Exploring the Relationship between Social Anxiety and Emotional Expression Recognition Through Meta-Analytic, Psychometric, and Experimental Methods

By

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ABSTRACT

Existing models of social anxiety (SA) have proposed that this disorder is, in part, maintained by an attentional bias towards threat cues. Cues that may signal negative evaluation in social situations are attended to more quickly and interpreted more negatively, and therefore avoided. Among these cues are emotional facial expressions. While many studies have investigated the relationship between SA and emotional expression recognition (EER), there is a lack of consensus regarding whether global or emotion-specific EER deficits exist within this population. Few studies have explored what factors may be modulating the relationship between EER and SA.

The work presented in this thesis used meta-analytic, self-report, psychometric, and experimental methods to examine the effects of several factors on the EER/SA relationship. Across the three studies, we systematically reviewed and meta-analyzed the current literature on EER and SA while exploring the impact of comorbidity and stimulus duration (Study 1), investigated how communication medium impacts perceived social skill abilities--including emotion decoding-- in people with SA (Study 2), and sought to assess the effects of an experimentally induced state of anxiety on EER performance (Study 3). Altogether, we observed within and between-subjects emotion-specific and global EER differences. The results from Study 1 revealed particularly poor performance on EER of neutral and happy facial expressions in people with SAD, the latter of which is affected by comorbidity but not stimulus duration. Study 2 highlighted that communication medium (online versus in-person) has a prominent influence on perceived social skill abilities. In Study 3, we observed no influence of our manipulation on state anxiety, but the results nevertheless partially supported our previous findings. Our results suggested that individuals with high trait SA have significant difficulties recognizing neutral facial expressions.

Together, these results uniquely broaden our understanding of the association between SA and EER, and how various relevant factors impact their relationship.

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I would like to dedicate this work to my grandmother, Maria Veneziano. I hope this work makes you proud.

Vorrei dedicare questo lavoro a mia nonna, Maria Veneziano. Essendo la prima persona nella nostra genealogia a perseguire e ottenere un' educazione superiore, spero che questo lavoro la renda fiera.

CONTRIBUTION OF AUTHORS

This dissertation is comprised of a thesis by articles. The research in all three articles was approved by the University of Ottawa's Research Ethics Board. For the first article, *The Impact of Social Anxiety Disorder on Emotional Expression Recognition: A Meta-analysis*, undergraduate student, Kathryn Simoneau, and doctoral student Karine Elalouf contributed to the article screening, and librarian Patrick Labelle assisted in developing the search strategy. For the second study, *Impact of Social Anxiety on Communication Skills in Face-to-face vs. Online Contexts*, Karine Elalouf contributed to the data analysis. For the third study, *Investigating the Role of Mood Induction on Emotion Recognition in Social Anxiety*, honour's student Kassia Dubé contributed to the data collection.

For all three articles, Corina Lacombe's contributions included theoretical and methodological formulations, literature review, formal analysis, data curation, project visualization, project administration, and manuscript preparation and revision. Dr. Charles Collin oversaw the conceptualization and progression of the articles.

TABLE OF CONTENTS

ABSTRACT ii
ACKNOWLEDGEMENTS iv
DEDICATIONS vi
CONTRIBUTION OF AUTHORS vii
LIST OF FIGURES xi
LIST OF ABBREVIATIONS xii
CHAPTER 1: GENERAL INTRODUCTION 1
1.1 Overview of Thesis Aims 1
1.2 Social Anxiety Disorder (SAD) 3
1.3 Cognitive Models of SAD 4
1.4 Attentional Biases in SAD 6
1.5 Overview of Emotional Facial Expression Recognition (FER) 7
1.6 FER Correlates in Social Anxiety 9
1.6.1 Summary and Research Aims 10
1.7 The Consequences of Gaze Avoidance 10
1.8 Communication Mediums and SAD 12
1.9 Social Skill Abilities 13
1.9.1 Summary and Research Aims 15
1.10 State Anxiety and SAD 15
1.11 State Anxiety and FER 17
1.11.1 Correlates of State Anxiety, SAD, and FER: Summary and Research Aims 18
1.12 The Costs of FER Deficits in SAD 19
1.13 Treatments in SAD 21
1.14 References 26
CHAPTER 2: STUDY 1 40
2.1 Abstract 41
2.2 Introduction 42
2.3 Method 45
2.3.1 Protocol and Registration 45
2.3.2 Eligibility Criteria 45
2.3.3 Literature Search and Information Sources 48
2.3.4 Study Selection 49

