. This thesis adds to the growing body of evidence for the **alexithymia hypothesis** of autism (Bird & Cook, 2013; Cook et al., 2013; Ketelaars et al., 2016; Ola & Gullon-Scott, 2020; Butera et al., 2023; Moraitopoulou et al., 2024). The neural mechanisms of the

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

alexithymia hypothesis are mostly unknown. Imaging research suggests differential but overlapping ER neural processes in autism and alexithymia (Bird and Cook, 2013). A recent fER study found evidence for differential processing within the social brain network (i.e., PCG, PC, TPJ) between autistic individuals with and without alexithymia (Kirsch et al., 2025). However, more research is required using more difficult ER tasks, as the test used in the study by Kirsch et al. (2025) was a less difficult two-choice test, and thus found no behavioural ER differences. Additionally, the neural mechanisms of bER in alexithymia and autism are unknown, and could explored by future research.

Study 1 found relationships between ER and **state and trait anxiety**, with stronger relationships with speed than accuracy, and mainly for body expressions, not facial expressions. Study 2, however, found no relationships between accuracy and anxiety in adults and children, regardless of autism diagnosis. The findings are likely explained by actor individual differences. In Study 1, anxiety was related primarily to the recognition of anger, disgust, and fear. Also, Figure 3.7 showed that actor m2, in particular, had highly recognisable expressions of anger, disgust, and fear (compared to the some of the other actors). However, in Study 2, the stimuli from actor m2 were not used. It is likely that some actors produce more threatening stimuli, making them more salient for trait anxious individuals, explaining the increased accuracy and speed, and more distracting for state anxious individuals, explaining the slower response times. This thesis offers actor individual differences as an explanation for the mixed findings in the literature on ER and anxiety (Surcinelli et al., 2006; Cooper et al, 2008; Japee et al., 2009; Demenescu et al., 2010; Attwood et al., 2017; Simcock et al., 2020; Dyer et al., 2022). More specifically, actors that portray more threatening stimuli might elicit biases in ER for anxious individuals. This explanation is mostly speculative, as this thesis did not measure the threat perception of the stimuli. Future studies should consider rating ER stimuli on threat-related dimensions and explore this proposed effect of actor individual differences. Anxiety being related to bER but not fER is a novel finding that has not been explored in past research, and raises important questions about ER research methodology (discussed further in this chapter). Possible explanations for this effect have been discussed in the Chapter 4.4.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Studies 1 and 2 found positive relationships between ER and empathy {bold empathy}, with differential patterns for cognitive and affective empathy. When modelled together, affective empathy was related to ERA, and cognitive empathy was related to ERC (Chapter 3.3.2), but only with fER, not bER. In the adult sample of Study 2, both types of empathy were related to total and body ERA, with only cognitive empathy being related to ERC. In the child sample, only cognitive empathy was related to accuracy in both modalities. Interpretations of the specific findings can be found in the discussion sections of each study (Chapter 3.4 and 4.4). The mixed findings in this thesis on empathy reflect the mixed findings in the literature (see the detailed review in Chapter 3.1.2). It is important to note that the relationships between empathy and ER in both studies were very small, and bordering significance, possibly explaining some of the mixed findings. Nonetheless, empathy explained the bER differences between autistic adults, and was a significant predictor of ERC above autism and alexithymia. In addition, in both studies, there were moderate relationships between alexithymia and empathy. Taken together, the findings offer some support for the **shared network hypothesis** (Singer & Lamm, 2009; Singer et al., 2009). Additionally, because both empathy and alexithymia explained variance in ER outcomes, and were themselves correlated, these results suggest a possible overlap between the alexithymia hypothesis of autism and the shared network hypothesis. Future studies should consider replicating the present research designs in neuroimaging studies.

Findings on the relationship between **age** and ERA in adults were inconclusive. Study 1 found a relationship between age and both ER types when controlling for personality traits and gender, Study 2 did not find a relationship, and Study 3 found a relationship between bERA and age, but not fERA. Findings on confidence and speed, however, were consistent across the three studies (only Study 1 and 3 for speed), with older adults being slower and less confident. The findings are likely explained by skewed distributions in all three studies (less in Study 3) towards younger ages. Study 3 had a distribution closer to normality, but contained data from only 12 individuals age 70 or older. Given that ER decline is likely caused by neuropsychological aging (Hayes et al., 2020), effects are likely to have been missed due to not sampling from ages where cognitive decline is more likely.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

The three studies demonstrate complex **gender differences** in ER. Study 1 found a difference in ERA between males and females that was explained by personality differences (anxiety and empathy). Study 1 did not find a difference in ERC between genders, but after modelling gender with age and personality traits, females had significantly lower ERC. This was {add likely} due to females having higher affective empathy than males, which was positively related to ERC. Study 2 did not find any gender differences, in neither adults nor children. Study 3 found a female advantage in ERA and ERS, with females having lower ERC than males. The findings are in line with previous studies where a female advantage was found only in more difficult tasks (Hall & Matsumoto, 2004; Hoffmann et al., 2010; Pavlova, 2017). Study 2 had no time constraint and allowed the videos to be replayed, whereas Study 1 and 3 had a time constraint and the videos were only displayed once. Overall, the present thesis demonstrates a novel finding: that personality differences explain the female advantage in more difficult tasks, particularly via increased trait anxiety and increased empathy in females (see Chapter 3.4 for a specific discussion).

Concerning **ER differences in autism**, the present thesis found small differences between autistic and non-autistic individuals in studies 2 and 3. However, these differences were explained by personality traits such as alexithymia and empathy (discussed in detail in Chapter 4.4) for both ERA and ERC. Study 3 also found small differences in ERA, but only in one sample out of two, and these differences were also explained by alexithymia. There were also ERS and ERC differences, with autistic people being faster and less confident; these differences were not explained by alexithymia. Overall, the findings suggest that autistic people are just as accurate as non-autistic people in ERA, with alexithymia being a likely explanation for small differences, supporting the **alexithymia hypothesis** of autism. Contrary to previous findings, autistic people were faster than non-autistic people in Study 3 (Georgopoulos et al., 2022; Masoomi et al., 2025). A possible explanation for the speed advantage is the increased trait anxiety in autistic adults observed in Study 2, given that Study 1 found that trait anxiety is associated with increased ERS (hypervigilance explanations discussed in Chapter 3.4.2). Future studies could clarify this possible explanation by measuring both anxiety and ERS of autistic individuals in the same sample. The ERA results contradict

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

both deficit models (Jaarsma & Welin, 2012) and social models. {comma, not full stop} or neurodiversity models (Dwyer, 2022), suggesting that there are no deficits, nor differences, between autistic and non-autistic people in ERA.

However, some differences were found in the **EEA** of autistic and non-autistic people. Autistic people portrayed emotions that are harder to recognise overall, but only in only one of the two actors sets used in Study 3. The differences were nonetheless small in effect size. This is in line with past research demonstrating lower EEA in autistic people (Volker et al., 2009), but adds to the literature by demonstrating variability in EEA within autistic samples of actors. There was no evidence found for the **double empathy hypothesis** of autism (Milton, 2012). This is in line with past research on fER (Brewer et al., 2016), with the present thesis containing the first study that extended this finding to bER (see Chapter 5.4.1 for a more detailed discussion).

In children, the development of ER matches key cognitive and social milestones. Study 2 constitutes the first study to demonstrate that bERA has a similar developmental trajectory to fERA in preschool and school children. Similar to past research, late school children do not have comparable levels of ER to adults, suggesting that it might still develop through adolescence to reach adult levels (Ross et al., 2012; Pollux, 2021). Regarding ER differences between autistic and non-autistic children, Study 2 found that ER differences were not explained by individual differences in empathy, anxiety, and age (detailed explanations discussed in Chapter 4.4.2).

A unique finding that has surfaced in this thesis, in Study 1, but especially in Study 3, is that there is high variability in how actors express different emotions via the two modalities, and that the recognisability of the produced EEs could be related to actor personality differences (i.e., alexithymia, ALTs, and anxiety). Both studies demonstrated that the accuracy scores of participants varied widely between actors, suggesting that actors indeed have differences in EEA (Le Mau et al., 2021). In a small correlational analysis in Study 3, the overall recognisability of actor expressions was found to be highly related to some of the personality traits of actors: trait anxiety, alexithymia, and ALTs. There were non-significant moderate to high correlations with empathy as well, but the analysis was too underpowered to detect significance (N = 15). No own-gender or own-age advantages were found in Studies 1 and 3, contrary to previous research (Krüger et al., 2013; Pollux et al., 2016). Although some previous research has found relationships between personality traits and EEA (Inoue & Ishii, 1990; Friedman & Riggio, 1999), the present thesis is the first work to uncover EEA relationships with alexithymia, anxiety, and ALTs. Methodological implications are discussed below.

The measurement of **confidence** in emotion recognition is an uncommon undertaking in ER studies. The present thesis has measured ERC in all studies except in the child sample in Study 2, demonstrating novel complex relationships with personality traits. ERC was consistently related to cognitive empathy (Study 1 and 2), showing that people who self-report more cognitive empathy are also more confident in their ER. Given that ERC was related to ERA, there is a possibility that ERC affects ERA. Research has explored how decision-making strategies are affected by low confidence or uncertainty (Lipshitz & Strauss, 1997), but little is known about how it affects ERA directly. Future studies should consider experimentally manipulating ERC to see if it directly impacts ERA. This can be of particular importance in autism research, given that relationships between autism (diagnosis or ALTs) have been found in all three studies. This is in contrast with previous research demonstrating no differences in confidence between autistic and non-autistic individuals (Folz et al., 2023), and aligns with studies that did find differences (Georgopoulos et al., 2022). The present thesis offers the novel explanation that ERC differences are explained by some personality traits such as anxiety and cognitive empathy.

6.3 Methodological and practical impact

The present thesis makes a major methodological contribution to the ER literature by creating the first stimulus set that contains EEs from autistic actors and matched non-autistic actors (FaBLE, Chapter 5.2.0). The findings from Study 3 serve as pre-validation data, demonstrating the recognisability of the stimuli; however, further dimensional validation is required. The stimuli are of immediate use to researchers, as they have been uploaded to the University of Lincoln intellectual property store (https://ipstore.lincoln.ac.uk/). The stimuli can also be useful for educational purposes, as emotion recognition teaching (Ryan & Charragáin, 2010) and emotion recognition training (Schlegel et al., 2017) programmes have been developed and implemented for a number of years. Given that many teaching protocols have been developed targeting autistic children (Kouo & Egel, 2016), the present research also demonstrates the importance of using body expressions when teaching ER, as autistic children had slightly worse bERA than fERA (Chapter 4.3B.2).

Additionally, the present thesis outlines an overlooked aspect of ER that may have a large impact on outcomes – individual differences in the EEA of actors. Study 3 has demonstrated that actors' individual differences in alexithymia, ALTs, and trait anxiety are related to the recognisability of actors' expressions. The study also revealed an effect of actor autism diagnosis on the differential ERA of autistic vs. non-autistic participants, suggesting that recogniser individual differences can interact with expresser individual differences. It is currently unknown if other traits that are related to EEA also interact with recogniser ERA. This is a possible extraneous effect that could explain many mixed findings in the ER literature. There is a general scarcity in research focusing on the relationships between personality and EEA (Inoue & Ishii, 1990; Friedman & Riggio, 1999), but there are no studies, to the knowledge of the author, that have explored interactions between personality traits of actors and recognisers. Future directions are discussed below.

Furthermore, the present thesis outlines a method of creating emotion recognition stimuli using guided free expression (Chapter 2 and 5.2.0). This method is useful for generating sets of emotion expressions in a relatively timely manner, without requiring actor training, coaching, directing, or eliciting emotions via vignettes. For example, recording approximately 30 expressions from an actor (Chapter 5.2.0) required a filming session of about 2-3 hours conducted just by the main {remove main} author and one actor. The sessions included carrying greenscreen and lighting equipment to a room on the university campus, setting up the greenscreen, lights, and camera, filming with the actor, then packing up the set. If multiple filming sessions were scheduled consecutively, the time required to install and uninstall the filming set-up was substantially reduced. Actors were paid £50 vouchers per session, and the editing of the stimuli of one actor required half a working day at technician pay rate (approximately £70), leading to a total cost of roughly £2000 for the filming of a set of

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

expressions from 16 actors. However, this does not include pay for work required to screen the actors, design the study, direct, and run a brief study to select images from videos, all undertaken by the main researchers. The main author also had no prior experience in photography or directing, with minimal video editing experience, learning the basics for the purposes of this PhD project. Therefore, the creation of stimuli for EEA studies with larger actor samples can be conducted by researchers in a timely manner using a similar methodology to this thesis, without requiring the employment of professional staff. The use of guide videos is not necessary, especially for EEA studies where the goal is to capture actor individual differences.

The thesis also demonstrates the successful deployment of a series of online ER tests that also measured response times. The tasks recording RTs (Study 1 and 3) were constructed in JavaScript and deployed using common online survey software (Qualtrics/QuestionPro). JavaScript has been previously found to be optimal for RT measurement (Reimers & Stewart, 2015). It is difficult to compare the RTs with previous studies, as most studies used less than eight emotion choice categories (see Chapters 1.1 and 1.2). Overall, all emotions in both modalities have been recognised above recognition chance. Future studies can consider conducting ER tests online for ease of data collection.

6.3 Limitations

There are a number of methodological limitations spanning across the three studies (Chapters 3, 4, and 5).

Forced choice ER tasks have been used throughout the thesis to measure ERA. This type of test has been criticised for inflating ER accuracy by priming participants with labels, for losing the complexity and nuance of emotional experiences by bounding expressions within strict categories, and for cross-cultural differences in the use of emotion labels (Russell, 1994; Nelson & Russell, 2013; Crivelli et al., 2016). Indeed, researchers have begun using free-labelling tasks in recent studies (Georgopoulos et al., 2022; Brewer et al., 2022). The present thesis focused on expanding the knowledge on bER to that of fER; as such, the use of forced-choice tasks was required given that it is the most common form of fER measurement (Bänziger, 2016).

The use of basic emotions is also an inherent limitation, in light of findings on complex emotions (e.g., Fridenson-Hayo et al., 2016). The nature of complex emotions is heavily debated, with various explanations being brought forward based on mixed findings, such as complex emotions being a combination of basic emotions (Lin et al., 2023), or a product of multiple dimensions, similar to basic expressions (Mohammadi & Vuilleumier, 2020), or a subset of the basic emotion categories (Johnson-Laird & Oatley, 1989; Power & Tarsia, 2007). As mentioned above, the present thesis is concerned with raising the level of knowledge on body EEs, given the reduced attention received by bER. Complex emotions are still being debated in the context of facial EEs, with less being known about complex body EEs. Given the already exploratory nature of many research questions in this thesis, as well as the size of the ER tasks used in this thesis, complex emotions were not included. Future research should consider extending some of the findings that emerged from this project in a comparative design involving basic vs. complex emotions. Moreover, the method for creating EE stimuli developed in this thesis can be used to obtain basic and complex emotions from the same actors, allowing for appropriate comparisons between the two types of stimuli.

The thesis could have benefitted from the inclusion of face-body EEs. Indeed, the stimuli filmed with actors have both faces and bodies visible. The measurement of fbER has been considered in the planning phase of the project, as comparisons between fER, bER, and fbER are theoretically relevant (Gunes & Piccardi, 2007; Aviezer et al., 2012; Pollux et al., 2019; Israelashvili et al., 2020). However, once the comparison between static and dynamic stimuli was planned, along with the number of emotions and the number of actors, it became apparent that including fbER would have created an unfeasibly large ER test that would have taken too long to complete by participants, especially in voluntary research. Moreover, there were concerns about learning effects. As demonstrated in Study 1 (Chapter 3.3.0), the use of static and dynamic stimuli derived from the same core video resulted in learning effects that were dependent on the order of presentation of images and videos, requiring counterbalancing. A task containing a third set of static and dynamic stimuli derived from the same video (face and body EE) would have created more methodological difficulties. This {thus, not this}, it was decided to not include fbER measurement in the designs of the three studies. Future research could explore the advantage of bimodal EEs using the stimuli created in Chapter 2.

One of the main unique findings that emerged from this project is the relationship between EEA and actor individual differences, which doubles as a limitation at the same time. There was general variability in EEA between actors when expressing via faces and bodies, but also when expressing different emotions. This finding, although not novel, tends to be overlooked by ER studies (see Chapter 5.1.1). Discrepancies between Study 1 and 2 demonstrate how task differences, such as actor recognisability differences, can affect the findings of an ER study, and could offer explanations for many mixed findings in the ER literature (Jongen et al., 2014; Pavlova, 2017; Yeung, 2022). This finding demonstrates the volatility of ER tests, and is a limitation of the present thesis as well, as actor EEA was not controlled but rather explored. Future studies should aim to select expressions from actors with controlled EEA based on the design of the study, i.e., a study interested in joy vs. disgust should select actors with joy and disgust expressions of equal recognisability.

Some of the questionnaires used in this thesis have some notable limitations: (1) the AQ-10 has been criticised for having reduced reliability and validity (Jia et al., 2019; Cheung et al., 2023); (2) the QCAE has some internal consistency issues for one of the five subscales (Reniers et al., 2011; Miu & Balteş, 2012); (3) the STAI has been criticised for poor discriminant validity between anxiety and depression (Bieling et al., 1998; Knowles & Olatunji, 2020), and for difficulty separating trait and state anxiety, especially in clinical populations (Barnes et al., 2002). To address the limitations mentioned above, future research should attempt to measure the relationships between ER and personality traits (anxiety, empathy, ALTs) using concurrent measures to the ones used in this project.

Additionally, there were some limitations concerning the participants recruited across the thesis. Participants were largely university students in studies 1 and 2 (chapters 3.2.1 and 4.2A.1), limiting the generalisability of the first two studies to the general population. Additionally, it was difficult to explore gender differences between

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

binary and non-binary identities due to small non-binary subsamples. Future studies could aim to explore non-binary gender differences via targeted recruitment. IQ of participants was not measured in the present study, mostly due to the studies already requiring a substantial amount of time to complete, especially in the unpaid volunteer samples in Study 1 and 2. Also, previous research has found small to moderate relationships between intelligence and ER (Murphy & Hall, 2011; Schlegel et al., 2017). It is possible that IQ can interact with a number of other traits or with autism (Wolff et al., 2022) to affect fER and bER, which could be a promising avenue of research in the future.