2.3.5 Risk of Bias in Individual Studies....49
2.3.6 Data Collection Process....50
2.3.7 Synthesis of Results....51
2.3.8 Power Analysis....53
2.4 Results....53
2.4.1 Accuracy....60
2.4.2 Reaction Time....66
2.5 Discussion....70
2.5.1 Limitations....74
2.5.2 Conclusion....75
2.6 Acknowledgements....76
2.7 References....77
2.8 Supplementary Materials....89
2.8.2 Supplementary Figures....90
CHAPTER 3: STUDY 2....118
3.1 Abstract....119
3.1 Introduction....121
3.1.1 Communication Importance....121
3.1.2 Social Anxiety....122
3.1.3 Impact of Technology Use as a Communication Medium in SAD....123
3.1.4 Current Study....125
3.2 Method....126
3.2.1 Participants....126
3.2.2 Procedure....127
3.2.3 Measures....127
3.3 Results....131
3.3.1 Preliminary Results....131
3.3.3 Correlation Results....132
3.3.4 Doubly Multivariate GLM Results....134
3.4. Discussion....135
3.4.1 Limitations....139
3.4.2 Future Directions....139
3.5 References....141
2.6 Supplementary Materials....147

2.6.2 Supplementary Tables 148
2.6.3 Supplementary References 152

CHAPTER 4: STUDY 3 153
4.1 Abstract 154
4.2 Introduction 155
4.3 Method 159
4.3.1 Participants 159
4.3.2 Measures 159
4.3.3 Emotion Rating Task 162
4.3.5 Conversation Task 163
4.3.6 Procedure 164
4.4 Results 166
4.4.1 Statistical Analyses 166
4.4.2 Emotion Recognition 168
4.4.2 Manipulation Check 172
4.4.3 Behavioural Ratings 172
4.4.4 Video Ratings 173
4.4.5 Credibility Check 174
4.5 Discussion 174
4.5.1 Conclusion 177
4.6 References 179
5.1 Summary of Goals and Results 185

APPENDICES: 199
APPENDIX A: Liebowitz Social Anxiety Scale – Self-report 199
APPENDIX B: Real and Electronic Communication Skills Questionnaire 201
APPENDIX C: Depression, Anxiety, Stress Scale (DASS-21) 203
APPENDIX D: Social Performance Rating Scale (SPRS) 204
APPENDIX E: Behaviour Checklist 207
Appendix F: Subjective Units of Distress Scale (SUDS) 209
APPENDIX G: Resource List 210

LIST OF FIGURES

Figure 2.1 Overview of workflow chart per PRISMA guidelines 55

Figure 2.2 Summary effect sizes for accuracy across positive, negative, and neutral emotion ... 62

Figure 2.3 Summary effect sizes for accuracy across happy emotion and comorbidity sub-group 65

Figure 2.4 Summary of effect sizes for reaction time across conditions showing positive, negative, and neural expressions 4..... 68

Figure 4.1 Sample facial emotion rating trial 5 163

Figure 4.2 Procedural flow chart 6 165

Figure 4.3 Proportion of errors for each emotional facial expressions category indicating types of errors made by participants 7..... 171

Figure 4.4 Subjective Units of Distress Scale (SUDS) ratings across study time points 8 172

Figure 4.5 Post-conversation self and other behavioural ratings 9..... 173

LIST OF ABBREVIATIONS

EER	Emotion Expression Recognition
FER	Facial Expression Recognition
FtF	Face-to-Face
LSAS-SR	Liebowitz Social Anxiety Scale – Self-Report
RECS	Real and Electronic Communication Skills
SAD	Social Anxiety Disorder
SA	Social Anxiety
SUDS	Subjective Units of Distress
TMC	Technology-Mediated Communication

CHAPTER 1: GENERAL INTRODUCTION

1.1 Overview of Thesis Aims

Anxiety disorders are the most common mental health issue Canadians face (Health Canada, 2009). Approximately 8% of Canadians suffer from social anxiety disorder (SAD) every year (Mackenzie & Fowler, 2013), a disorder that results from an intense fear of judgement in social situations. This fear, which is often out of proportion to real threats, places those with social anxiety disorder at increased risk of experiencing loneliness and isolation. The social cost of these alone are extensive, often leading to less satisfaction and greater impairment in establishing relationships, and lower quality of life (Masi et al., 2011; Stentz & Cougle, 2022). Their fear of negative evaluation biases people with SAD to be vigilant towards potential signs of scrutiny in their environments, one of which is emotional facial expressions.