Firstly, not all stimuli contain a full view of the actors' bodies, as actors sometimes went off-screen. When actors went off-screen early in the expression or to a large degree, the expression was repeated (see Chapter 2). However, often the expressions went slightly off screen at the final motion of the expressions; such expressions were kept in the stimulus set. Secondly, for some of the facial expressions of disgust the actors could not help but move their head back (i.e., as if moving away from something disgusting). Although shots were repeated, actors still repeated the motion to a lesser degree. The moving of the head back technically constitutes a body expression (i.e., a postural change), not a facial expression. Some other expressions may also contain such movements, especially in the first stimulus set created in Chapter 2. This is a limitation when the intention is too {to, not too} separate and compare fER and bER, but also a qualitative finding that demonstrates the interconnection between the two modalities. Thirdly, many images taken from the videos contain some motion blur. The main author attempted to select images that contained as little motion blur as possible, but the method of frame capturing is inherently prone to motion blur.

6.4 Future directions

Possible future directions have been discussed throughout the thesis, both in the discussions of each study (chapters 3.4, 4.4, 5.4), and previously in this chapter when discussing findings and limitations. This subchapter will bring together all suggestions and highlight the ones with the highest possible future impact.

The increased dynamic advantage for body expressions compared to facial expressions discussed earlier in this chapter is of great theoretical importance for the embodied simulation ER models (Goldman & Sripada, 2005; Niedenthal et al., 2010; Gallese & Sinigaglia, 2011). As discussed in Chapter 1.2 and Chapter 3.1, previous studies have only compared static vs. dynamic faces (Kilts et al., 2003; Sato et al., 2004; Van der Gaag et al., 2007; Khosdelazad et al., 2020), static vs. dynamic bodies (Mazzoni et al., 2020), or static faces vs. static bodies (Zhang et al., 2015; Li, 2021, Ren et al., 2023), with dynamic faces vs. dynamic bodies being compared only in PLDs (Atkinson et al., 2004). Whilst this thesis addressed the static – dynamic by body – face interaction in behavioural measures, this interaction has not been investigated in fMRI and mimicry studies (Kilts et al., 2003; Sato et al., 2004; Van der Gaag et al., 2007; De Gelder et al., 2015). fMRI studies employing the motion by modality interaction, both in perception and in recognition experiments, could elucidate the simulation processing differences between the combinations of stimulus types. More specifically, such research could investigate if the advantage of bodies is due to increased simulation, or a different factor. Additionally, mimicry studies have also used only static or static vs. dynamic face stimuli (Cacioppo et al., 1986; Oberman et al, 2007; Rymarczyk et al., 2019), or face vs. body static stimuli (Borgomaneri et al., 2020). Mimicry EMG studies and mimicry blocking studies could also be conducted using the motion by modality interaction design to explore differences in the proprioceptive feedback loop (Niedenthal et al., 2016). The present thesis initially planned to conduct a face vs. body, static vs. dynamic mimicry blocking experiment before the COVID-19 pandemic, but abandoned the design due to difficulties with in-lab testing brought by UK lockdowns. Given that a classic facial mimicry blocking methodological paradigm is to give a participant a pen to hold with their lips or teeth (Oberman et al., 2007), such an experiment would have been difficult to run even after lockdowns ended, given the unease around viral infections. The gaps in fMRI and mimicry research are strong reasons to continue research using the motion x modality design, and the stimuli provided by the present thesis can facilitate such studies.

In Study 3, relationships were found between EE recognisability and actor personality traits: alexithymia, anxiety, and ALTs, with possible relationships with

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

empathy that were not confirmed due to low sample size. A very impactful theoretical and methodological undertaking is the further exploration of the relationship between EEA and personality traits. In particular, future studies could employ a similar design to Study 3 and explore the relationship between personality traits and the interaction between EEA of actors and ERA of participants. Study 3 represents the foundation that uncovered possible associations, but future studies would benefit from building on these findings using larger sample sizes of actors. Moreover, studies have demonstrated relationships between fEEA and fERA, suggesting that individuals who can express better can also recognise better (Zuckerman et al., 1975; Boyatzis & Satyaprasad, 1994; Wieckowski et al., 2019). Future research could explore if these associations are also present when expressing via bodies.

Study 2 explored age differences in ER in children, young adults, and older adults. Whilst substantial differences were found between children and adults, the study was unable to replicate previous findings of ER decline towards older age (Mill et al., 2009; Hayes et al., 2020). Future research could replicate the comparison with older adults, but in a larger sample, as Study 2 had a smaller sample of older adults, and insufficient participants on the higher end of age. Additionally, the present thesis did not compare fER and bER in adolescents; it is currently unknown what the comparative face and body ER developmental trajectory is throughout adolescence.

Given the high actor EEA variability discussed in the previous subchapter, and given how the differences are multifaceted (i.e., by modality, by emotion, by motion, etc.) and with no discernible patterns (e.g., some actors are better at body anger, others at face anger, other have no differences), one of the main recommendations emerging from this thesis is for researchers to use stimuli from actors of similar EEA for each condition that they compare in the tests they build. This applies to EEs of CG avatars if the movements were derived from the motions of human actors.

6.5 Final conclusion

The present thesis contributes to the understanding of emotion recognition by expanding the study of body expression recognition to a degree of methodological and empirical detail comparable to the study of face emotion recognition. Two stimulus sets of face and body expressions were developed and used in empirical studies, comparing fER and bER in relation to individual differences, with a focus on autism. The discovery of a larger dynamic advantage for body expressions than for facial expressions raises new methodological and theoretical questions for the field of ER, with implications for embodied simulation models. The studies uncovered complex relationships between ERA, autism, personality traits, and demographic characteristics. The findings suggest small differences between autistic and non-autistic people in bER but not fER, with the differences being explained by personality traits such as empathy and alexithymia. The measurement of ERC enriches the understanding of ERA, especially in the context of individual differences. The last study uncovered a relationship between EEA and personality traits in actors, offering a possible explanation for previous mixed findings in the literature. The thesis did not find an own-group advantage for autism, gender, or age groups. Developmental trajectories are similar for both fER and bER in preschool and school children. Autistic children have impaired emotion recognition, with the difference not being explained by personality traits or age. The most pressing future direction is the exploration of EEA and ERA relationships, and associations between ERA and personality traits of expressers. In summary, emotion recognition is a complex ability that is related to many characteristics and traits, with the distinction between the recognition of faces and bodies being necessary when researching how humans recognise emotions.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

References

Abbruzzese, L., Magnani, N., Robertson, I. H., & Mancuso, M. (2019). Age and gender differences in emotion recognition. *Frontiers in psychology, 10*, 2371. https://doi.org/10.3389/fpsyg.2019.02371

Actis-Grosso, R., Bossi, F., & Ricciardelli, P. (2015). Emotion recognition through static faces and moving bodies: a comparison between typically developed adults and individuals with high level of autistic traits. *Frontiers in Psychology, 6*, 1570. https://doi.org/10.3389/fpsyg.2015.01570

Adobe Inc. (2020). Adobe After Effects (Version 17.5.0, Build 40) [Computer software]. https://www.adobe.com/products/aftereffects.html

Alaerts, K., Nackaerts, E., Meyns, P., Swinnen, S. P., & Wenderoth, N. (2011). Action and emotion recognition from point light displays: an investigation of gender differences. *PloS one, 6*(6)*,* e20989. https://doi.org/10.1371/journal.pone.0020989

Allison, C., Auyeung, B., & Baron-Cohen, S. (2012). Toward brief "red flags" for autism screening: the short autism spectrum quotient and the short quantitative checklist in 1,000 cases and 3,000 controls. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(2), 202-212. https://doi.org/10.1016/j.jaac.2011.11.003

Ambadar, Z., Schooler, J. W., & Cohn, J. F. (2005). Deciphering the enigmatic face: The importance of facial dynamics in interpreting subtle facial expressions. *Psychological science, 16*(5), 403-410. https://doi.org/10.1111/j.0956-7976.2005.01548.x

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Author.

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). https://doi.org/10.1176/appi.books.9780890425787

Argaud, S., Vérin, M., Sauleau, P., & Grandjean, D. (2018). Facial emotion recognition in Parkinson's disease: a review and new hypotheses. *Movement disorders, 33(4)*, 554-567. https://doi.org/10.1002/mds.27305

Asperger, H. (1944). Die „autistischen Psychopathen" im Kindesalter. *Archiv für Psychiatrie und Nervenkrankheiten, 117*(1), 76–136.

Atkinson, A. P., & Adolphs, R. (2005). Visual Emotion Perception: Mechanisms and Processes. In L. F. Barrett, P. M. Niedenthal, & P. Winkielman (Eds.), *Emotion and consciousness* (pp. 150–182). The Guilford Press.

Atkinson, A. P., Dittrich, W. H., Gemmell, A. J., & Young, A. W. (2004). Emotion perception from dynamic and static body expressions in point-light and full-light displays. *Perception, 33*(6), 717-746. https://doi.org/10.1068/p5096

Atkinson, A. P., Tunstall, M. L., & Dittrich, W. H. (2007). Evidence for distinct contributions of form and motion information to the recognition of emotions from body gestures. *Cognition, 104*(1), 59-72. https://doi.org/10.1016/j.cognition.2006.05.005

Attwood, A. S., Easey, K. E., Dalili, M. N., Skinner, A. L., Woods, A., Crick, L., ... & Munafò, M. R. (2017). State anxiety and emotional face recognition in healthy volunteers. *Royal Society Open Science, 4*(5), 160855. https://doi.org/10.1098/rsos.160855

Aviezer, H., Trope, Y., & Todorov, A. (2012). Body cues, not facial expressions, discriminate between intense positive and negative emotions. *Science, 338*(6111), 1225-1229. https://doi.org/10.1126/science.1224313

Bachorowski, J. A., & Owren, M. J. (2008). Vocal expressions of emotion. *Handbook of emotions, 3*, 196-210.

Baer, C., Malik, P., & Odic, D. (2021). Are children's judgments of another's accuracy linked to their metacognitive confidence judgments?. *Metacognition and Learning, 16*(2), 485-516. https://doi.org/10.1007/s11409-021-09263-x

Bagby, R. M., Parker, J. D., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. *Journal of psychosomatic research, 38*(1), 23-32. https://doi.org/10.1016/0022-3999(94)90005-1

Bänziger, T. (2014). Measuring Emotion Recognition Ability. In: Michalos, A.C. (eds*)* *Encyclopedia of Quality of Life and Well-Being Research*. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0753-5_4188

Bänziger, T. (2016). Accuracy of judging emotions. In J. A. Hall, M. Schmid Mast, & T. V. West (Eds.), *The social psychology of perceiving others accurately* (pp. 23–51). Cambridge University Press.

Bänziger, T., & Scherer, K. R. (2007, September). Using actor portrayals to systematically study multimodal emotion expression: The GEMEP corpus. In *International conference on affective computing and intelligent interaction* (pp. 476-487). Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-74889-2_42

Bänziger, T., & Scherer, K. R. (2010). Introducing the geneva multimodal emotion portrayal (gemep) corpus. *Blueprint for affective computing: A sourcebook*, 2010, 271-94.

Bänziger, T., Grandjean, D., & Scherer, K. R. (2009). Emotion recognition from expressions in face, voice, and body: the Multimodal Emotion Recognition Test (MERT). *Emotion, 9*(5), 691. https://doi.org/10.1037/a0017088

Bänziger, T., Pirker, H., & Scherer, K. (2006, May). GEMEP-GEneva Multimodal Emotion Portrayals: A corpus for the study of multimodal emotional expressions. In *Proceedings of LREC* (Vol. 6, pp. 15-019).

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. *Psychological bulletin, 133*(1), 1. https://doi.org/10.1037/0033-2909.133.1.1

Barisnikov, K., Thomasson, M., Stutzmann, J., & Lejeune, F. (2021). Sensitivity to emotion intensity and recognition of emotion expression in neurotypical children. *Children, 8*(12), 1108. https://doi.org/10.3390/children8121108

Barnes, L. L., Harp, D., & Jung, W. S. (2002). Reliability generalization of scores on the Spielberger state-trait anxiety inventory. *Educational and psychological measurement, 62*(4), 603-618. https://doi.org/10.1177/0013164402062004005

Baron-Cohen, S. (2013). Empathy deficits in autism and psychopaths: Mirror opposites. In M. R. Banaji & S. A. Gelman (Eds.), *Navigating the social world: What infants, children, and other species can teach us* (pp. 212–215). Oxford University Press.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"?. *Cognition, 21*(1), 37-46. https://doi.org/10.1016/0010-0277(85)90022-8

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, malesand females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*, 5-17. https://doi.org/10.1023/A:1005653411471

Barrera, M. E., & Maurer, D. (1981). The perception of facial expressions by the three-month-old. *Child development, 203-206*. https://doi.org/10.2307/1129231

Bassili, J. N. (1978). Facial motion in the perception of faces and of emotional expression. *Journal of experimental psychology: human perception and performance, 4*(3), 373. https://doi.org/10.1037/0096-1523.4.3.373

Beals, K., Sperry, S. H., & Sheffield, J. M. (2022). Empathy, emotion recognition, and paranoia in the general population. *Frontiers in Psychology, 13*, 804178. https://doi.org/10.3389/fpsyg.2022.804178

Bègue, I., Vaessen, M., Hofmeister, J., Pereira, M., Schwartz, S., & Vuilleumier, P. (2019). Confidence of emotion expression recognition recruits brain regions outside the face perception network. *Social cognitive and affective neuroscience, 14*(1), 81-95. https://doi.org/10.1093/scan/nsy102

Bell, C., Bourke, C., Colhoun, H., Carter, F., Frampton, C., & Porter, R. (2011). The misclassification of facial expressions in generalised social phobia. *Journal of anxiety disorders, 25*(2), 278-283. https://doi.org/10.1016/j.janxdis.2010.10.001

Benda, M. S., & Scherf, K. S. (2020). The Complex Emotion Expression Database: A validated stimulus set of trained actors. *PloS one, 15*(2), e0228248. https://doi.org/10.1371/journal.pone.0228248

Berardis, D. D., Campanella, D., Nicola, S., Gianna, S., Alessandro, C., Chiara, C., ... & Ferro, F. M. (2008). The impact of alexithymia on anxiety disorders: a review of the literature. *Current Psychiatry Reviews, 4*(2), 80-86. https://doi.org/10.2174/157340008784529287

Berenbaum, H., & Prince, J. D. (1994). Alexithymia and the interpretation of emotion-relevant information. *Cognition & Emotion, 8*(3), 231-244. https://doi.org/10.1080/02699939408408939

Bertrams, A., & Schlegel, K. (2020). Speeded reasoning moderates the inverse relationship between autistic traits and emotion recognition. *Autism, 24*(8), 2304-2309. https://doi.org/10.1177/1362361320937090

Besel, L. D., & Yuille, J. C. (2010). Individual differences in empathy: The role of facial expression recognition. *Personality and individual differences, 49*(2), 107-112. https://doi.org/10.1016/j.paid.2010.03.013

Bieling, P. J., Antony, M. M., & Swinson, R. P. (1998). The State--Trait Anxiety Inventory, Trait version: structure and content re-examined. *Behaviour research and therapy, 36*(7-8), 777-788. https://doi.org/10.1016/S0005-7967(98)00023-0

Binetti, N., Roubtsova, N., Carlisi, C., Cosker, D., Viding, E., & Mareschal, I. (2022). Genetic algorithms reveal profound individual differences in emotion recognition. *Proceedings of the National Academy of Sciences, 119*(45), e2201380119. https://doi.org/10.1073/pnas.2201380119

Bird, G., & Cook, R. (2013). Mixed emotions: the contribution of alexithymia to the emotional symptoms of autism. *Translational psychiatry, 3*(7), e285-e285. https://doi.org/10.1038/tp.2013.61

Black, M. H., Chen, N. T., Iyer, K. K., Lipp, O. V., Bölte, S., Falkmer, M., ... & Girdler, S. (2017). Mechanisms of facial emotion recognition in autism spectrum disorders: Insights from eye tracking and electroencephalography. *Neuroscience & Biobehavioral Reviews, 80*, 488-515. https://doi.org/10.1016/j.neubiorev.2017.06.016

Blakemore, S. J. (2008). The social brain in adolescence. *Nature Reviews Neuroscience, 9*(4), 267-277. https://doi.org/10.1038/nrn2353

Blanck, P. D., Rosenthal, R., Snodgrass, S. E., DePaulo, B. M., & Zuckerman, M. (1981). Sex differences in eavesdropping on nonverbal cues: Developmental changes. *Journal of personality and social psychology, 41*(2), 391. https://doi.org/10.1037/0022-3514.37.2.273

Blonder, L. X., Pettigrew, L. C., & Kryscio, R. J. (2012). Emotion recognition and marital satisfaction in stroke. *Journal of Clinical and Experimental Neuropsychology, 34*(6), 634-642. https://doi.org/10.1080/13803395.2012.667069

Blythe, E., Garrido, L., & Longo, M. R. (2023). Emotion is perceived accurately from isolated body parts, especially hands. *Cognition, 230*, 105260. https://doi.org/10.1016/j.cognition.2022.105260

Bonassi, A., Ghilardi, T., Gabrieli, G., Truzzi, A., Doi, H., Borelli, J. L., ... & Esposito, G. (2021). The recognition of cross-cultural emotional faces is affected by intensity and ethnicity in a Japanese sample. *Behavioral Sciences, 11*(5), 59. https://doi.org/10.3390/bs11050059

Boone, R. T., & Cunningham, J. G. (1998). Children's decoding of emotion in expressive body movement: the development of cue attunement. *Developmental psychology, 34*(5), 1007. https://doi.org/10.1037/0012-1649.34.5.1007

Booth, R. W., Sharma, D., & Leader, T. I. (2016). The age of anxiety? It depends where you look: Changes in STAI trait anxiety, 1970–2010. *Social Psychiatry and Psychiatric Epidemiology, 51*, 193-202. https://doi.org/10.1007/s00127-015-1096-0

Borgomaneri, S., Bolloni, C., Sessa, P., & Avenanti, A. (2020). Blocking facial mimicry affects recognition of facial and body expressions. *PloS one, 15*(2), e0229364. https://doi.org/10.1371/journal.pone.0229364

Borhani, K., Borgomaneri, S., Làdavas, E., & Bertini, C. (2016). The effect of alexithymia on early visual processing of emotional body postures. *Biological psychology, 115*, 1-8. https://doi.org/10.1016/j.biopsycho.2015.12.010

Boyatzis, C. J., & Satyaprasad, C. (1994). Children's facial and gestural decoding and encoding: Relations between skills and with popularity. *Journal of Nonverbal behavior, 18*, 37-55. https://doi.org/10.1007/BF02169078

Bradshaw, J., & Cameron-Beaumont, C. (2000). *The signalling repertoire of the domestic cat and its undomesticated relatives*.

Bray, K. O., Pozzi, E., Vijayakumar, N., Richmond, S., Deane, C., Pantelis, C., ... & Whittle, S. (2022). Individual differences in brain structure and self-reported empathy in children. *Cognitive, Affective, & Behavioral Neuroscience, 22*(5), 1078-1089. https://doi.org/10.3758/s13415-022-00993-2

Brewer, N., Lucas, C. A., Georgopoulos, M. A., & Young, R. L. (2022). Facing up to others' emotions: No evidence of autism-related deficits in metacognitive awareness of emotion recognition. *Autism Research, 15*(8), 1508-1521. https://doi.org/10.1002/aur.2781

Brewer, R., Biotti, F., Catmur, C., Press, C., Happé, F., Cook, R., & Bird, G. (2016). Can neurotypical individuals read autistic facial expressions? Atypical production of emotional facial expressions in autism spectrum disorders. *Autism Research, 9*(2), 262-271. https://doi.org/10.1002/aur.1508

Brewer, R., Cook, R., Cardi, V., Treasure, J., & Bird, G. (2015). Emotion recognition deficits in eating disorders are explained by co-occurring alexithymia. *Royal Society Open Science, 2*(1), 140382. https://doi.org/10.1098/rsos.140382

Brosnan, S. F., & De Waal, F. B. (2003). Monkeys reject unequal pay. *Nature, 425*(6955), 297-299. https://doi.org/10.1038/nature01963

Brown, R. H., Murray, A., Stewart, M. E., & Auyeung, B. (2021). Psychometric validation of a parent-reported measure of childhood alexithymia. *European Journal of Psychological Assessment*. Advance online publication. https://doi.org/10.1027/1015-5759/a000640

Brugha, T. S., McManus, S., Bankart, J., Scott, F., Purdon, S., Smith, J., Bebbington, P., Jenkins, R., & Meltzer, H. (2011). Epidemiology of autism spectrum disorders in adults in the community in England. *Archives of General Psychiatry, 68*(5), 459–465. https://doi.org/10.1001/archgenpsychiatry.2011.38

Brüne, M., Nadolny, N., Güntürkün, O., & Wolf, O. T. (2013). Stress induces a functional asymmetry in an emotional attention task. *Cognition & emotion, 27*(3), 558-566. https://doi.org/10.1080/02699931.2012.726211

Buitelaar, J. K., Van der Wees, M., Swaab–Barneveld, H. A. N. N. A., & Van der Gaag, R. J. (1999). Theory of mind and emotion-recognition functioning in autistic spectrum disorders and in psychiatric control and normal children. *Development and psychopathology, 11*(1), 39-58. https://doi.org/10.1017/S0954579499001947

Burgin, C. J., Brown, L. H., Royal, A., Silvia, P. J., Barrantes-Vidal, N., & Kwapil, T. R. (2012). Being with others and feeling happy: Emotional expressivity in everyday life. *Personality and Individual Differences, 53*(3), 185-190. https://doi.org/10.1016/j.paid.2012.03.006

Butera, C. D., Harrison, L., Kilroy, E., Jayashankar, A., Shipkova, M., Pruyser, A., & Aziz-Zadeh, L. (2023). Relationships between alexithymia, interoception, and emotional empathy in autism spectrum disorder. *Autism, 27*(3), 690-703. https://doi.org/10.1177/13623613221111310

Cacioppo, J. T., Petty, R. E., Losch, M. E., & Kim, H. S. (1986). Electromyographic activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of personality and social psychology, 50*(2), 260. https://doi.org/10.1037/0022-3514.50.2.260

Calder, A. J., Young, A. W., Perrett, D. I., Etcoff, N. L., & Rowland, D. (1996). Categorical perception of morphed facial expressions. *Visual Cognition, 3*(2), 81-118. https://doi.org/10.1080/713756735

Cargill, M. I., Lerner, M. D., & Kang, E. (2024). The Moderating Effect of Sex on Autistic Trait Emotional Intelligence, Alexithymia, and Empathy. *Journal of autism and developmental disorders, 1-14*. https://doi.org/10.1007/s10803-024-06540-x

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Carton, J. S., Kessler, E. A., & Pape, C. L. (1999). Nonverbal decoding skills and relationship well-being in adults. *Journal of Nonverbal Behavior, 23*(1), 91-100. https://doi.org/10.1023/A:1021339410262

Cecchetto, C., Aiello, M., D'Amico, D., Cutuli, D., Cargnelutti, D., Eleopra, R., & Rumiati, R. I. (2014). Facial and bodily emotion recognition in multiple sclerosis: the role of alexithymia and other characteristics of the disease. *Journal of the International Neuropsychological Society, 20*(10), 1004-1014. https://doi.org/10.1017/S1355617714000939

Centers for Disease Control and Prevention. (2022, March 10). *Data and statistics on children's mental health*. U.S. Department of Health and Human Services. https://www.cdc.gov/children-mental-health/data-research/index.html

Centers for Disease Control and Prevention. (2023). *Data and statistics on autism spectrum disorder*. U.S. Department of Health and Human Services. https://www.cdc.gov/autism/data-research/index.html

Chaplin, T. M., & Aldao, A. (2013). Gender differences in emotion expression in children: a meta-analytic review. *Psychological bulletin, 139*(4), 735. https://doi.org/10.1037/a0030737

Chapman, R. (2020). Defining neurodiversity for research and practice. In *Neurodiversity studies* (pp. 218-220). Routledge.

Cheang, R. T., Skjevling, M., Blakemore, A. I., Kumari, V., & Puzzo, I. (2024). Do you feel me? Autism, empathic accuracy and the double empathy problem. *Autism*. Advance online publication. https://doi.org/10.1177/13623613241252320

Chen, Y. L., Senande, L. L., Thorsen, M., & Patten, K. (2021). Peer preferences and characteristics of same-group and cross-group social interactions among autistic and non-autistic adolescents. *Autism, 25*(7), 1885-1900. https://doi.org/10.1177/13623613211005918

Cheung, T. C., Reza, T. B., Pereira, C. F., Mukhi, S., & Niemeier, M. (2023). Limited reliability and validity of the autism spectrum quotient short form (AQ-10) to screen Autistic traits in undergraduate students. *Journal of Autism and Developmental Disorders, 53*(7), 2919-2920. https://doi.org/10.1007/s10803-022-05889-1

Chikovani, G., Babuadze, L., Iashvili, N., Gvalia, T., & Surguladze, S. (2015). Empathy costs: Negative emotional bias in high empathisers. *Psychiatry research, 229*(1-2), 340-346. https://doi.org/10.1016/j.psychres.2015.07.001

Christov-Moore, L., Simpson, E. A., Coudé, G., Grigaityte, K., Iacoboni, M., & Ferrari, P. F. (2014). Empathy: Gender effects in brain and behavior. *Neuroscience & biobehavioral reviews, 46*, 604-627. https://doi.org/10.1016/j.neubiorev.2014.09.001

Cisler, J. M., & Koster, E. H. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical psychology review, 30*(2), 203-216. https://doi.org/10.1016/j.cpr.2009.11.003

Clark, C. R., Paul, R. H., Williams, L. M., Arns, M., Fallahpour, K., Handmer, C., & Gordon, E. (2006). Standardized assessment of cognitive functioning during development and aging using an automated touchscreen battery. *Archives of Clinical Neuropsychology, 21*(5), 449-467. https://doi.org/10.1016/j.acn.2006.06.005

Cleveland, W. S. (1979). *Robust locally weighted regression and smoothing scatterplots*. Journal of the American Statistical Association, 74(368), 829–836. https://doi.org/10.2307/2286407

Coats, E. J., & Feldman, R. S. (1996). Gender differences in nonverbal correlates of social status. *Personality and Social Psychology Bulletin, 22*(10), 1014-1022. https://doi.org/10.1177/01461672962210004

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Routledge.

Conley, M. I., Dellarco, D. V., Rubien-Thomas, E., Cohen, A. O., Cervera, A., Tottenham, N., & Casey, B. J. (2018). The racially diverse affective expression (RADIATE) face stimulus set. *Psychiatry research, 270*, 1059-1067. https://doi.org/10.1016/j.psychres.2018.04.066

Cook, R., Brewer, R., Shah, P., & Bird, G. (2013). Alexithymia, not autism, predicts poor recognition of emotional facial expressions. *Psychological science, 24*(5), 723-732. https://doi.org/10.1177/0956797612463582

Cooper, H., Brar, A., Beyaztas, H., Jennings, B. J., & Bennetts, R. J. (2022). The effects of face coverings, own-ethnicity biases, and attitudes on emotion recognition. *Cognitive research: principles and implications, 7*(1), 57. https://doi.org/10.1186/s41235-022-00400-x

Cooper, R. M., Rowe, A. C., & Penton-Voak, I. S. (2008). The role of trait anxiety in the recognition of emotional facial expressions. *Journal of Anxiety Disorders, 22*(7), 1120-1127. https://doi.org/10.1016/j.janxdis.2007.11.010

Crivelli, C., Jarillo, S., Russell, J. A., & Fernández-Dols, J. M. (2016). Reading emotions from faces in two indigenous societies. *Journal of Experimental Psychology: General, 145*(7), 830. https://psycnet.apa.org/doi/10.1037/xge0000172

Crompton, C. J., Ropar, D., Evans-Williams, C. V., Flynn, E. G., & Fletcher-Watson, S. (2020). Autistic peer-to-peer information transfer is highly effective. *Autism, 24*(7), 1704-1712. https://doi.org/10.1177/1362361320919286

Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social–affective engagement and goal flexibility. *Nature reviews neuroscience, 13*(9), 636-650. https://doi.org/10.1038/nrn3313

Dael, N., Mortillaro, M., & Scherer, K. R. (2012). The body action and posture coding system (BAP): Development and reliability. *Journal of Nonverbal Behavior, 36*, 97-121. https://doi.org/10.1007/s10919-012-0130-0

Dalili, M. N., Penton-Voak, I. S., Harmer, C. J., & Munafò, M. R. (2015). Meta-analysis of emotion recognition deficits in major depressive disorder. *Psychological medicine, 45*(6), 1135-1144. https://doi.org/10.1017/S0033291714002591

Darwin, C. (1872). *The expression of the emotions in man and animals*. John Murray. https://doi.org/10.1037/10001-000

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology, 44*(1), 113–126. https://psycnet.apa.org/doi/10.1037/0022-3514.44.1.113

De Gelder, B. (2006). Towards the neurobiology of emotional body language. *Nature reviews neuroscience, 7*(3), 242-249. https://doi.org/10.1038/nrn1872

De Gelder, B. (2009). Why bodies? Twelve reasons for including bodily expressions in affective neuroscience. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1535), 3475-3484. https://doi.org/10.1098/rstb.2009.0190

De Gelder, B., & Hadjikhani, N. (2006). Non-conscious recognition of emotional body language. *Neuroreport, 17*(6), 583-586.

De Gelder, B., & Van den Stock, J. (2011). The bodily expressive action stimulus test (BEAST). Construction and validation of a stimulus basis for measuring perception of whole body expression of emotions. *Frontiers in psychology, 2*, 181. https://doi.org/10.3389/fpsyg.2011.00181

De Gelder, B., de Borst, A. W., & Watson, R. (2015). The perception of emotion in body expressions. *Wiley Interdisciplinary Reviews: Cognitive Science, 6*(2), 149-158. https://doi.org/10.1002/wcs.1335

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and cognitive neuroscience reviews, 3*(2), 71-100. https://doi.org/10.1177/1534582304267187

Demenescu, L. R., Kortekaas, R., den Boer, J. A., & Aleman, A. (2010). Impaired attribution of emotion to facial expressions in anxiety and major depression. *PloS one, 5*(12), e15058. https://doi.org/10.1371/journal.pone.0015058

Di Cesare, G., Bruschetta, R., Vitale, A., Pelosi, A., Leonardi, E., Famà, F. I., ... & Ruta, L. (2024). Exploring divergent kinematics in autism across social and non-social vitality forms. *Scientific Reports, 14*(1), 24164. https://doi.org/10.1038/s41598-024-74232-8

Di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: a neurophysiological study. *Experimental brain research, 91*, 176-180. https://doi.org/10.1007/BF00230027

Di Tella, M., Benfante, A., Castelli, L., Adenzato, M., & Ardito, R. B. (2024). On the relationship between alexithymia and social cognition: A systematic review. *Clinical Neuropsychiatry, 21*(4), 236. https://doi.org/10.36131/cnfioritieditore20240402

Dimberg, U., & Thunberg, M. (1998). Rapid facial reactions to emotional facial expressions. *Scandinavian journal of psychology, 39*(1), 39-45. https://doi.org/10.1111/1467-9450.00054

Donaldson, P. H., Bekkali, S., Youssef, G. J., Kirkovski, M., Ford, T. C., & Enticott, P. G. (2022). Does empathy predict autistic traits? A multi-modal investigation. *Personality and Individual Differences, 196*, 111722. https://doi.org/10.1016/j.paid.2022.111722

Doody, J. P., & Bull, P. (2013). Evidence for impaired verbal identification but intact nonverbal recognition of fearful body postures in Asperger's syndrome. *Journal of Autism and Developmental Disorders, 43*, 1652-1661. https://doi.org/10.1007/s10803-012-1715-5

Doucet, L., Shao, B., Wang, L., & Oldham, G. R. (2016). I know how you feel, but it does not always help: Integrating emotion recognition, agreeableness, and cognitive ability in a compensatory model of service performance. *Journal of Service Management, 27*(3), 320-338. https://doi.org/10.1108/JOSM-11-2014-0307

Durbeej, N., Sörman, K., Norén Selinus, E., Lundström, S., Lichtenstein, P., Hellner, C., & Halldner, L. (2019). Trends in childhood and adolescent internalizing symptoms: results from Swedish population based twin cohorts. *BMC psychology, 7*, 1-10. https://doi.org/10.1186/s40359-019-0326-8

Dwyer, P. (2022). The neurodiversity approach (es): What are they and what do they mean for researchers?. *Human development, 66*(2), 73-92. https://doi.org/10.1159/000523723

Dyer, M. L., Attwood, A. S., Penton-Voak, I. S., & Munafò, M. R. (2022). The role of state and trait anxiety in the processing of facial expressions of emotion. *Royal Society open science, 9*(1), 210056. https://doi.org/10.1098/rsos.210056

Edey, R., Cook, J., Brewer, R., Johnson, M. H., Bird, G., & Press, C. (2016). Interaction takes two: Typical adults exhibit mind-blindness towards those with autism spectrum disorder. *Journal of abnormal psychology, 125*(7), 879. https://doi.org/10.1037/abn0000199

Eerola, T., & Vuoskoski, J. K. (2011). A comparison of the discrete and dimensional models of emotion in music. *Psychology of Music, 39*(1), 18-49. https://doi.org/10.1177/0305735610362821

Ekman, P. (1976). *Pictures of facial affect*. Consulting Psychologists Press.

Ekman, P. (1982). Methods for measuring facial action. In K. R. Scherer & P. Ekman (Eds.), *Handbook of methods in nonverbal behavior research* (pp. 45–90). Cambridge University Press.

Ekman, P. (1992). An argument for basic emotions. *Cognition & Emotion, 6*(3-4), 169-200. https://doi.org/10.1080/02699939208411068

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion review, 3*(4), 364-370. https://doi.org/10.1177/1754073911410740

Ekman, P., & Friesen, W. V. (1969). The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica, 1*(1), 49-98. https://doi.org/10.1515/semi.1969.1.1.49

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17*(2), 124. https://doi.org/10.1037/h0030377

Ekman, P., Dalgleish, T., & Power, M. (1999). *Handbook of cognition and emotion*.

Elfenbein, H. A., Foo, M. D., White, J., Tan, H. H., & Aik, V. C. (2007). Reading your counterpart: The benefit of emotion recognition accuracy for effectiveness in negotiation. *Journal of Nonverbal Behavior, 31*, 205-223. https://doi.org/10.1007/s10919-007-0033-7

Endler, N. S., & Kocovski, N. L. (2001). State and trait anxiety revisited. *Journal of anxiety disorders, 15*(3), 231-245. https://doi.org/10.1016/S0887-6185(01)00060-3

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*(2), 336. https://doi.org/10.1037/1528-3542.7.2.336

Farhane-Medina, N. Z., Luque, B., Tabernero, C., & Castillo-Mayén, R. (2022). Factors associated with gender and sex differences in anxiety prevalence and comorbidity: A systematic review. *Science Progress, 105*(4), 00368504221135469. https://doi.org/10.1177/00368504221135469

Faso, D. J., Sasson, N. J., & Pinkham, A. E. (2015). Evaluating posed and evoked facial expressions of emotion from adults with autism spectrum disorder. *Journal of autism and developmental disorders, 45*, 75-89. https://doi.org/10.1007/s10803-014-2194-7

Ferretti, V., & Papaleo, F. (2019). Understanding others: emotion recognition in humans and other animals. *Genes, Brain and Behavior, 18*(1), e12544. https://doi.org/10.1111/gbb.12544

Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. (1982). Discrimination and imitation of facial expression by neonates. *Science, 218*(4568), 179-181. https://doi.org/10.1126/science.7123230

Filippi, R., Ceccolini, A., Periche-Tomas, E., & Bright, P. (2020). Developmental trajectories of metacognitive processing and executive function from childhood to older age. *Quarterly journal of experimental psychology, 73*(11), 1757-1773. https://doi.org/10.1177/1747021820931096

Finzi, E., & Rosenthal, N. E. (2014). Treatment of depression with onabotulinumtoxinA: a randomized, double-blind, placebo controlled trial. *Journal of psychiatric research, 52*, 1-6. https://doi.org/10.1016/j.jpsychires.2013.11.006

Flom, R., & Bahrick, L. E. (2007). The development of infant discrimination of affect in multimodal and unimodal stimulation: The role of intersensory redundancy. *Developmental psychology, 43*(1), 238. https://doi.org/10.1037/0012-1649.43.1.238

Folz, J., Akdağ, R., Nikolić, M., van Steenbergen, H., & Kret, M. E. (2023). Facial mimicry and metacognitive judgments in emotion recognition are distinctly modulated by social anxiety and autistic traits. *Scientific Reports, 13*(1), 9730. https://doi.org/10.1038/s41598-023-35773-6

Franzoi, I. G., Sauta, M. D., & Granieri, A. (2020). State and trait anxiety among university students: A moderated mediation model of negative affectivity, alexithymia, and housing conditions. *Frontiers in psychology, 11*, 1255. https://doi.org/10.3389/fpsyg.2020.01255