Emotional facial expressions help guide our behaviour, they serve as a clue as to whether approach or avoid a social situation. Deficits in the ability to correctly recognize facial expressions can skew this behaviour. Decades of research have established that individuals with social anxiety have a negative attentional bias towards threatening facial expressions (Bar-Haim et al., 2007). Shorter reaction times towards angry and fearful expressions suggest hypervigilance and increased alertness (Mullins & Duke, 2004). Less evident is whether this attentional bias influences the ability to identify an emotional facial expression correctly. Research with conflicting results has painted an unclear picture on this topic. Similarly, there are even fewer studies investigating the potential variables that may be impacting emotion recognition abilities within this population. Therefore, the general aim of the work presented in this thesis was to explore whether individuals with social anxiety have emotion recognition deficits, and if so, what factors may be influencing this

relationship. Chapter 1 presents a summary of previous work in this area. Following this, Chapters 2 to 4 present original research studies. The final chapter summarizes the results of the thesis work as a whole.

The goal of the work in Chapter 2 was to provide a comprehensive review of the literature on the relationship between social anxiety disorder and facial emotion recognition performance. This was achieved by conducting a systematic review and meta-analysis. In this review, we also assessed the impact of mental health comorbidity and stimulus duration on this relationship. The purpose of the work in Chapter 3 was to explore whether communication medium influenced perceived social skill abilities, one of which is facial emotion recognition, in individuals high in social anxiety. To address this question, we first validated a questionnaire that assesses social skill abilities in online and in-person contexts in a group of individuals with high-trait social anxiety and social anxiety disorder. We then compared responses between the in-person and online questionnaires to assess how perceived social skill abilities differ across these two communication mediums. The work in Chapter 4 aimed to determine whether state anxiety influences emotion recognition abilities in a group of individuals with high-trait social anxiety. We studied this research question by inducing state anxiety through a pre-post mood-induction paradigm.

The systematic review and meta-analysis presented in Chapter 2 constitutes a meaningful contribution to the social sciences because (to our knowledge) no other meta-analysis investigating this research question has been published before. The work presented in Chapter 3 is an equally significant contribution as no other research group has explicitly investigated the impact of communication medium on perceived social skills abilities in social anxiety using the validated measure applied in this thesis. Finally, the study presented in Chapter 4 is an important contribution as it provides insight into the efficacy of mood-induction paradigms to evaluate state anxiety on emotion recognition abilities in a group with high trait social anxiety.

1.2 Social Anxiety Disorder (SAD)

Social Anxiety Disorder (SAD) is an anxiety disorder characterized by a persistent and highly interfering fear of being negatively evaluated by others. It can be distinguished from clinically significant levels of social anxiety (SA): Individuals with SAD have received a formal diagnosis according to a diagnostic manual such as the DSM-5-TR, whereas those with clinically significant SA have met or surpassed clinical thresholds on clinician or self-report measures of social anxiety but have not received a diagnosis of SAD. Both individuals with SAD and those with clinically elevated SA fear acting or showing physical signs of anxiety that will be embarrassing, humiliating, result in rejection, or possibly offend others. This debilitating anxiety and fear of scrutiny occurs when encountering social situations, or when faced with the prospect of entering social situations or interacting with others (APA, 2022; DSM-5-TR). Social situations like speaking with unfamiliar people, talking on the phone, giving a speech or a presentation, or being observed while eating may be endured with severe distress or avoided altogether (Clark & Wells, 1995). As a result, SAD can be incredibly isolating and socially impairing. Difficulties in establishing or maintaining relationships may occur due to withdrawal from social situations (e.g., avoiding social gatherings), or due to more indirect effects arising from the use of safety behaviours when interacting with others (e.g., avoiding eye contact, keeping head down). The social costs of engaging in these often subtle and maladaptive safety behaviours can be deleterious and can impact the success of future interactions (Warnock-Parkes et al., 2020). One of these social consequences is a less accurate appraisal of emotional facial expressions, an impairment which may be maintaining the disorder over time (Rapee & Heimberg, 1997). The following sections review the literature on models of SAD, the impacts of SAD on emotional facial recognition, and some factors that may be influencing the relationship between them.

1.3 Cognitive Models of SAD

Two of the most widely cited models of SAD are by Clark and Wells (1995; updated by Clark 2001) and Rapee and Heimberg (1997; updated by Heimberg, Brozovich & Rapee, 2010). In Clark and Wells' (1995) model, the authors suggest that the core of SAD lies in excessively high performance-related standards (e.g., "*I must always sound intelligent*") and strong a desire to portray a favourable impression of the self to others. However, marked insecurities about their ability to do so result in negative beliefs (e.g., "*I am incompetent*"), and their behaviours will reflect this in social situations resulting in severe social consequences like rejection. Social situations are therefore perceived to be dangerous and threatening, activating impairing cognitive, behavioural, and somatic symptoms. The elements of this triad interact with one another to create self-generated 'evidence' that one is being negatively evaluated by others. An individual with SAD who is asked to give a presentation may experience somatic signs like a racing heart or feeling warm, which is equated to the thought that they are noticeably "losing control" or "making a fool of themselves." As a result, the individual may begin to speak quickly or breathe heavily. In a situation like this, the individual perceives that a spotlight is on them, with their physical signs and behaviours noticeable for everyone to see and judge. This biased and detailed negative self-monitoring is central to Clark and Wells' (1995) model.

In contrast, Rapee and Heimberg's (1997) model focuses on the perception of having an inherently critical audience. This feared audience is present across various social situations, including when giving a presentation, in dating situations, or even when casually walking down the street. The individual with SAD fears that members of the audience will judge them on appearance or behaviour-based characteristics (e.g., blushing, sounding stupid/boring, walking 'weirdly,' etc.). In response to this fear, individuals with SAD develop a mental representation, an

image, of how they believe they are being perceived by the audience. This illusory image of the audience is then compared to a mental representation of how they perceive themselves. For instance, internal physiological sensations like feeling warm may conjure a mental image of the self, such as "*I'm sweating*," which results in the belief that the audience not only observes this but is judging them as well "*others think that I'm anxious because they can see me sweating*."

According to Rapee and Heimberg's model, an extensive allocation of attentional resources is used by individuals with SAD to make these erroneous conclusions. Beginning with attention, individuals with SAD will monitor their environments and scan for potential signs of negative evaluation. External cues like signs of boredom or facial expressions (e.g., frowns) are biasedly fixated on, while potentially disconfirming cues like observing a smile in an observer may be disregarded or go unnoticed. These perceived indicators of negative evaluation, among other sources of information, are used to form a mental representation of the self as seen by their feared audience. For instance, a person with SAD may think to themselves "*That [facial] expression means I look stupid*." Comparisons between their manufactured mental image and the perception of the audience's high social standards for performance are drawn, resulting in significant distress. The experienced distress is particularly marked because of the overestimation of social cost attributed to them, such as viewing past interactions as "failures." To regulate the distress that comes with such experiences, individuals with SAD will engage in subtle avoidance, such as avoiding eye contact or speaking in a low tone. Consequently, these safety behaviours reinforce the individual's erroneous mental representation of the self and perpetuate the need to look out for other signs of negative evaluation in an attempt to avoid future social 'failures.' For these reasons, Heimberg, Brozovich and Rapee (2010) argue that attentional biases towards threat cues are not

only a crucial starting point to this negative cycle but play a causal role in the maintenance of the disorder as well.

1.4 Attentional Biases in SAD

Attentional bias is an important perceptual and cognitive construct that has been widely studied in a variety of disorders (Bar-Haim et al., 2007). First studied among individuals with major depressive disorder, researchers found that participants displayed enhanced recall for, and selectively attended to, mood-congruent material more quickly than competing stimuli (Bradley et al., 1997; MacLeod et al., 1986). In anxious individuals, like those with SAD, attentional biases are thought to be cognitive processes that favour threat-related material. Beginning with stimulus encoding, individuals with SAD preferentially allocate attentional resources to threatening stimuli (e.g., angry facial expressions), remember them more saliently, and interpret them more negatively (Taylor et al., 2016). Tasks like the emotional Stroop task (MacLeod, 1991), dot-probe paradigm (MacLeod et al., 1986), emotional spatial cueing (Fox et al., 2001), and visual search paradigms (Gilboa Schechtman et al., 1999), have all been used to evaluate different mechanisms of attentional bias (Bar-Haim et al., 2007). Although each of these tasks has been heavily studied and critiqued for their poor validity and conflicting results, there is an overarching consensus that individuals with SAD demonstrate an attentional bias towards socially threatening stimuli (Bar-Haim et al., 2007; Machado-de-Sousa et al., 2010).