Frewen, P. A., Lanius, R. A., Dozois, D. J., Neufeld, R. W., Pain, C., Hopper, J. W., ... & Stevens, T. K. (2008). Clinical and neural correlates of alexithymia in posttraumatic stress disorder. *Journal of abnormal psychology, 117*(1), 171. https://doi.org/10.1037/0021-843X.117.1.171

Fridenson-Hayo, S., Berggren, S., Lassalle, A., Tal, S., Pigat, D., Bölte, S., Baron-Cohen, S., & Golan, O. (2016). Basic and complex emotion recognition in children with autism: cross-cultural findings. *Molecular Autism, 7*, 1-11. https://doi.org/10.1186/s13229-016-0113-9

Friedman, A., Paltoglou, A., & Sorte, R. (2024). A qualitative exploration of the experiences of self-diagnosed autistic women and gender-diverse individuals who are not pursuing an autism diagnosis. *Neurodiversity, 2*, 27546330241307828. https://doi.org/10.1177/27546330241307828

Friedman, H. S., & Riggio, R. E. (1999). Individual differences in ability to encode complex affects. *Personality and individual differences, 27*(1), 181-194. https://doi.org/10.1016/S0191-8869(98)00228-1

Gallagher, J. (2019). medmod [jamovi module]. https://github.com/jamovi/medmod

Gallese, V., & Sinigaglia, C. (2011). What is so special about embodied simulation?. *Trends in cognitive sciences, 15*(11), 512-519. https://doi.org/10.1016/j.tics.2011.09.003

Gallese, V., Keysers, C., & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in cognitive sciences, 8*(9), 396-403. https://doi.org/10.1016/j.tics.2004.07.002

Georgopoulos, M. A., Brewer, N., Lucas, C. A., & Young, R. L. (2022). Speed and accuracy of emotion recognition in autistic adults: The role of stimulus type, response format, and emotion. *Autism Research, 15*(9), 1686-1697. https://doi.org/10.1002/aur.2713

Gery, I., Miljkovitch, R., Berthoz, S., & Soussignan, R. (2009). Empathy and recognition of facial expressions of emotion in sex offenders, non-sex offenders and normal controls. *Psychiatry research, 165*(3), 252-262. https://doi.org/10.1016/j.psychres.2007.11.006

Giese, M. A., & Poggio, T. (2003). Neural mechanisms for the recognition of biological movements. *Nature Reviews Neuroscience, 4*(3), 179-192. https://doi.org/10.1038/nrn1057

Gleichgerrcht, E., Torralva, T., Rattazzi, A., Marenco, V., Roca, M., & Manes, F. (2013). Selective impairment of cognitive empathy for moral judgment in adults with high functioning autism. *Social cognitive and affective neuroscience, 8*(7), 780-788. https://doi.org/10.1093/scan/nss067

Goldman, A. I., & Sripada, C. S. (2005). Simulationist models of face-based emotion recognition. *Cognition, 94*(3), 193-213. https://doi.org/10.1016/j.cognition.2004.01.005

Gonzalez-Gadea, M. L., Herrera, E., Parra, M., Gomez Mendez, P., Baez, S., Manes, F., & Ibanez, A. (2014). Emotion recognition and cognitive empathy deficits in adolescent offenders revealed by context-sensitive tasks. *Frontiers in Human Neuroscience, 8*, 850. https://doi.org/10.3389/fnhum.2014.00850

Gottheil, E., Paredes, A., Exline, R. V., & Winkelmayer, R. (1970). Communication of affect in schizophrenia. *Archives of General Psychiatry, 22*(5), 439-444. https://doi.org/10.1001/archpsyc.1970.01740290055007

Gottheil, E., Thornton, C. C., & Exline, R. V. (1976). Appropriate and background affect in facial displays of emotion: Comparison of normal and schizophrenic males. *Archives of General Psychiatry, 33*(5), 565-568. https://doi.org/10.1001/archpsyc.1976.01770050033004

Grainger, S. A., Henry, J. D., Phillips, L. H., Vanman, E. J., & Allen, R. (2017). Age deficits in facial affect recognition: The influence of dynamic cues. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 72*(4), 622-632. https://doi.org/10.1093/geronb/gbv100

Griffin, C., Lombardo, M. V., & Auyeung, B. (2016). Alexithymia in children with and without autism spectrum disorders. *Autism research, 9*(7), 773-780. https://doi.org/10.1002/aur.1569

Grummt, M. (2024). Sociocultural perspectives on neurodiversity—An analysis, interpretation and synthesis of the basic terms, discourses and theoretical positions. *Sociology Compass, 18*(8), e13249. https://doi.org/10.1111/soc4.13249

Grundmann, F., Epstude, K., & Scheibe, S. (2021). Face masks reduce emotion-recognition accuracy and perceived closeness. *PloS one, 16*(4), e0249792. https://doi.org/10.1371/journal.pone.0249792

Grynberg, D., Chang, B., Corneille, O., Maurage, P., Vermeulen, N., Berthoz, S., & Luminet, O. (2012). Alexithymia and the processing of emotional facial expressions (EFEs): Systematic review, unanswered questions and further perspectives. *PLOS ONE, 7*(8), e42429. https://doi.org/10.1371/journal.pone.0042429

Guha, T., Yang, Z., Ramakrishna, A., Grossman, R. B., Hedley, D., Lee, S., & Narayanan, S. S. (2015, April). On quantifying facial expression-related atypicality of children with autism spectrum disorder. In *2015 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)* (pp. 803–807). IEEE. https://doi.org/10.1109/ICASSP.2015.7178080

Gunes, H., & Piccardi, M. (2007). Bi-modal emotion recognition from expressive face and body gestures. *Journal of Network and Computer Applications, 30*(4), 1334-1345. https://doi.org/10.1016/j.jnca.2006.09.007

Hadjikhani, N., Joseph, R. M., Manoach, D. S., Naik, P., Snyder, J., Dominick, K., Hoge, R., Van den Stock, J., Flusberg, H. T., & De Gelder, B. (2009). Body expressions of emotion do not trigger fear contagion in autism spectrum disorder. *Social Cognitive and Affective Neuroscience, 4*(1), 70-78. https://doi.org/10.1093/scan/nsn038

Hall, J. A., & Matsumoto, D. (2004). Gender differences in judgments of multiple emotions from facial expressions. *Emotion, 4*(2), 201. https://doi.org/10.1037/1528-3542.4.2.201

Hall, J. A., Gunnery, S. D., & Schlegel, K. (2025). Gender and Accuracy in Decoding Affect Cues: A Meta-Analysis. *Journal of Intelligence, 13*(3), 38. https://doi.org/10.3390/jintelligence13030038

Hamann, S. (2012). Mapping discrete and dimensional emotions onto the brain: controversies and consensus. *Trends in cognitive sciences, 16*(9), 458-466. https://doi.org/10.1016/j.tics.2012.07.006

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in autism spectrum disorders: a review of behavioral and neuroimaging studies. *Neuropsychology Review, 20*, 290-322. https://doi.org/10.1007/s11065-010-9138-6

Hatfield, E., Bensman, L., Thornton, P. D., & Rapson, R. L. (2014). New perspectives on emotional contagion: A review of classic and recent research on facial mimicry and contagion. *Interpersona: An International Journal on Personal Relationships, 8*(2), 159–179. https://doi.org/10.5964/ijpr.v8i2.162

Hauschild, K. M., Felsman, P., Keifer, C. M., & Lerner, M. D. (2020). Evidence of an own-age bias in facial emotion recognition for adolescents with and without autism spectrum disorder. *Frontiers in Psychiatry, 11*, 428. https://doi.org/10.3389/fpsyt.2020.00428

Hayes, G. S., McLennan, S. N., Henry, J. D., Phillips, L. H., Terrett, G., Rendell, P. G., ... & Labuschagne, I. (2020). Task characteristics influence facial emotion recognition age-effects: A meta-analytic review. *Psychology and aging, 35*(2), 295. https://doi.org/10.1037/pag0000441

He, Z., Liu, Z., Wang, J., & Zhang, D. (2018). Gender differences in processing fearful and angry body expressions. *Frontiers in behavioral neuroscience, 12*, 164. https://doi.org/10.3389/fnbeh.2018.00164

Heasman, B., & Gillespie, A. (2018). Perspective-taking is two-sided: Misunderstandings between people with Asperger's syndrome and their family members. *Autism, 22*(6), 740-750. https://doi.org/10.1177/1362361317708287

Heck, A., Chroust, A., White, H., Jubran, R., & Bhatt, R. S. (2018). Development of body emotion perception in infancy: From discrimination to recognition. *Infant Behavior and Development, 50*, 42-51. https://doi.org/10.1016/j.infbeh.2017.10.007

Herba, C., & Phillips, M. (2004). Annotation: Development of facial expression recognition from childhood to adolescence: Behavioural and neurological perspectives. *Journal of Child Psychology and Psychiatry, 45*(7), 1185-1198. https://doi.org/10.1111/j.1469-7610.2004.00316.x

Hess, U., & Blairy, S. (2001). Facial mimicry and emotional contagion to dynamic emotional facial expressions and their influence on decoding accuracy. *International journal of psychophysiology, 40*(2), 129-141. https://doi.org/10.1016/S0167-8760(00)00161-6

Hilbig, B. E. (2016). Reaction time effects in lab-versus Web-based research: Experimental evidence. *Behavior research methods, 48*, 1718-1724. https://doi.org/10.3758/s13428-015-0678-9

Hoffmann, H., Kessler, H., Eppel, T., Rukavina, S., & Traue, H. C. (2010). Expression intensity, gender and facial emotion recognition: Women recognize only subtle facial emotions better than men. *Acta psychologica, 135*(3), 278-283. https://doi.org/10.1016/j.actpsy.2010.07.012

Hogeveen, J., & Grafman, J. (2021). Alexithymia. *Handbook of clinical neurology, 183*, 47-62. https://doi.org/10.1016/B978-0-12-822290-4.00004-9

Holland, A. C., O'Connell, G., & Dziobek, I. (2021). Facial mimicry, empathy, and emotion recognition: A meta-analysis of correlations. *Cognition and Emotion, 35*(1), 150-168. https://doi.org/10.1080/02699931.2020.1815655

Honkalampi, K., Hintikka, J., Tanskanen, A., Lehtonen, J., & Viinamäki, H. (2000). Depression is strongly associated with alexithymia in the general population. *Journal of psychosomatic research, 48*(1), 99-104. https://doi.org/10.1016/S0022-3999(99)00083-5

Huber, P. J. (1981). *Robust statistics*. Wiley.

Huis In 't Veld, E. M., van Boxtel, G. J., & de Gelder, B. (2014). The Body Action Coding System II: muscle activations during the perception and expression of emotion. *Frontiers in behavioral neuroscience, 8*, 330. https://doi.org/10.3389/fnbeh.2014.00330

Hurley, M. M., Dennett, D. C., & Adams Jr, R. B. (2013). *Inside jokes: Using humor to reverse-engineer the mind*. MIT press.

Hyde, J., Ryan, K. M., & Waters, A. M. (2019). Psychophysiological markers of fear and anxiety. *Current Psychiatry Reports, 21*, 1-10. https://doi.org/10.1007/s11920-019-1036-x

IBM Corp. (2023). IBM SPSS Statistics for Windows (Version 29.0.2.0) [Computer software]. Armonk, NY: IBM Corp.

Ickes, W. (1993). Empathic accuracy. *Journal of personality, 61*(4), 587-610. https://doi.org/10.1111/j.1467-6494.1993.tb00783.x

Ihme, K., Sacher, J., Lichev, V., Rosenberg, N., Kugel, H., Rufer, M., ... & Suslow, T. (2014). Alexithymia and the labeling of facial emotions: response slowing and increased motor and somatosensory processing. *BMC neuroscience, 15*, 1-10. https://doi.org/10.1186/1471-2202-15-40

Ihme, K., Sacher, J., Lichev, V., Rosenberg, N., Kugel, H., Rufer, M., ... & Suslow, T. (2014). Alexithymic features and the labeling of brief emotional facial expressions–An fMRI study. *Neuropsychologia, 64*, 289-299. https://doi.org/10.1016/j.neuropsychologia.2014.09.044

Inoue, W., & Ishii, S. (1990). Individual differences in encoding and decoding of nonverbal expressions. Shinrigaku kenkyu: *The Japanese journal of psychology, 61*(1), 47-50. https://doi.org/10.4992/jjpsy.61.47

Insch, P. M., Slessor, G., Phillips, L. H., Atkinson, A., & Warrington, J. (2015). The impact of aging and Alzheimer's disease on decoding emotion cues from bodily motion. *AIMS Neuroscience, 2*(3), 139–153. https://doi.org/10.3934/Neuroscience.2015.3.139

Isernia, S., Sokolov, A. N., Fallgatter, A. J., & Pavlova, M. A. (2020). Untangling the ties between social cognition and body motion: gender impact. *Frontiers in Psychology, 11*, 128. https://doi.org/10.3389/fpsyg.2020.00128

Isomura, T., & Nakano, T. (2016). Automatic facial mimicry in response to dynamic emotional stimuli in five-month-old infants. *Proceedings of the Royal Society B: Biological Sciences, 283*(1844), 20161948. https://doi.org/10.1098/rspb.2016.1948

Israelashvili, J., Sauter, D., & Fischer, A. (2020). Two facets of affective empathy: Concern and distress have opposite relationships to emotion recognition. *Cognition and Emotion, 34*(6), 1112-1122. https://doi.org/10.1080/02699931.2020.1724893

Jaarsma, P., & Welin, S. (2012). Autism as a natural human variation: Reflections on the claims of the neurodiversity movement. *Health care analysis, 20*, 20-30. https://doi.org/10.1007/s10728-011-0169-9

Japee, S., Crocker, L., Carver, F., Pessoa, L., & Ungerleider, L. G. (2009). Individual differences in valence modulation of face-selective M170 response. *Emotion, 9*(1), 59. https:// doi.org/10.1037/a0014487

Jarros, R. B., Salum, G. A., da Silva, C. T. B., Toazza, R., de Abreu Costa, M., de Salles, J. F., & Manfro, G. G. (2012). Anxiety disorders in adolescence are associated with impaired facial expression recognition to negative valence. *Journal of psychiatric research, 46*(2), 147-151. https://doi.org/10.1016/j.jpsychires.2011.09.023

Javanbakht, A., Tompson, S., Kitayama, S., King, A., Yoon, C., & Liberzon, I. (2018). Gene by culture effects on emotional processing of social cues among East Asians and European Americans. *Behavioral Sciences, 8*(7), 62. https://doi.org/10.3390/bs8070062

Jayashankar, A., & Aziz-Zadeh, L. (2023). Disgust processing and potential relationships with behaviors in autism. *Current Psychiatry Reports, 25*(10), 465-478. https://doi.org/10.1007/s11920-023-01445-5

Jayashankar, A., Kilroy, E., Ringold, S. M., Butera, C., McGuire, R., & Aziz-Zadeh, L. (2024). Disgust processing differences and their neural correlates in autistic youth. *Scientific Reports*.

Jelili, S., Halayem, S., Taamallah, A., Ennaifer, S., Rajhi, O., Moussa, M., ... & Bouden, A. (2021). Impaired recognition of static and dynamic facial emotions in children with autism spectrum disorder using stimuli of varying intensities, different genders, and age ranges faces. *Frontiers in psychiatry, 12*, 693310. https://doi.org/10.3389/fpsyt.2021.693310

Ji, Y., Wang, S., Xu, R., Chen, J., Jiang, X., Deng, Z., ... & Liu, J. (2024). Hugging Rain Man: A Novel Facial Action Units Dataset for Analyzing Atypical Facial Expressions in Children with Autism Spectrum Disorder. *arXiv preprint arXiv:2411.13797*. https://doi.org/10.48550/arXiv.2411.13797

Jia, R., Steelman, Z. R., & Jia, H. H. (2019). Psychometric assessments of three self-report autism scales (AQ, RBQ-2A, and SQ) for general adult populations. *Journal of Autism and Developmental Disorders, 49*, 1949-1965. https://doi.org/10.1007/s10803-019-03880-x

Johnson-Laird, P. N., & Oatley, K. (1989). The language of emotions: An analysis of a semantic field. *Cognition and emotion, 3*(2), 81-123. https://doi.org/10.1080/02699938908408075

Jolliffe, R., Adams, D., & Simpson, K. (2023). Trait anxiety in individuals on the autism spectrum: a systematic review. *Review Journal of Autism and Developmental Disorders, 10*(3), 523-545. https://doi.org/10.1007/s40489-022-00308-8

Jongen, S., Axmacher, N., Kremers, N. A., Hoffmann, H., Limbrecht-Ecklundt, K., Traue, H. C., & Kessler, H. (2014). An investigation of facial emotion recognition impairments in alexithymia and its neural correlates. *Behavioural brain research, 271*, 129-139. https://doi.org/10.1016/j.bbr.2014.05.069

Kaminski, J., Hynds, J., Morris, P., & Waller, B. M. (2017). Human attention affects facial expressions in domestic dogs. *Scientific reports, 7*(1), 12914. https://doi.org/10.1038/s41598-017-12781-x

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2*, 217–250.

Kapp, S. (2019). How social deficit models exacerbate the medical model: Autism as case in point. *Autism Policy & Practice, 2*(1), 3-28.

Kapp, S. K., Gillespie-Lynch, K., Sherman, L. E., & Hutman, T. (2013). Deficit, difference, or both? Autism and neurodiversity. *Developmental Psychology, 49*(1), 59.

Kashlak, M. (2014). Dynamic vs static stimuli: Effectiveness in emotion recognition for individuals with Autism Spectrum Disorder.

Keating, C. T., & Cook, J. L. (2020). Facial expression production and recognition in autism spectrum disorders: A shifting landscape. *Child and Adolescent Psychiatric Clinics, 29*(3), 557-571. https://doi.org/10.1016/j.chc.2020.02.006

Keating, C. T., Fraser, D. S., Sowden, S., & Cook, J. L. (2022). Differences between autistic and non-autistic adults in the recognition of anger from facial motion remain after controlling for alexithymia. *Journal of autism and developmental disorders, 52*(4), 1855-1871. https://doi.org/10.1007/s10803-021-05083-9

Keltner, D., & Cordaro, D. T. (2017). Understanding multimodal emotional expressions: Recent advances in basic emotion theory. *The science of facial expression*, 57-75.