A systematic review by Bantin and colleagues (2016) found that using word stimuli in dot-probe and Stroop tasks to be an ineffective way of assessing attentional biases in SAD. Conversely, naturalistic stimuli like emotional facial expressions are much more salient and potent at conveying threatening information. The rapidity with which facial information can be processed also makes using emotional facial expressions a valid method for assessing bottom-up attentional processing

(Bantin et al., 2016; Bar-Haim et al., 2007). In Bantin et al. (2016), the authors highlight that individuals with clinically significant social anxiety and SAD attune to threatening stimuli (e.g., fearful/negative facial expressions) more quickly than neutral and positive emotional facial expressions. The significantly shorter reaction times towards these stimuli were moderated by the duration of the displayed emotional facial expression. Participants were especially vigilant towards these stimuli when presented briefly (<200 ms). However, attuning to a stimulus quickly does not mean that an individual understands what is being presented before them. Quick and biased processing of others' negative emotions can result in emotion recognition misinterpretations. Assessing emotion recognition accuracy rates is one of the most effective methods for evaluating whether facial expressions are being correctly interpreted.

1.5 Overview of Emotional Facial Expression Recognition (FER)

Emotion processing involves the perception, recognition, identification, and experience of emotions. The abilities to display and understand expressions of emotion benefit social functioning as they facilitate communication in social interaction (Plutchik, 2001). A fearful facial expression, which is prototypically conveyed through widened eyes, is an adaptive behavioural response to signal a threat. Similarly, a facial expression of disgust, normatively characterized by a wrinkled nose and raised upper lip, can signal the presence of a poisonous or toxic stimulus (Shariff & Tracy, 2011). Accurately recognizing facial expressions of emotion is, therefore, an evolutionarily adaptive skill necessary for avoiding potential danger (Darwin, 1872; Keltner et al., 2019). In social contexts, these dangers include aversive experiences like rejection (Clark & Wells et al., 1995), which can result in isolation and feelings of loneliness (Masi et al., 2011). Thus, accurately recognizing emotional facial expressions is a key component of approaching and fostering interpersonal relationships (Gutierrez-Garcia & Calvo, 2016; van 't Wout & Sanfey, 2008).

Evaluating emotion recognition accuracy has primarily been conducted through forced-choice paradigms. In many studies, observers are presented with a select number of images displaying some or all of six basic emotions (i.e., anger, disgust, fear, happiness, sadness, and surprise; Ekman, 1972) and asked to categorize the photographs according to their respective group. Through these tasks, researchers can assess whether an emotion was correctly identified through hit rates, whether it was misinterpreted as another emotion via error rates and the speed at which they made this decision with reaction time (Calvo & Lundqvist, 2008). For instance, Calvo and Lundqvist (2008) assessed the impact of stimulus duration on accuracy, error rates and reaction times in a normative group of undergraduate students. Students were asked to select the written word that best characterized the six (including neutral as a seventh) emotional facial expressions displayed on a computer screen. In this two-part study, participants were initially provided with unlimited viewing time of the stimuli. In the latter part, a separate group of undergraduate participants were asked to repeat the emotion recognition task, but with stimuli presented at durations of 25, 50, 100, 250, and 500 ms. Across both studies, Calvo and Lundqvist (2008) found that happy and neutral facial expressions were recognized the most accurately and quickly, with the least number of errors regardless of the stimulus duration. Anger was the emotion with the third-best accuracy rates, though miscategorized as disgust when rated incorrectly (and vice versa). Fearful and surprised faces were categorized the least accurately across all stimulus durations and often miscategorized for one another. Although these results have been observed in many studies with a normative sample (Nelson & Russell, 2013), differing patterns have been observed among populations with clinically significant social anxiety and SAD.

1.6 FER Correlates in Social Anxiety

A number of studies have published conflicting results regarding whether individuals with SAD or high-trait social anxiety exhibit difficulties recognizing emotional facial expressions (Kleberg et al., 2019; Klumpp et al., 2013; Xing et al., 2020). Mixed results concerning whether these observed deficits are global, emotion-specific, or exist at all justify further investigation. To illustrate, Tseng and colleagues (2017) found that individuals with SAD demonstrated global emotion recognition deficits. When collapsing happy, sad, angry, and fearful expressions together, the authors found that individuals with SAD had lower accuracy rates compared to healthy controls. Only for fearful expressions did individuals with SAD demonstrate lower accuracy rates and longer reaction times compared to the control group. Meanwhile, several other researchers have found no global or emotion-specific recognition differences between SAD and healthy controls (Binelli et al., 2015; Demenescu et al., 2013; Kleberg et al., 2019; Klumpp et al., 2013; Melfsen & Florin, 2002; Mohlman et al., 2007; Straube et al., 2004).