Kessler, H., Schwarze, M., Filipic, S., Traue, H. C., & von Wietersheim, J. (2006). Alexithymia and facial emotion recognition in patients with eating disorders. *International Journal of Eating Disorders, 39*(3), 245-251. https://doi.org/10.1002/eat.20228

Ketelaars, M. P., Mol, A., Swaab, H., & van Rijn, S. (2016). Emotion recognition and alexithymia in high functioning females with autism spectrum disorder. *Research in Autism Spectrum Disorders, 21*, 51-60. https://doi.org/10.1016/j.rasd.2015.09.006

Khanjani, Z., Mosanezhad Jeddi, E., Hekmati, I., Khalilzade, S., Etemadi Nia, M., Andalib, M., & Ashrafian, P. (2015). Comparison of cognitive empathy, emotional empathy, and social functioning in different age groups. *Australian Psychologist, 50*(1), 80-85. https://doi.org/10.1111/ap.12099

Khosdelazad, S., Jorna, L. S., McDonald, S., Rakers, S. E., Huitema, R. B., Buunk, A. M., & Spikman, J. M. (2020). Comparing static and dynamic emotion recognition tests: Performance of healthy participants. *PloS one, 15*(10), e0241297. https://doi.org/10.1371/journal.pone.0241297

Kilts, C. D., Egan, G., Gideon, D. A., Ely, T. D., & Hoffman, J. M. (2003). Dissociable neural pathways are involved in the recognition of emotion in static and dynamic facial expressions. *Neuroimage, 18*(1), 156-168. https://doi.org/10.1006/nimg.2002.1323

Kinnaird, E., Stewart, C., & Tchanturia, K. (2019). Investigating alexithymia in autism: A systematic review and meta-analysis. *European Psychiatry, 55*, 80-89. https://doi.org/10.1016/j.eurpsy.2018.09.004

Kirk, B. A., Schutte, N. S., & Hine, D. W. (2008). Development and preliminary validation of an emotional self-efficacy scale. *Personality and individual Differences, 45*(5), 432-436. https://doi.org/10.1016/j.paid.2008.06.010

Kirsch, S., Maier, S., Lin, M., Guendelman, S., Kaufmann, C., Dziobek, I., & van Elst, L. T. (2025). The Alexithymia Hypothesis of Autism Revisited: Alexithymia Modulates Social Brain Activity During Facial Affect Recognition in Autistic Adults. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*. https://doi.org/10.1016/j.bpsc.2025.01.007

Kleinsmith, A., & Bianchi-Berthouze, N. (2012). Affective body expression perception and recognition: A survey. *IEEE Transactions on Affective Computing, 4*(1), 15-33. https://doi.org/10.1109/T-AFFC.2012.16

Kliemann, D., Rosenblau, G., Bölte, S., Heekeren, H. R., & Dziobek, I. (2013). Face puzzle—two new video-based tasks for measuring explicit and implicit aspects of facial emotion recognition. *Frontiers in psychology, 4*, 376. https://doi.org/10.3389/fpsyg.2013.00376

Knowles, K. A., & Olatunji, B. O. (2020). Specificity of trait anxiety in anxiety and depression: Meta-analysis of the State-Trait Anxiety Inventory. *Clinical psychology review, 82*, 101928. https://doi.org/10.1016/j.cpr.2020.101928

Koet, L. B., de Schepper, E. I., Bohnen, A. M., Bindels, P. J., & Gerger, H. (2022). Anxiety problems in children and adolescents: a population-based cohort study on incidence and management in Dutch primary care. *British Journal of General Practice, 72*(719), e405-e412. https://doi.org/10.3399/BJGP.2021.0557

Kouo, J. L., & Egel, A. L. (2016). The effectiveness of interventions in teaching emotion recognition to children with autism spectrum disorder. *Review Journal of Autism and Developmental Disorders, 3*, 254-265. https://doi.org/10.1007/s40489-016-0081-1

Kret, M. E., & De Gelder, B. (2012). A review on sex differences in processing emotional signals. *Neuropsychologia, 50*(7), 1211-1221. https://doi.org/10.1016/j.neuropsychologia.2011.12.022

Kring, A. M., & Gordon, A. H. (1998). Sex differences in emotion: expression, experience, and physiology. *Journal of personality and social psychology, 74*(3), 686.

Kring, A. M., Smith, D. A., & Neale, J. M. (1994). Individual differences in dispositional expressiveness: development and validation of the Emotional Expressivity

Scale. *Journal of personality and social psychology, 66*(5), 934. https://doi.org/10.1037/0022-3514.66.5.934

Krüger, S., Sokolov, A. N., Enck, P., Krägeloh-Mann, I., & Pavlova, M. A. (2013). Emotion through locomotion: gender impact. *PloS one, 8*(11), e81716. https://doi.org/10.1371/journal.pone.0081716

Krumhuber, E. G., Kappas, A., & Manstead, A. S. (2013). Effects of dynamic aspects of facial expressions: A review. *Emotion Review, 5*(1), 41-46. https://doi.org/10.1177/1754073912451349

Lambrecht, L., Kreifelts, B., & Wildgruber, D. (2014). Gender differences in emotion recognition: Impact of sensory modality and emotional category. *Cognition & emotion, 28*(3), 452-469. https://doi.org/10.1080/02699931.2013.837378

Lampi, A. J., Jaswal, V. K., & Evans, T. M. (2021). How closely related are parent and child reports of child alexithymia?. *Frontiers in Psychology, 11*, 588001. https://doi.org/10.3389/fpsyg.2020.588001

Larionow, P., Preece, D. A., & Mudło-Głagolska, K. (2022). Assessing alexithymia across negative and positive emotions: Psychometric properties of the Polish version of the Perth Alexithymia Questionnaire. *Frontiers in Psychiatry, 13*, 1047191. https://doi.org/10.3389/fpsyt.2022.1047191

Lausen, A., & Hammerschmidt, K. (2020). Emotion recognition and confidence ratings predicted by vocal stimulus type and prosodic parameters. *Humanities and Social Sciences Communications, 7*(1), 1-17. https://doi.org/10.1057/s41599-020-0499-z

Le Mau, T., Hoemann, K., Lyons, S. H., Fugate, J. M., Brown, E. N., Gendron, M., & Barrett, L. F. (2021). Professional actors demonstrate variability, not stereotypical expressions, when portraying emotional states in photographs. *Nature communications, 12*(1), 5037. https://doi.org/10.1038/s41467-021-25352-6

Leppänen, J. M., Moulson, M. C., Vogel-Farley, V. K., & Nelson, C. A. (2007). An ERP study of emotional face processing in the adult and infant brain. *Child development, 78*(1), 232-245. https://doi.org/10.1111/j.1467-8624.2007.00994.x

Levant, R. F., Hall, R. J., Williams, C. M., & Hasan, N. T. (2009). Gender differences in alexithymia. *Psychology of men & masculinity, 10*(3), 190. https://doi.org/10.1037/a0015652

Lewis, L. F. (2016). Exploring the experience of self-diagnosis of autism spectrum disorder in adults. *Archives of psychiatric nursing, 30*(5), 575-580. https://doi.org/10.1016/j.apnu.2016.03.009

Li, X. (2021). Recognition characteristics of facial and bodily expressions: Evidence from ERPs. *Frontiers in Psychology, 12*, 680959. https://doi.org/10.3389/fpsyg.2021.680959

Lin, C., Jin, W., Ling, X., Chen, H., Ruan, M., Zhang, Y., & Fang, Y. (2023, October). Comparison of complex emotion detection based on the basic emotion model and the complex emotion model. In *Proceedings of the 2023 International Conference on Communication Network and Machine Learning* (pp. 264–268). ACM. https://doi.org/10.1145/3640912.3640964

Lipshitz, R., & Strauss, O. (1997). Coping with uncertainty: A naturalistic decision-making analysis. *Organizational behavior and human decision processes, 69*(2), 149-163. https://doi.org/10.1006/obhd.1997.2679

Litz, B. T., Litz, B. T., & Gray, M. J. (2002). Emotional numbing in posttraumatic stress disorder: Current and future research directions. *Australian & New Zealand Journal of Psychiatry, 36*(2), 198-204. https://doi.org/10.1046/j.1440-1614.2002.01002.x

Liu, F., Wang, Y., Burkhart, T. A., González Penedo, M. F., Ma, S. D., & Chan, Y. C. (2014). Emotional structure of jokes: a corpus-based investigation. *Bio-medical materials and engineering, 24*(6), 3083-3090. https://doi.org/10.3233/BME-141130

Livingston, L. A., & Happé, F. (2017). Conceptualising compensation in neurodevelopmental disorders: Reflections from autism spectrum disorder. *Neuroscience & Biobehavioral Reviews, 80*, 729-742. https://doi.org/10.1016/j.neubiorev.2017.06.005

Livingston, L. A., Waldren, L. H., Walton, E., & Shah, P. (2022). Emotion processing differences mediate the link between sex and autistic traits in young adulthood. *JCPP advances, 2*(3), e12096. https://doi.org/10.1002/jcv2.12096

Livingstone, S. R., Vezer, E., McGarry, L. M., Lang, A. E., & Russo, F. A. (2016). Deficits in the mimicry of facial expressions in Parkinson's disease. *Frontiers in psychology, 7*, 780. https://doi.org/10.3389/fpsyg.2016.00780

Loas, G., Braun, S., Delhaye, M., & Linkowski, P. (2017). The measurement of alexithymia in children and adolescents: Psychometric properties of the Alexithymia Questionnaire for Children and the twenty-item Toronto Alexithymia Scale in different non-clinical and clinical samples of children and adolescents. *PloS one, 12*(5), e0177982. https://doi.org/10.1371/journal.pone.0177982

Lorey, B., Kaletsch, M., Pilgramm, S., Bischoff, M., Kindermann, S., Sauerbier, I., ... & Munzert, J. (2012). Confidence in emotion perception in point-light displays varies with the ability to perceive own emotions. *PLOS ONE, 7*(8), e42169. https://doi.org/10.1371/journal.pone.0042169

Losh, M., Adolphs, R., Poe, M. D., Couture, S., Penn, D., Baranek, G. T., & Piven, J. (2009). Neuropsychological profile of autism and the broad autism phenotype. *Archives of general psychiatry, 66*(5), 518-526. https://doi.org/10.1001/archgenpsychiatry.2009.34

Lott, L. L., Spengler, F. B., Stächele, T., Schiller, B., & Heinrichs, M. (2022). EmBody/EmFace as a new open tool to assess emotion recognition from body and face expressions. *Scientific Reports, 12*(1), 14165. https://doi.org/10.1038/s41598-022-17866-w

Lott-Sandkamp, L. L., Spengler, F. B., & Heinrichs, M. (2023). Impairment in reading negative social cues extends beyond the face in autism. *Journal of Psychiatric Research, 164*, 350-356. https://doi.org/10.1016/j.jpsychires.2023.06.032

Loveland, K. A., Tunali-Kotoski, B., Pearson, D. A., Brelsford, K. A., Ortegon, J., & Chen, R. (1994). Imitation and expression of facial affect in autism. *Development and Psychopathology, 6*(3), 433-444. https://doi.org/10.1017/S0954579400006039

Lundqvist, D., Flykt, A., & Öhman, A. (1998). *Karolinska Directed Emotional Faces (KDEF)* [Photographic stimulus set]. Department of Clinical Neuroscience, Psychology Section, Karolinska Institutet. https://doi.org/10.1037/t27732-000

Lyvers, M., McCann, K., Coundouris, S., Edwards, M. S., & Thorberg, F. A. (2018). Alexithymia in relation to alcohol use, emotion recognition, and empathy: The role of externally oriented thinking. *The American Journal of Psychology, 131*(1), 41-51. https://doi.org/10.5406/amerjpsyc.131.1.0041

Macdonald, H., Rutter, M., Howlin, P., Rios, P., Conteur, A. L., Evered, C., & Folstein, S. (1989). Recognition and expression of emotional cues by autistic and normal adults. *Journal of Child Psychology and Psychiatry, 30*(6), 865-877. https://doi.org/10.1111/j.1469-7610.1989.tb00288.x

Magiati, I., Ong, C., Lim, X. Y., Tan, J. W. L., Ong, A. Y. L., Patrycia, F., ... & Howlin, P. (2016). Anxiety symptoms in young people with autism spectrum disorder attending special schools: Associations with gender, adaptive functioning and autism symptomatology. *Autism, 20*(3), 306-320. https://doi.org/10.1177/1362361315577519

Marsh, A. A., & Blair, R. J. R. (2008). Deficits in facial affect recognition among antisocial populations: A meta-analysis. *Neuroscience & Biobehavioral Reviews, 32*(3), 454-465. https://doi.org/10.1016/j.neubiorev.2007.08.003

Marteau, T. M., & Bekker, H. (1992). The development of a six-item short-form of the state scale of the Spielberger State—Trait Anxiety Inventory (STAI). *British journal of clinical Psychology, 31*(3), 301-306. https://doi.org/10.1111/j.2044-8260.1992.tb00997.x

Martin, R. A., Berry, G. E., Dobranski, T., Horne, M., & Dodgson, P. G. (1996). Emotion perception threshold: Individual differences in emotional sensitivity. *Journal of Research in Personality, 30*(2), 290-305. https://doi.org/10.1006/jrpe.1996.0019

Martin, R., McKenzie, K., Metcalfe, D., Pollet, T., & McCarty, K. (2019). A preliminary investigation into the relationship between empathy, autistic like traits and emotion recognition. *Personality and Individual Differences, 137*, 12-16. https://doi.org/10.1016/j.paid.2018.07.039

Masoomi, M., Saeidi, M., Cedeno, R., Shahrivar, Z., Tehrani-Doost, M., Ramirez, Z., ... & Gunturu, S. (2025). Emotion recognition deficits in children and adolescents with autism spectrum disorder: a comprehensive meta-analysis of accuracy and response

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

time. *Frontiers in Child and Adolescent Psychiatry, 3*, 1520854. https://doi.org/10.3389/frcha.2024.1520854

Mattila, A. K., Salminen, J. K., Nummi, T., & Joukamaa, M. (2006). Age is strongly associated with alexithymia in the general population. *Journal of psychosomatic research, 61*(5), 629-635. https://doi.org/10.1016/j.jpsychores.2006.04.013

Maxim, L. A., & Nowicki, S. J. (2003). Developmental associations between nonverbal ability and social competence. *Facta universitatis-series: Philosophy, Sociology and Psychology, 2*(10), 745-758.

May, T., Cornish, K., & Rinehart, N. (2014). Does gender matter? A one year follow-up of autistic, attention and anxiety symptoms in high-functioning children with autism spectrum disorder. *Journal of autism and developmental disorders, 44*, 1077-1086. https://doi.org/10.1007/s10803-013-1964-y

Mazzoni, N., Landi, I., Ricciardelli, P., Actis-Grosso, R., & Venuti, P. (2020). Motion or emotion? Recognition of emotional bodily expressions in children with autism spectrum disorder with and without intellectual disability. *Frontiers in Psychology, 11*, 478. https://doi.org/10.3389/fpsyg.2020.00478

Mazzoni, N., Ricciardelli, P., Actis-Grosso, R., & Venuti, P. (2022). Difficulties in recognising dynamic but not static emotional body movements in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 52*, 1–14. https://doi.org/10.1007/s10803-021-05015-7

Mazzonna, F., & Peracchi, F. (2024). Are Older People Aware of Their Cognitive Decline? Misperception and Financial Decision-Making. *Journal of Political Economy, 132*(6), 1793-1830. https://doi.org/10.1086/728697

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological bulletin, 126*(3), 424. https://doi.org/doi/10.1037/0033-2909.126.3.424

McDonald, P. W., & Prkachin, K. M. (1990). The expression and perception of facial emotion in alexithymia: a pilot study. *Biopsychosocial Science and Medicine, 52*(2), 199-210.

McDonald, T. A. M. (2020). Autism identity and the “lost generation”: Structural validation of the autism spectrum identity scale and comparison of diagnosed and self-diagnosed adults on the autism spectrum. *Autism in Adulthood, 2*(1), 13-23. https://doi.org/10.1089/aut.2019.0069

McKenzie, K., Murray, A. L., Wilkinson, A., Murray, G. C., Metcalfe, D., O'Donnell, M., & McCarty, K. (2018). The relations between processing style, autistic-like traits, and emotion recognition in individuals with and without Autism Spectrum Disorder. *Personality and Individual Differences, 120*, 1-6. https://doi.org/10.1016/j.paid.2017.08.007

Meeren, H. K., Van Heijnsbergen, C. C., & De Gelder, B. (2005). Rapid perceptual integration of facial expression and emotional body language. *Proceedings of the National Academy of Sciences, 102*(45), 16518-16523. https://doi.org/10.1073/pnas.0507650102

Melchers, M., Montag, C., Reuter, M., Spinath, F. M., & Hahn, E. (2016). How heritable is empathy? Differential effects of measurement and subcomponents. *Motivation and Emotion, 40*, 720-730. https://doi.org/10.1007/s11031-016-9573-7

Meltytech, LLC. (2022). Shotcut (Version 22.10.25) [Computer software]. https://www.shotcut.org/

Mendia, J., Zumeta, L. N., Cusi, O., Pascual, A., Alonso-Arbiol, I., Díaz, V., & Páez, D. (2024). Gender differences in alexithymia: Insights from an Updated Meta-Analysis. *Personality and Individual Differences, 227*, 112710. https://doi.org/10.1016/j.paid.2024.112710

Metcalfe, D., McKenzie, K., McCarty, K., & Pollet, T. V. (2019). Emotion recognition from body movement and gesture in children with Autism Spectrum Disorder is improved by situational cues. *Research in Developmental Disabilities, 86*, 1-10. https://doi.org/10.1016/j.ridd.2018.12.008

Metcalfe, D., McKenzie, K., McCarty, K., & Pollet, T. V. (2019). Emotion recognition from body movement and gesture in children with Autism Spectrum Disorder is improved by situational cues. *Research in Developmental Disabilities, 86*, 1-10. https://doi.org/10.1016/j.ridd.2018.12.008

Metzger, R. L. (1976). A reliability and validity study of the State-Trait Anxiety Inventory. *Journal of Clinical Psychology, 32*(2).

Mill, A., Allik, J., Realo, A., & Valk, R. (2009). Age-related differences in emotion recognition ability: a cross-sectional study. *Emotion, 9*(5), 619. https://doi.org/10.1037/a0016562

Milton, D. E. (2012). On the ontological status of autism: The ‘double empathy problem’. *Disability & Society, 27*(6), 883-887. https://doi.org/10.1080/09687599.2012.710008

Miu, A. C., & Balteş, F. R. (2012). Empathy manipulation impacts music-induced emotions: A psychophysiological study on opera. *PloS one, 7*(1), e30618. https://doi.org/10.1371/journal.pone.0030618

Mohammadi, G., & Vuilleumier, P. (2020). A multi-componential approach to emotion recognition and the effect of personality. *IEEE Transactions on Affective Computing, 13*(3), 1127-1139. https://doi.org/10.1109/TAFFC.2020.3028109

Momm, T., Blickle, G., Liu, Y., Wihler, A., Kholin, M., & Menges, J. I. (2015). It pays to have an eye for emotions: Emotion recognition ability indirectly predicts annual

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

income. *Journal of Organizational Behavior, 36*(1), 147-163. https://doi.org/10.1002/job.1975

Mondloch, C. J., Horner, M., & Mian, J. (2013). Wide eyes and drooping arms: Adult-like congruency effects emerge early in the development of sensitivity to emotional faces and body postures. *Journal of Experimental Child Psychology, 114*(2), 203-216. https://doi.org/10.1016/j.jecp.2012.06.003

Monroy, M., Cowen, A. S., & Keltner, D. (2022). Intersectionality in emotion signaling and recognition: The influence of gender, ethnicity, and social class. *Emotion, 22*(8), 1980.

Montagne, B., Schutters, S., Westenberg, H. G., van Honk, J., Kessels, R. P., & de Haan, E. H. (2006). Reduced sensitivity in the recognition of anger and disgust in social anxiety disorder. *Cognitive Neuropsychiatry, 11*(4), 389-401. https://doi.org/10.1080/13546800444000254

Moraitopoulou, G., Pickard, H., Simonoff, E., Pickles, A., Bedford, R., & Carter Leno, V. (2024). No association between alexithymia and emotion recognition or theory of mind in a sample of adolescents enhanced for autistic traits. *Autism, 28*(4), Article 13623613231221928. https://doi.org/10.1177/13623613231221928

Moret-Tatay, C., Mundi-Ricós, P., & Irigaray, T. Q. (2022). The relationship between face processing, cognitive and affective empathy. *Behavioral Sciences, 13*(1), 21. https://doi.org/10.3390/bs13010021

Morningstar, M., Nelson, E. E., & Dirks, M. A. (2018). Maturation of vocal emotion recognition: Insights from the developmental and neuroimaging literature. *Neuroscience & Biobehavioral Reviews, 90*, 221-230. https://doi.org/10.1016/j.neubiorev.2018.04.019

Mul, C. L., Stagg, S. D., Herbelin, B., & Aspell, J. E. (2018). The feeling of me feeling for you: Interoception, alexithymia and empathy in autism. *Journal of autism and developmental disorders, 48*, 2953-2967. https://doi.org/10.1007/s10803-018-3564-3

Murphy, J., Millgate, E., Geary, H., Catmur, C., & Bird, G. (2019). No effect of age on emotion recognition after accounting for cognitive factors and depression. *Quarterly journal of experimental psychology, 72*(11), 2690-2704. https://doi.org/10.1177/1747021819859514

Murphy, N. A., & Hall, J. A. (2011). Intelligence and interpersonal sensitivity: A meta-analysis. Intelligence, 39(1), 54-63. https://doi.org/10.1016/j.intell.2010.10.001

Nair, T. K., Waslin, S. M., Rodrigues, G. A., Datta, S., Moore, M. T., & Brumariu, L. E. (2024). A meta-analytic review of the relations between anxiety and empathy. *Journal of anxiety disorders, 101*, 102795. https://doi.org/10.1016/j.janxdis.2023.102795

Narumoto, J., Okada, T., Sadato, N., Fukui, K., & Yonekura, Y. (2001). Attention to emotion modulates fMRI activity in human right superior temporal sulcus. *Cognitive Brain Research, 12*(2), 225-231. https://doi.org/10.1016/S0926-6410(01)00053-2

Neal, D. T., & Chartrand, T. L. (2011). Embodied emotion perception: amplifying and dampening facial feedback modulates emotion perception accuracy. *Social Psychological and Personality Science, 2*(6), 673-678. https://doi.org/10.1177/1948550611406138

Nelson, N. L., & Russell, J. A. (2011). Preschoolers' use of dynamic facial, bodily, and vocal cues to emotion. *Journal of experimental child psychology, 110*(1), 52-61. https://doi.org/10.1016/j.jecp.2011.03.014

Nelson, N. L., & Russell, J. A. (2013). Universality revisited. *Emotion Review, 5*(1), 8-15. https://doi.org/10.1177/1754073912457227

Niedenthal, P. M., & Brauer, M. (2012). Social functionality of human emotion. *Annual review of psychology, 63*, 259-285. https://doi.org/10.1146/annurev.psych.121208.131605

Niedenthal, P. M., Brauer, M., Halberstadt, J. B., & Innes-Ker, Å. H. (2001). When did her smile drop? Facial mimicry and the influences of emotional state on the detection of change in emotional expression. *Cognition & Emotion, 15*(6), 853-864. https://doi.org/10.1080/02699930143000194

Niedenthal, P. M., Korb, S., Wood, A., & Rychlowska, M. (2016). Revisiting the Simulation of Smiles model: The what, when, and why of mimicking smiles. In U. Hess & A. Fischer (Eds.), *Emotional mimicry in social context* (pp. 44–71). Cambridge University Press.

Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2010). The Simulation of Smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *Behavioral and brain sciences, 33*(6), 417-433. https://doi.org/10.1017/S0140525X10000865

Nowicki Jr, S., & Duke, M. P. (1994). Individual differences in the nonverbal communication of affect: The Diagnostic Analysis of Nonverbal Accuracy Scale. *Journal of Nonverbal behavior, 18*(1), 9-35. https://doi.org/10.1007/BF02169077

O'Reilly, H., Pigat, D., Fridenson, S., Berggren, S., Tal, S., Golan, O., ... & Lundqvist, D. (2016). The EU-emotion stimulus set: a validation study. *Behavior research methods, 48*, 567-576. https://doi.org/10.3758/s13428-015-0601-4

Oakley, B. F., Brewer, R., Bird, G., & Catmur, C. (2016). Theory of mind is not theory of emotion: A cautionary note on the Reading the Mind in the Eyes Test. *Journal of abnormal psychology, 125*(6), 818. https://doi.org/10.1037/abn0000182

Oberman, L. M., Winkielman, P., & Ramachandran, V. S. (2007). Face to face: Blocking facial mimicry can selectively impair recognition of emotional expressions. *Social neuroscience, 2*(3-4), 167-178. https://doi.org/10.1080/17470910701391943

Oh, K. S., Lee, W. H., Kim, S., Shin, D. W., Shin, Y. C., & Lim, S. W. (2018). Impaired facial expression recognition in patients with social anxiety disorder: a case-control study. *Cognitive Neuropsychiatry, 23*(4), 218-228. https://doi.org/10.1080/13546805.2018.1462695

Ola, L., & Gullon-Scott, F. (2020). Facial emotion recognition in autistic adult females correlates with alexithymia, not autism. *Autism, 24*(8), 2021-2034. https://doi.org/10.1177/1362361320932727

Olderbak, S., & Wilhelm, O. (2017). Emotion perception and empathy: An individual differences test of relations. *Emotion, 17*(7), 1092. https://doi.org/10.1037/emo0000308

Palm, M. E., Elliott, R., McKie, S., Deakin, J. F. W., & Anderson, I. M. (2011). Attenuated responses to emotional expressions in women with generalized anxiety disorder. *Psychological medicine, 41*(5), 1009-1018. https://doi.org/10.1017/S0033291710001455

Parker, A. E., Mathis, E. T., & Kupersmidt, J. B. (2013). How is this child feeling? Preschool-aged children's ability to recognize emotion in faces and body poses. *Early Education & Development, 24*(2), 188-211. https://doi.org/10.1080/10409289.2012.657536

Parker, J. D., Eastabrook, J. M., Keefer, K. V., & Wood, L. M. (2010). Can alexithymia be assessed in adolescents? Psychometric properties of the 20-item Toronto Alexithymia Scale in younger, middle, and older adolescents. *Psychological assessment, 22*(4), 798. https://doi.org/10.1037/a0020256

Parker, P. D., Prkachin, K. M., & Prkachin, G. C. (2005). Processing of facial expressions of negative emotion in alexithymia: the influence of temporal constraint. *Journal of personality, 73*(4), 1087-1107. https://doi.org/10.1111/j.1467-6494.2005.00339.x

Pavlova, M. A. (2017). Sex and gender affect the social brain: beyond simplicity. *Journal of Neuroscience Research, 95*(1-2), 235-250. https://doi.org/10.1002/jnr.23871

Pavlova, M. A., Romagnano, V., Kubon, J., Isernia, S., Fallgatter, A. J., & Sokolov, A. N. (2022). Ties between reading faces, bodies, eyes, and autistic traits. *Frontiers in Neuroscience, 16*, 997263. https://doi.org/10.3389/fnins.2022.997263

Peterson, C. C., Slaughter, V., & Brownell, C. (2015). Children with autism spectrum disorder are skilled at reading emotion body language. *Journal of Experimental Child Psychology, 139*, 35-50. https://doi.org/10.1016/j.jecp.2015.04.012

Philip, R. C., Whalley, H. C., Stanfield, A. C., Sprengelmeyer, R., Santos, I. M., Young, A. W., Atkinson, A. P., Calder, A. J., Johnstone, E. C., & Lawrie, S. M. (2010). Deficits in facial, body movement and vocal emotional processing in autism spectrum disorders. *Psychological Medicine, 40*(11), 1919-1929. https://doi.org/10.1017/S0033291709992364

Philippot, P., & Feldman, R. S. (1990). Age and social competence in preschoolers' decoding of facial expression. *British Journal of Social Psychology, 29*(1), 43-54. https://doi.org/10.1111/j.2044-8309.1990.tb00885.x

Pizzagalli, D., Regard, M., & Lehmann, D. (1999). Rapid emotional face processing in the human right and left brain hemispheres: an ERP study. *Neuroreport, 10*(13), 2691-2698.

Plant, R. R., Hammond, N., & Whitehouse, T. (2003). How choice of mouse may affect response timing in psychological studies. *Behavior Research Methods, Instruments, & Computers, 35*(2), 276-284. https://doi.org/10.3758/BF03202553

Poenitz, V., & Román, F. (2020, July). Trajectory of the recognition of basic emotions in the neurodevelopment of children and its evaluation through the "Recognition of Basic Emotions in Childhood" Test (REBEC). In *Frontiers in Education* (Vol. 5, p. 110). Frontiers Media SA. https://doi.org/10.3389/feduc.2020.00110

Poljac, E., Poljac, E., & Wagemans, J. (2013). Reduced accuracy and sensitivity in the perception of emotional facial expressions in individuals with high autism spectrum traits. *Autism, 17*(6), 668-680. https://doi.org/10.1177/1362361312455703

Pollux, P. M. (2021). Age-of-actor effects in body expression recognition of children. *Acta Psychologica, 220*, 103421. https://doi.org/10.1016/j.actpsy.2021.103421

Pollux, P. M., Craddock, M., & Guo, K. (2019). Gaze patterns in viewing static and dynamic body expressions. *Acta psychologica, 198*, 102862. https://doi.org/10.1016/j.actpsy.2019.05.014

Pollux, P. M., Hermens, F., & Willmott, A. P. (2016). Age-congruency and contact effects in body expression recognition from point-light displays (PLD). *PeerJ, 4*, e2796. https://doi.org/10.7717/peerj.2796

Ponari, M., Conson, M., D'Amico, N. P., Grossi, D., & Trojano, L. (2012). Mapping correspondence between facial mimicry and emotion recognition in healthy subjects. *Emotion, 12*(6), 1398. https://doi.org/10.1037/a0028588

Power, M. J., & Tarsia, M. (2007). Basic and complex emotions in depression and anxiety. *Clinical Psychology & Psychotherapy, 14*(1), 19-31. https://doi.org/10.1002/cpp.515

Preece, D., Becerra, R., Allan, A., Robinson, K., & Dandy, J. (2017). Establishing the theoretical components of alexithymia via factor analysis: Introduction and validation of the attention-appraisal model of alexithymia. *Personality and individual differences, 119*, 341-352. https://doi.org/10.1016/j.paid.2017.08.003

Preece, D., Becerra, R., Robinson, K., Dandy, J., & Allan, A. (2018). The psychometric assessment of alexithymia: Development and validation of the Perth Alexithymia Questionnaire. *Personality and Individual Differences, 132*, 32-44. https://doi.org/10.1016/j.paid.2018.05.011

Prenger, M. T., & MacDonald, P. A. (2018). Problems with facial mimicry might contribute to emotion recognition impairment in Parkinson's disease. *Parkinson's Disease, 2018*(1), 5741941. https://doi.org/10.1155/2018/5741941

Preston, S. D., & de Waal, F. B. M. (2002). Empathy: Its ultimate and proximate bases. *Behavioral and Brain Sciences, 25*(1), 1–20. https://doi.org/10.1017/S0140525X02000018

Prior, M., Dahlstrom, B., & Squires, T. (1990). Autistic children's knowledge of thinking and feeling states in other people. *Journal of Child Psychology and Psychiatry, 31*(4), 587-601. https://doi.org/10.1111/j.1469-7610.1990.tb00799.x

Prolific. (n.d.). Prolific: The platform for high-quality participant recruitment. Prolific. https://www.prolific.com

Qualtrics. (2022). Qualtrics XM [Computer software]. Qualtrics. https://www.qualtrics.com/

QuestionPro. (2024). QuestionPro [Computer software]. https://www.questionpro.com/

R Core Team. (2023). R: A language and environment for statistical computing (Version 4.4.2) [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Range, F., Horn, L., Viranyi, Z., & Huber, L. (2009). The absence of reward induces inequity aversion in dogs. *Proceedings of the National Academy of Sciences, 106*(1), 340-345. https://doi.org/10.1073/pnas.0810957105

Rasting, M., Brosig, B., & Beutel, M. E. (2005). Alexithymic characteristics and patient-therapist interaction: a video analysis of facial affect display. *Psychopathology, 38*(3), 105-111. https://doi.org/10.1159/000085772

Reardon, T., Spence, S. H., Hesse, J., Shakir, A., & Creswell, C. (2018). Identifying children with anxiety disorders using brief versions of the Spence Children’s Anxiety Scale for children, parents, and teachers. *Psychological assessment, 30*(10), 1342. https://doi.org/10.1037/pas0000570

Rehnman, J., & Herlitz, A. (2006). Higher face recognition ability in girls: Magnified by own-sex and own-ethnicity bias. *Memory, 14*(3), 289-296. https://doi.org/10.1080/09658210500233581

Reimers, S., & Stewart, N. (2015). Presentation and response timing accuracy in Adobe Flash and HTML5/JavaScript Web experiments. *Behavior research methods, 47*, 309-327. https://doi.org/10.3758/s13428-014-0471-1

Ren, H., Huang, L., Du, F., Huang, W., Lin, G., Kret, M. E., & Chen, S. (2023). Preschoolers Can Match the Facial and Bodily Emotional Expressions: A Behavior and Eye-Tracking Study. *SAGE Open, 13*(4), 21582440231214347. https://doi.org/10.1177/21582440231214347

Reniers, R. L., Corcoran, R., Drake, R., Shryane, N. M., & Völlm, B. A. (2011). The QCAE: A questionnaire of cognitive and affective empathy. *Journal of personality assessment, 93*(1), 84-95. https://doi.org/10.1080/00223891.2010.528484

Richter, D., & Kunzmann, U. (2011). Age differences in three facets of empathy: performance-based evidence. *Psychology and aging, 26*(1), 60. https://doi.org/10.1037/a0021138

Richter, D., Dietzel, C., & Kunzmann, U. (2011). Age differences in emotion recognition: The task matters. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 66*(1), 48-55. https://doi.org/10.1093/geronb/gbq068

Riddell, C., Nikolić, M., Dusseldorp, E., & Kret, M. E. (2024). Age-related changes in emotion recognition across childhood: A meta-analytic review. *Psychological Bulletin, 150*(9), 1094. https://doi.org/10.1037/bul0000442

Rieffe, C., Oosterveld, P., & Terwogt, M. M. (2006). An alexithymia questionnaire for children: Factorial and concurrent validation results. *Personality and individual differences, 40*(1), 123-133. https://doi.org/10.1016/j.paid.2005.05.013

Ritzl, A., Csukly, G., Balázs, K., & Égerházi, A. (2018). Facial emotion recognition deficits and alexithymia in borderline, narcissistic, and histrionic personality disorders. *Psychiatry Research, 270*, 154-159. https://doi.org/10.1016/j.psychres.2018.09.017

Rives Bogart, K., & Matsumoto, D. (2010). Facial mimicry is not necessary to recognize emotion: Facial expression recognition by people with Moebius syndrome. *Social neuroscience, 5*(2), 241-251. https://doi.org/10.1080/17470910903395692

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annu. Rev. Neurosci., 27*(1), 169-192. https://doi.org/10.1146/annurev.neuro.27.070203.144230

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive brain research, 3*(2), 131-141. https://doi.org/10.1016/0926-6410(95)00038-0

Robinson, O. J., Letkiewicz, A. M., Overstreet, C., Ernst, M., & Grillon, C. (2011). The effect of induced anxiety on cognition: threat of shock enhances aversive processing in healthy individuals. *Cognitive, Affective, & Behavioral Neuroscience, 11*(2), 217-227. https://doi.org/10.3758/s13415-011-0030-5

Rosenthal, R., Hall, J. A., DiMatteo, M. R., Rogers, P. L., & Archer, D. (1979). *Sensitivity to nonverbal communication: The PONS test*. Johns Hopkins University Press.

Ross, P. D., Polson, L., & Grosbras, M. H. (2012). Developmental changes in emotion recognition from full-light and point-light displays of body movement. *PLOS ONE, 7*(9), e44815. https://doi.org/10.1371/journal.pone.0044815

Ross, P., & Flack, T. (2020). Removing hand form information specifically impairs emotion recognition for fearful and angry body stimuli. *perception, 49*(1), 98-112. https://doi.org/10.1177/0301006619893229

Ross, P., de Gelder, B., Crabbe, F., & Grosbras, M. H. (2019). Emotion modulation of the body-selective areas in the developing brain. *Developmental Cognitive Neuroscience, 38*, 100660. https://doi.org/10.1016/j.dcn.2019.100660

Rousseeuw, P., Croux, C., Todorov, V., Ruckstuhl, A., Salibian-Barrera, M., Verbeke, T., & Maechler, M. (2024). robustbase: Basic robust statistics (Version 0.99-0) [R package]. https://CRAN.R-project.org/package=robustbase

RStudio Team. (2023). RStudio: Integrated development environment for R (Version 2023.06.1, Build 524) [Computer software]. Posit, PBC. https://posit.co/

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: Implications for neuropsychological models of aging. *Neuroscience & Biobehavioral Reviews, 32*(4), 863-881. https://doi.org/10.1016/j.neubiorev.2008.01.001

Ruffman, T., Ng, M., & Jenkin, T. (2009). Older adults respond quickly to angry faces despite labeling difficulty. *Journals of Gerontology: Series B, 64*(2), 171-179. https://doi.org/10.1093/geronb/gbn035

Russell, J. A. (1980). A circumplex model of affect. *Journal of personality and social psychology, 39*(6), 1161. https://doi.org/10.1037/h0077714

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological bulletin, 115*(1), 102.

Ryan, C., & Charragáin, C. N. (2010). Teaching emotion recognition skills to children with autism. *Journal of autism and developmental disorders, 40*(12), 1505-1511. https://doi.org/10.1007/s10803-010-1009-8

Rymarczyk, K., Żurawski, Ł., Jankowiak-Siuda, K., & Szatkowska, I. (2016a). Do dynamic compared to static facial expressions of happiness and anger reveal enhanced facial mimicry?. *PloS one, 11*(7), e0158534. https://doi.org/10.1371/journal.pone.0158534

Rymarczyk, K., Żurawski, Ł., Jankowiak-Siuda, K., & Szatkowska, I. (2016b). Emotional empathy and facial mimicry for static and dynamic facial expressions of fear and disgust. *Frontiers in psychology, 7*, 1853. https://doi.org/10.3389/fpsyg.2016.01853

Rymarczyk, K., Żurawski, Ł., Jankowiak-Siuda, K., & Szatkowska, I. (2018). Neural correlates of facial mimicry: simultaneous measurements of EMG and BOLD responses during perception of dynamic compared to static facial expressions. *Frontiers in psychology, 9*, 52. https://doi.org/10.3389/fpsyg.2018.00052

Rymarczyk, K., Żurawski, Ł., Jankowiak-Siuda, K., & Szatkowska, I. (2019). Empathy in facial mimicry of fear and disgust: simultaneous EMG-fMRI recordings during observation of static and dynamic facial expressions. *Frontiers in psychology, 10*, 701. https://doi.org/10.3389/fpsyg.2019.00701

Sáez-Suanes, G. P., García-Villamisar, D., & Pozo Armentia, A. D. (2023). Does the gender matter?: Anxiety symptoms and emotion dysregulation in adults with autism and intellectual disabilities. *Autism Research, 16*(1), 113-121. https://doi.org/10.1002/aur.2839

Şakir, G. I. C. A., Büyükavşar, A., Iyisoy, M. S., & Güleç, H. (2021). Psychometric properties of questionnaire of cognitive and affective empathy (QCAE): reliability and factor analysis study in Turkish sample. *Archives of Neuropsychiatry, 58*(3), 228. https://doi.org/10.29399/npa.27248

Salminen, J. K., Saarijärvi, S., Äärelä, E., Toikka, T., & Kauhanen, J. (1999). Prevalence of alexithymia and its association with sociodemographic variables in the general population of Finland. *Journal of psychosomatic research, 46*(1), 75-82. https://doi.org/10.1016/S0022-3999(98)00053-1

Sarkar, D. (2020). A review of behavioral tests to evaluate different types of anxiety and anti-anxiety effects. *Clinical Psychopharmacology and Neuroscience, 18*(3), 341. https://doi.org/10.9758/cpn.2020.18.3.341

Sarrett, J. C. (2016). Biocertification and neurodiversity: The role and implications of self-diagnosis in autistic communities. *Neuroethics, 9*, 23-36. https://doi.org/10.1007/s12152-016-9247-x

Sasson, N. J., Faso, D. J., Nugent, J., Lovell, S., Kennedy, D. P., & Grossman, R. B. (2017). Neurotypical peers are less willing to interact with those with autism based on thin slice judgments. *Scientific reports, 7*(1), 40700. https://doi.org/10.1038/srep40700

Sato, W., Kochiyama, T., Yoshikawa, S., Naito, E., & Matsumura, M. (2004). Enhanced neural activity in response to dynamic facial expressions of emotion: an fMRI study. *Cognitive Brain Research, 20*(1), 81-91. https://doi.org/10.1016/j.cogbrainres.2004.01.008

Sato, W., Toichi, M., Uono, S., & Kochiyama, T. (2012). Impaired social brain network for processing dynamic facial expressions in autism spectrum disorders. *BMC neuroscience, 13*, 1-17. https://doi.org/10.1186/1471-2202-13-99

Sato, W., Uono, S., & Toichi, M. (2013). Atypical recognition of dynamic changes in facial expressions in autism spectrum disorders. *Research in Autism Spectrum Disorders, 7*(7), 906-912. https://doi.org/10.1016/j.rasd.2013.04.008

Sauter, D. (2010). More than happy: The need for disentangling positive emotions. *Current Directions in Psychological Science, 19*(1), 36-40. https://doi.org/10.1177/0963721409359290

Scherer, K. R. (2009). The dynamic architecture of emotion: Evidence for the component process model. *Cognition and emotion, 23*(7), 1307-1351. https://doi.org/10.1080/02699930902928969

Scherer, K. R., & Bänziger, T. (2010). On the use of actor portrayals in research on emotional expression. In K. R. Scherer, T. Bänziger, & E. B. Roesch (Eds.), *Blueprint for affective computing: A sourcebook* (pp. 166–176). Oxford University Press.

Schirmer, A., & Adolphs, R. (2017). Emotion perception from face, voice, and touch: comparisons and convergence. *Trends in cognitive sciences, 21*(3), 216-228. https://doi.org/10.1016/j.tics.2017.01.001

Schlegel, K., Fontaine, J. R., & Scherer, K. R. (2017). The nomological network of emotion recognition ability. *European Journal of Psychological Assessment, 33*(2), 89–104. https://doi.org/10.1027/1015-5759/a000396

Schlegel, K., Grandjean, D., & Scherer, K. R. (2012). Emotion recognition: Unidimensional ability or a set of modality-and emotion-specific skills?. *Personality and Individual Differences, 53*(1), 16-21. https://doi.org/10.1016/j.paid.2012.01.026

Schlegel, K., Vicaria, I. M., Isaacowitz, D. M., & Hall, J. A. (2017). Effectiveness of a short audiovisual emotion recognition training program in adults. *Motivation and Emotion, 41*, 646-660. https://doi.org/10.1007/s11031-017-9631-9

Schlinger, H. D. (2009). Theory of mind: An overview and behavioral perspective. *The Psychological Record, 59*, 435-448. https://doi.org/10.1007/BF03395673

Schneider, K., Regenbogen, C., Pauly, K. D., Gossen, A., Schneider, D. A., Mevissen, L., ... & Schneider, F. (2013). Evidence for gender-specific endophenotypes in high-functioning autism spectrum disorder during empathy. *Autism Research, 6*(6), 506-521. https://doi.org/10.1002/aur.1310

Schwenck, C., Göhle, B., Hauf, J., Warnke, A., Freitag, C. M., & Schneider, W. (2014). Cognitive and emotional empathy in typically developing children: The influence of age, gender, and intelligence. *European Journal of Developmental Psychology, 11*(1), 63-76. https://doi.org/10.1080/17405629.2013.808994

Sedgewick, F., Leppanen, J., & Tchanturia, K. (2020). Gender differences in mental health prevalence in autism. *Advances in Autism, 7*(3), 208-224. https://doi.org/10.1108/AIA-01-2020-0007

Sevdalis, V., & Keller, P. E. (2012). Perceiving bodies in motion: expression intensity, empathy, and experience. *Experimental brain research, 222*, 447-453. https://doi.org/10.1007/s00221-012-3229-y

Shalev, I., Warrier, V., Greenberg, D. M., Smith, P., Allison, C., Baron-Cohen, S., ... & Uzefovsky, F. (2022). Reexamining empathy in autism: Empathic disequilibrium as a novel predictor of autism diagnosis and autistic traits. *Autism Research, 15*(10), 1917-1928. https://doi.org/10.1002/aur.2794

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika, 52*(3-4), 591-611. https://doi.org/10.1093/biomet/52.3-4.591

Sheppard, E., Pillai, D., Wong, G. T. L., Ropar, D., & Mitchell, P. (2016). How easy is it to read the minds of people with autism spectrum disorder?. *Journal of autism and developmental disorders, 46*, 1247-1254. https://doi.org/10.1007/s10803-015-2662-8

Sifneos, P. E. (1973). The prevalence of 'alexithymic'characteristics in psychosomatic patients. *Psychotherapy and psychosomatics, 22*(2-6), 255-262. https://doi.org/10.1159/000286529

Simcock, G., McLoughlin, L. T., De Regt, T., Broadhouse, K. M., Beaudequin, D., Lagopoulos, J., & Hermens, D. F. (2020). Associations between facial emotion recognition and mental health in early adolescence. *International journal of environmental research and public health, 17*(1), 330. https://doi.org/10.3390/ijerph17010330

Singer, T., & Lamm, C. (2009). The social neuroscience of empathy. *Annals of the new York Academy of Sciences, 1156*(1), 81-96. https://doi.org/10.1111/j.1749-6632.2009.04418.x

Singer, T., Critchley, H. D., & Preuschoff, K. (2009). A common role of insula in feelings, empathy and uncertainty. *Trends in cognitive sciences, 13*(8), 334-340. https://doi.org/10.1016/j.tics.2009.05.001

Sinvani, R. T., & Fogel-Grinvald, H. (2024). You better listen to yourself: studying metacognitive efficiency in emotion recognition by voice. *Frontiers in Communication, 9*, 1366597. https://doi.org/10.3389/fcomm.2024.1366597

Smith, M. J. L., Montagne, B., Perrett, D. I., Gill, M., & Gallagher, L. (2010). Detecting subtle facial emotion recognition deficits in high-functioning autism using dynamic stimuli of varying intensities. *Neuropsychologia, 48*(9), 2777-2781. https://doi.org/10.1016/j.neuropsychologia.2010.03.008

Sokolov, A. A., Krüger, S., Enck, P., Krägeloh-Mann, I., & Pavlova, M. A. (2011). Gender affects body language reading. *Frontiers in psychology, 2*, 2259. https://doi.org/10.3389/fpsyg.2011.00016

Song, Y., Nie, T., Shi, W., Zhao, X., & Yang, Y. (2019). Empathy impairment in individuals with autism spectrum conditions from a multidimensional perspective: A meta-analysis. *Frontiers in psychology, 10*, 1902. https://doi.org/10.3389/fpsyg.2019.01902

Spencer, J. M., Sekuler, A. B., Bennett, P. J., Giese, M. A., & Pilz, K. S. (2016). Effects of aging on identifying emotions conveyed by point-light walkers. *Psychology and Aging, 31*(1), 126.

Spielberger, C. D. (1983). State-trait anxiety inventory for adults. https://psycnet.apa.org/doi/10.1037/t06496-000

Stoner, S. B., & Spencer, W. B. (1986). Age and sex differences on the State-Trait Personality Inventory. *Psychological Reports, 59*(3), 1315-1319. https://doi.org/10.2466/pr0.1986.59.3.1315

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: a nonobtrusive test of the facial feedback hypothesis. *Journal of* *personality and social psychology, 54*(5), 768. https://doi.org/10.1037/0022-3514.54.5.768

Subbaraju, V., Sundaram, S., & Narasimhan, S. (2018). Identification of lateralized compensatory neural activities within the social brain due to autism spectrum disorder in adolescent males. *European Journal of Neuroscience, 47*(6), 631-642. https://doi.org/10.1111/ejn.13634

Sucksmith, E., Allison, C., Baron-Cohen, S., Chakrabarti, B., & Hoekstra, R. A. (2013). Empathy and emotion recognition in people with autism, first-degree relatives, and controls. *Neuropsychologia, 51*(1), 98-105. https://doi.org/10.1016/j.neuropsychologia.2012.11.013

Sullivan, S., Campbell, A., Hutton, S. B., & Ruffman, T. (2017). What's good for the goose is not good for the gander: Age and gender differences in scanning emotion faces. *Journals of Gerontology Series b: Psychological Sciences and Social Sciences, 72*(3), 441-447. https://doi.org/10.1093/geronb/gbv033

Surcinelli, P., Codispoti, M., Montebarocci, O., Rossi, N., & Baldaro, B. (2006). Facial emotion recognition in trait anxiety. *Journal of anxiety disorders, 20*(1), 110-117. https://doi.org/10.1016/j.janxdis.2004.11.010

Tamietto, M., & De Gelder, B. (2010). Neural bases of the non-conscious perception of emotional signals. *Nature Reviews Neuroscience, 11*(10), 697-709. https://doi.org/10.1038/nrn2889

The jamovi project (2023). jamovi. (Version 2.4) [Computer Software]. Retrieved from https://www.jamovi.org.

Thiele-Swift, H. N., & Dorstyn, D. S. (2024). Anxiety prevalence in youth with autism: A systematic review and meta-analysis of methodological and sample moderators. *Review Journal of Autism and Developmental Disorders, 11*(1), 1–14. https://doi.org/10.1007/s40489-023-00427-w

Thompson, A. E., & Voyer, D. (2014). Sex differences in the ability to recognise non-verbal displays of emotion: A meta-analysis. *Cognition and Emotion, 28*(7), 1164-1195. https://doi.org/10.1080/02699931.2013.875889

Timoney, L. R., & Holder, M. D. (2013). Definition of alexithymia. In *Emotional processing deficits and happiness: Assessing the measurement, correlates, and well-being of people with alexithymia* (pp. 1–6). Springer. https://doi.org/10.1007/978-94-007-7177-2_1

Tindall, I. K., Curtis, G. J., & Locke, V. (2021). Dimensionality and measurement invariance of the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA) and validity comparison With measures of negative emotionality. *Frontiers in Psychology, 12*, 644889. https://doi.org/10.3389/fpsyg.2021.644889

Torres, E. B., Vero, J., Drain, N., Rai, R., & Bermperidis, T. (2025). Hidden social and emotional competencies in autism spectrum disorders captured through the digital lens. *Frontiers in Psychiatry, 16*, 1559202. https://doi.org/10.3389/fpsyt.2025.1559202

Torunsky, N., & Vilares, I. (2020). *Alexithymia is associated with lower confidence in both perceptual and emotion recognition tasks* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/xqfev

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., ... & Nelson, C. (2009). The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry research, 168*(3), 242-249. https://doi.org/10.1016/j.psychres.2008.05.006

Trevisan, D. A., Hoskyn, M., & Birmingham, E. (2018). Facial expression production in autism: A meta-analysis. *Autism Research, 11*(12), 1586-1601. https://doi.org/10.1002/aur.2037

Tuminello, E. R., & Davidson, D. (2011). What the face and body reveal: In-group emotion effects and stereotyping of emotion in African American and European American children. *Journal of experimental child psychology, 110*(2), 258-274. https://doi.org/10.1016/j.jecp.2011.02.016

Uljarević, M., Hedley, D., Cai, R. Y., Hardan, A. Y., & South, M. (2021). Anxiety and depression from adolescence to old age in autism spectrum disorder. In F. R. Volkmar (Ed.), *Encyclopedia of autism spectrum disorders* (pp. 257–270). Springer International Publishing. https://doi.org/10.1007/978-3-319-91280-6_102432

Vaiouli, P., & Panayiotou, G. (2021). Alexithymia and autistic traits: associations with social and emotional challenges among college students. *Frontiers in Neuroscience, 15*, 733775. https://doi.org/10.3389/fnins.2021.733775

Van den Stock, J., Righart, R., & De Gelder, B. (2007). Body expressions influence recognition of emotions in the face and voice. *Emotion, 7*(3), 487. https://psycnet.apa.org/doi/10.1037/1528-3542.7.3.487

Van der Gaag, C., Minderaa, R. B., & Keysers, C. (2007). Facial expressions: what the mirror neuron system can and cannot tell us. *Social neuroscience, 2*(3-4), 179-222. https://doi.org/10.1080/17470910701376878

Van Der Schalk, J., Hawk, S. T., Fischer, A. H., & Doosje, B. (2011). Moving faces, looking places: validation of the Amsterdam Dynamic Facial Expression Set (ADFES). *Emotion, 11*(4), 907. https://doi.org/10.1037/a0023853

Vasa, R. A., Kalb, L., Mazurek, M., Kanne, S., Freedman, B., Keefer, A., ... & Murray, D. (2013). Age-related differences in the prevalence and correlates of anxiety in youth with autism spectrum disorders. *Research in Autism Spectrum Disorders, 7*(11), 1358-1369. https://doi.org/10.1016/j.rasd.2013.07.005

Vera-Villarroel, P., Celis-Atenas, K., Pavez, P., Lillo, S., Bello, F., Díaz, N., & López, V. (2009). Preliminary analysis and normative data of the State-Trait Anxiety Inventory (STAI) in adolescents and adults of Santiago, Chile. *Terapia Psicológica, 27*(2), 163–170. https://www.academia.edu/14628670/Preliminary_Analysis_and_Normative_Data_of_the_State_Trait_Anxiety_Inventory_STAI_in_Adolescent_and_Adults_of_Santiago_Chile

Vicari, S., Reilly, J. S., Pasqualetti, P., Vizzotto, A., & Caltagirone, C. (2000). Recognition of facial expressions of emotions in school-age children: the intersection of perceptual and semantic categories. *Acta Paediatrica, 89*(7), 836-845. https://doi.org/10.1111/j.1651-2227.2000.tb00392.x

VideoLAN. (2021). VLC media player (Version 3.0.16) [Computer software]. https://www.videolan.org/vlc/

Vilaverde, R. F., Correia, A. I., & Lima, C. F. (2020). Higher trait mindfulness is associated with empathy but not with emotion recognition abilities. *Royal Society Open Science, 7*(8), 192077. https://doi.org/10.1098/rsos.192077

Villaume, S. C., Chen, S., & Adam, E. K. (2023). Age disparities in prevalence of anxiety and depression among US adults during the COVID-19 pandemic. *JAMA network open, 6*(11), e2345073-e2345073. https://doi.org/10.1001/jamanetworkopen.2023.45073

Volker, M. A., Lopata, C., Smith, D. A., & Thomeer, M. L. (2009). Facial encoding of children with high-functioning autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities, 24*(4), 195-204. https://doi.org/10.1177/1088357609347325

Vorst, H. C., & Bermond, B. (2001). Validity and reliability of the Bermond–Vorst alexithymia questionnaire. *Personality and individual differences, 30*(3), 413-434. https://doi.org/10.1016/S0191-8869(00)00033-7

Vuong, Q. C., & Geangu, E. (2023). The development of emotion processing of body expressions from infancy to early childhood: A meta-analysis. *Frontiers in Cognition, 2*, 1155031. https://doi.org/10.3389/fcogn.2023.1155031

Wagner, H. L. (1993). On measuring performance in category judgment studies of nonverbal behavior. *Journal of nonverbal behavior, 17*, 3-28. https://doi.org/10.1007/BF00987006

Wagner, H., & Lee, V. (2008). Alexithymia and individual differences in emotional expression. *Journal of Research in Personality, 42*(1), 83-95. https://doi.org/10.1016/j.jrp.2007.04.001

Wai, M., & Tiliopoulos, N. (2012). The affective and cognitive empathic nature of the dark triad of personality. *Personality and individual differences, 52*(7), 794-799. https://doi.org/10.1016/j.paid.2012.01.008

Watling, D., & Damaskinou, N. (2020). Children's facial emotion recognition skills: Longitudinal associations with lateralization for emotion processing. *Child Development, 91*(2), 366-381. https://doi.org/10.1111/cdev.13188

Watson, R., & De Gelder, B. (2017). How white and black bodies are perceived depends on what emotion is expressed. *Scientific reports, 7*(1), 41349. https://doi.org/10.1038/srep41349

Way, I. F., Applegate, B., Cai, X., Franck, L. K., Black-Pond, C., Yelsma, P., ... & Muliett, M. (2010). Children's Alexithymia Measure (CAM): A new instrument for screening difficulties with emotional expression. *Journal of Child & Adolescent Trauma, 3*, 303-318. https://doi.org/10.1080/19361521.2010.523778

Wegrzyn, M., Vogt, M., Kireclioglu, B., Schneider, J., & Kissler, J. (2017). Mapping the emotional face. How individual face parts contribute to successful emotion recognition. *PloS one, 12*(5), e0177239. https://doi.org/10.1371/journal.pone.0177239

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion: Evidence from natural language. *Cognition & Emotion, 9*(2-3), 117-149. https://doi.org/10.1080/02699939508409005

Wells, A. E., Hunnikin, L. M., Ash, D. P., & Van Goozen, S. H. (2021). Improving emotion recognition is associated with subsequent mental health and well-being in children with severe behavioural problems. *European child & adolescent psychiatry, 30*(11), 1769-1777. https://doi.org/10.1007/s00787-020-01652-y

Widen, S. C., & Russell, J. A. (2003). A closer look at preschoolers' freely produced labels for facial expressions. *Developmental psychology, 39*(1), 114. https://doi.org/10.1037/0012-1649.39.1.114

Widen, S. C., & Russell, J. A. (2008). Children acquire emotion categories gradually. *Cognitive development, 23*(2), 291-312. https://doi.org/10.1016/j.cogdev.2008.01.002

Wieck, C., & Kunzmann, U. (2017). Age differences in emotion recognition: A question of modality?. *Psychology and Aging, 32*(5), 401. https://psycnet.apa.org/doi/10.1037/pag0000178

Wieckowski, A. T., Swain, D. M., Abbott, A. L., & White, S. W. (2019). Task dependency when evaluating association between facial emotion recognition and facial emotion expression in children with ASD. *Journal of autism and developmental disorders, 49*, 460-467. https://doi.org/10.1007/s10803-018-3712-9

Wing, L. (1988). The continuum of autistic characteristics. In Diagnosis and assessment in autism (pp. 91-110). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4899-0792-9_7

Winkelmayer, R., Gottheil, E., Exline, R. V., & Paredes, A. (1978). The relative accuracy of US, British, and Mexican raters in judging the emotional displays of schizophrenic and normal US women. *Journal of Clinical Psychology, 34*(3), 600–608. https://doi.org/10.1002/1097-4679(197807)34:3<600::AID-JCLP2270340304>3.0.CO;2-A

Witherow, M. A., Diawara, N., Keener, J., Harrington, J. W., & Iftekharuddin, K. M. (2024). *Pilot study to discover candidate biomarkers for autism based on perception and production of facial expressions* [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2404.16040

Witkower, Z., Tracy, J. L., Pun, A., & Baron, A. S. (2021). Can children recognize bodily expressions of emotion?. *Journal of Nonverbal Behavior, 45*(4), 505-518. https://doi.org/10.1007/s10919-021-00368-0

Wolff, N., Stroth, S., Kamp-Becker, I., Roepke, S., & Roessner, V. (2022). Autism spectrum disorder and IQ–A complex interplay. *Frontiers in psychiatry, 13*, 856084. https://doi.org/10.3389/fpsyt.2022.856084

Woods, R. (2017). Exploring how the social model of disability can be re-invigorated for autism: In response to Jonathan Levitt. *Disability & society, 32*(7), 1090-1095. https://doi.org/10.1080/09687599.2017.1328157

Yeung, M. K. (2022). A systematic review and meta-analysis of facial emotion recognition in autism spectrum disorder: The specificity of deficits and the role of task characteristics. *Neuroscience & Biobehavioral Reviews, 133*, 104518. https://doi.org/10.1016/j.neubiorev.2021.104518

Yirmiya, N., Kasari, C., Sigman, M., & Mundy, P. (1989). Facial expressions of affect in autistic, mentally retarded and normal children. *Journal of Child Psychology and Psychiatry, 30*(5), 725-735. https://doi.org/10.1111/j.1469-7610.1989.tb00785.x

Yoo, S. H., Matsumoto, D., & LeRoux, J. A. (2006). The influence of emotion recognition and emotion regulation on intercultural adjustment. *International Journal of Intercultural Relations, 30*(3), 345-363. https://doi.org/10.1016/j.ijintrel.2005.08.006

Young, A. W., Perrett, D. I., Calder, A. J., Sprengelmeyer, R., & Ekman, P. (2002). *Facial Expressions of Emotion: Stimuli and Test (FEEST)* [Measurement instrument]. Thames Valley Test Company.

Zhang, D., Zhao, T., Liu, Y., & Chen, Y. (2015). Comparison of facial expressions and body expressions: An event-related potential study. *Acta Psychologica Sinica, 47*(8), 963. https://doi.org/10.3724/SP.J.1041.2015.00963

Zhang, M., Xu, S., Chen, Y., Lin, Y., Ding, H., & Zhang, Y. (2022). Recognition of affective prosody in autism spectrum conditions: A systematic review and meta-analysis. *Autism, 26*(4), 798-813. https://doi.org/10.1177/1362361321995725

Zhang, S., Liu, X., Yang, X., Shu, Y., Liu, N., Zhang, D., & Liu, Y. J. (2021). The influence of key facial features on recognition of emotion in cartoon faces. *Frontiers in psychology, 12*, 687974. https://doi.org/10.3389/fpsyg.2021.687974

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Zuckerman, M., Lipets, M. S., Koivumaki, J. H., & Rosenthal, R. (1975). Encoding and decoding nonverbal cues of emotion. *Journal of Personality and Social Psychology, 32*(6), 1068. https://doi.org/10.1037/0022-3514.32.6.1068

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Appendix

Appendix A – Stimuli and guide videos

A.1.1 - Rating study of guide videos - definitions of the rating dimensions.docx

Definitions provided to participants for the dimensions they would rate the videos on.

A.1.2 - Guide videos (selected after rating study).rar

Guide videos that were used during the filming of the stimuli. They were “selected” by participants in the rating study described in chapter 2.

A.2.1 - Image stimuli.zip & A.2.2 - Video stimuli.zip

Stimuli used in studies 1 and 2.

A.3 - Amusement guide videos.zip

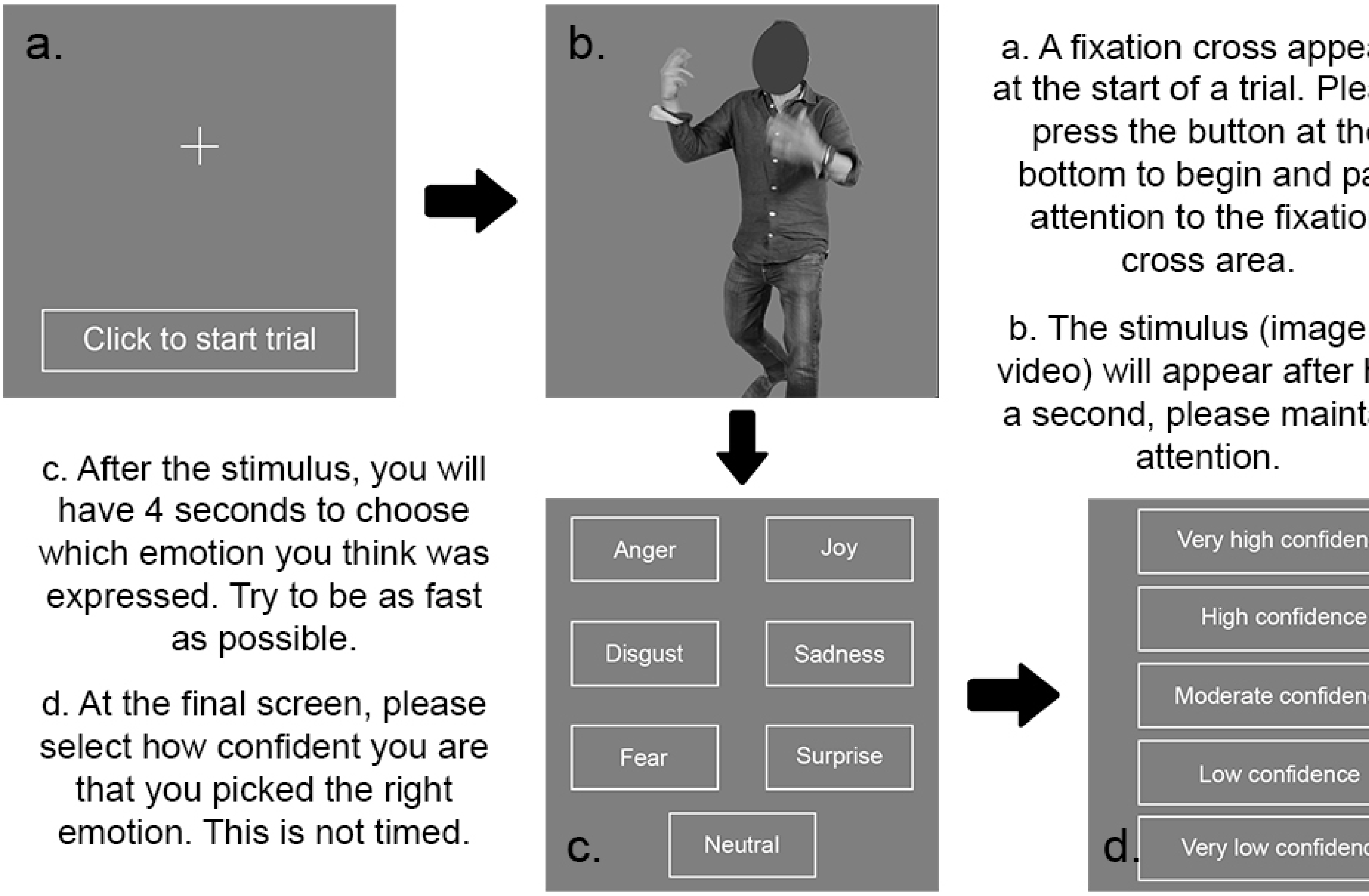
Guide videos added to the original set (A.1.2) after amusement was added as an emotion in Study 3.

Appendix B – Methodology

B.1 – Loading function

B.C.1.1 Loading function.txt

B.2 – Instructions for the ER test in Study 1



B.3 ANOVA interactions function

B.3 ANOVA interactions function.txt

File contains the R (markdown) code for the function used to obtain estimated marginal means, post-hoc tests, and plots for the .

Appendix C.1 – Study 1

C.1.0 – Pre-analysis

C.1.0.0 – Descriptives and overall normality

C.1.0.0 – Descriptives and overall normality.docx

C.1.0.1 – Methodological checks

C.1.0.1 – Methodological checks.docx

File contains the jamovi output of all the methodological checks, with the exception of the 4 x 2 x 2 ANOVA examining learning effects, which is contained in the next section (and file).

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

C.1.0.2 Learning effects

C.1.0.2 Learning effects ANOVA.xlsx

File contains the ANOVA test results with assumption checks, as well as post-hocs for the relevant, significant interaction effect of order x Motion.

C.1.1 Task characteristics

anova_2x2x7_task_char_emmeans_posthocs_plots.zip

ANOVAs_2x2x7_table_and_assumptions.xlsx

Excel files contain ANOVA results along with assumption checks. Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.1.1.2 Confus{t}ion matrices

C.1.1.2 - Confusion matrices.xlsx

Excel file contains the confusion matrices based on hit rates. On the rows, the matrices are listed by the level of modality x motion: total, face and body trials, image and video trials, and combinations of motion and modality (e.g., video face). On the columns matrices are listed by levels of actors: average of all actors, average of the two males, average of the two females, male 1, female 1, female 2, male 2.

C.1.2 Individual differences

C.1.2.1 Gender differences t-tests

C.1.2.1 Gender differences t-tests.docx

Contains jamovi t-test output for each variable between the genders, along with descriptives, and assumption checks.

C.1.2.2 Regression models: individual differences --> ER

C.1.2.2 - 27 regressions for overall measures (with assumptions).xlsx

C.1.2.2 - 42 regressions for emotion-specific measures (with assumptions)

Two excel files containing the results of the regressions and their assumption checks.

C.1.3 Actor differences

C.1.3.1 Actor differences on overall measures of ER

C.1.3.1 anova_2x2x4_actors_emmeans_posthocs_plots.zip

C.1.3.1 ANOVAs_2x2x4_table_and_assumptions.xlsx

Excel files contain ANOVA results along with assumption checks. Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.1.3.2 Actor differences on emotion-specific measures of ER

C.1.3.2 anova_4x7_actorsemotions_emmeans_posthocs_plots.zip

C.1.3.2 ANOVAs_4x7_table_and_assumptions.xlsx

Excel files contain ANOVA results along with assumption checks. Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.1.3.3 Gender of actor differences on overall measures of ER

C.1.3.3 anova_2x2x2_actorgender_emmeans_posthocs_plots.zip

C.1.3.3 ANOVAs_2x2x2_table_and_assumptions.xlsx

Excel files contain ANOVA results along with assumption checks. Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.1.3.4 Gender of actor differences on emotion-specific measures of ER

C.1.3.4 anova_actorgender_em_emmeans_posthocs_plots.zip

C.1.3.4 ANOVAs_2x2x7_actorgenderemotion_uhit_table_and_assumptions.xlsx

Excel files contain ANOVA results along with assumption checks. Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

Appendix C.2 – Study 2

C.2A.0 – Pre-analysis

C.2A.0.0 – Descriptives and overall normality

C.2A.0.0 – Descriptives and overall normality.docx

C.2A.0.1 – Methodological checks

C.2A.0.1 – Methodological checks.docx

C.2A.1 – Correlations

C.2A.1 - Correlations.xlsx

C.2A.2 – Autism differences (adults)

C.2A.2.1 - ANOVAs and ANCOVAs.xlsx

Excel file contains ANOVA and ANCOVA results along with assumption checks.

C.2A.2.2 - Robust regressions.docx

Word file contains the R output of the robust regression functions.

C.2A.2.3 - Emotion-specific tests.xlsx

Excel file contains all Mann-Whitney U tests conducted to investigate emotion-specific differences.

C.2B.0 – Pre-analysis

C.2B.0.0 – Descriptives and overall normality

C.2B.0.0 – Descriptives and overall normality.docx

C.2B.0.1 – Methodological checks

C.2B.0.1 – Methodological checks.docx

C.2B.1 – Individual differences in autism

C.2B.1 - Correlations.xlsx

Excel file contains correlations and t-tests conducted to investigate individual differences in autism.

C.2B.2.1 - ANOVAs and ANCOVAs

C.2B.2.1 - ANOVAs and ANCOVAs.xlsx

Excel file contains ANOVA and ANCOVA results along with assumption checks.

C.2B.2.2 - Emotion-specific tests

C.2B.2.2 - Emotion-specific tests.xlsx

Excel file contains all Mann-Whitney U tests conducted to investigate emotion-specific differences.

C.2C - 2x3 age ANOVAs for whole sample and children only

C.2C - 2x3 age ANOVAs for whole sample and children only.xlsx

Excel file contains ANOVA results along with assumption checks for the age comparison analysis.

Appendix C.3 – Study 3

C.3.0 – Pre-analysis

C.3.0.0 Descriptives of the main variables by study.docx

C.3.0.0 Descriptives of the main variables by study.docx

C.3.0.1 Methodological checks

C.3.0.1 Methodological checks

C.3.1 - Double empathy

C.3.1 - Double empathy - ANOVA tables and assumptions

C.3.1 - Double empathy - ANOVA tables and assumptions.xlsx

Excel file contains ANOVA results and assumptions.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

C.3.1.1 - Double empathy - uhit set1 interactions - emmeans, posthocs and plots.zip

C.3.1.2 - Double empathy - uhit set2 interactions - emmeans, posthocs and plots.zip

C.3.1.3 - Double empathy - RT interactions - emmeans, posthocs and plots.zip

C.3.1.4 - Double empathy - conf interactions - emmeans, posthocs and plots.zip

Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.3.2.1 - Participant autism x modality x actor

C.3.2.1 - Participant autism x modality x actor - ANOVA tables and assumptions.xlsx

Excel file contains ANOVA results and assumptions.

C.3.2.2 - Participant autism x modality x actor - emmeans, posthocs and plots.zip

Zip file contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.3.3 - Motion x autism by modality or by emotion

C.3.3 - ANOVA tables - motion x autism by modality or by emotion.xlsx

Excel file contains ANOVA results for both the 3-way ANOVA with the modality factor, and the one with the emotion factor.

C.3.4 - Actor variability

C.3.4 - Actor variability - ANOVA tables and assumptions.xlsx

Excel file contains ANOVA results and assumptions.

C.3.4.1 - Actor variability - emmeans, posthocs and plots - Set1.zip

C.3.4.2 - Actor variability - emmeans, posthocs and plots - Set1.zip

Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

C.3.5 - Age and gender of participants by actor effects

C.3.5 - Age and gender participant x actor interactions.xlsx

Excel file contains ANOVA results and assumptions.

C.3.5.1 - Gender differences - uhit - emmeans, posthocs and plots.zip

C.3.5.2 - Gender differences - RT - emmeans, posthocs and plots.zip

C.3.5.3 - Gender differences - conf - emmeans, posthocs and plots.zip

Zip files contain Bonferroni post-hocs, estimated marginal means and bar plots for every main effect and interaction effect.

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display

Abbreviations: ER – emotion recognition; ERA – emotion recognition ability; ERS – emotion recognition speed; ERC – emotion recognition confidence; ERI – emotion recognition intensity; fER(A) – face emotion recognition (ability); vER(A) – vocal emotion recognition (ability); bER(A) – body emotion recognition (ability); fbER(A) – face-body emotion recognition (ability); EE – emotion expression; BET – basic emotion theory; PLD – point-light display; FLD – full-light display