Another point of confusion in the literature regards which emotional expressions tend to get miscategorized. Although the methodologies and stimuli used across a vast number of studies investigating this topic are quite similar, primarily comprised of forced-choice paradigms using validated facial stimuli databases, differing results are nonetheless reported. While some researchers have found that individuals with SAD display deficits primarily for negative (Oh et al., 2018; Xing et al., 2020), and neutral expressions (Oh et al, 2018), others have found that it is happy facial expressions that are processed inaccurately (Ran & Chen, 2017). The confusion imparted by these mixed results suggests that a comprehensive review of the literature is warranted. A deeper and more comprehensive analysis of the past literature summarizing this topic can be found in the introductory section of Chapter 2.

1.6.1 Summary and Research Aims

Individuals with SAD demonstrate a combined hypervigilance-avoidance behavioural pattern towards various emotional facial expressions (Gomes e Claudino et al., 2019; Günther et al., 2021). However, the extent to which behavioural pattern influences emotion recognition abilities is unclear. The lack of consensus regarding whether these purported deficits occur with specific emotions, globally across emotions, when compared to a normative sample, or within subjects, warrants further investigation. It is also unclear whether sample or stimulus characteristics, such as comorbidity or stimulus duration, influence the relationship between SAD and FER.

The work presented in Chapter 2 addresses these questions by systematically reviewing the literature on SAD and emotion recognition. The goal of this study was to focus on meta-analysing behavioural outcome metrics (i.e., accuracy and reaction time) to get a better understanding of emotional facial processing in this population. The present study only included studies comprising samples of individuals with a primary diagnosis of SAD or clinically significant symptoms based on validated self-report measures. The findings from this study improve our understanding of whether there are any significant emotion-processing deficits among those with SAD. Conducting this research as an initial study was a necessary first step to help conceptualize future research directions and guide our investigation into what other factors may be impacting emotion recognition abilities.

1.7 The Consequences of Gaze Avoidance

Gaze avoidance of crucial parts of the face (i.e., face and mouth) is a common safety behaviour among those with SAD. Safety behaviours, such as avoiding eye contact during social interactions, are used with the intention to avoid feared outcomes from a social situation (e.g.,

negative evaluation) and to relieve short-term distress. However, their use can cause significant impairment in social functioning (Clark, 2001; Thwaites & Freeston, 2005) and exacerbate social anxiety symptoms (Moscovitch et al., 2013). Avoiding eye contact and failing to attend to other regions of the face during social interactions limits the ability to accurately determine whether an emotional facial expression is truly negative. Engaging in such avoidance strategies also prevents individuals with SAD from testing their negative predictions (e.g., "*that expression means I am stupid*") and learning new information (Clark et al., 2001; Heimberg et al., 2010), thus perpetuating the belief that they are being negatively evaluated (Günther et al., 2021).

Furthermore, the social consequences of engaging in safety behaviours when entering social situations can also be quite adverse. Eye contact is a key nonverbal social skill that facilitates appropriate and effective interactions (Segrin & Givertz, 2003). Clark (2001) and others argued that actively utilizing safety behaviours when interacting can impact social skills, making individuals with SAD less appealing to others (Rapee & Heimberg, 1997; McManus et al., 2008). Poor eye contact among other safety behaviours used during in-person social interactions may project an impression of distance or disinterest to other people (Alden & Taylor, 2004; Rapee and Heimberg, 1997). The unintended effects of this serve as a self-fulfilling prophecy whereby others may interpret the behaviours of those with SAD as being less friendly (Curtis & Miller, 1986; McManus et al., 2008). This negative feedback then reinforces the belief that they are socially inept, lack social skills and must therefore continue utilizing their safety behaviours (Ashbaugh et al., 2005; Hofmann, 2007; McManus et al., 2008).

To date, the majority of the research investigating the consequences of poor eye contact and other social skill deficits in SAD has been conducted in the context of in-person social interactions. It is unclear at this point in time whether eye contact and other social skills would

improve in online interactions. Investigating this is important as it can have implications for emotion recognition abilities. Decreased reliance on avoidance during social interactions may provide individuals with SAD the opportunity to process emotional facial expressions for longer durations, possibly yielding more accurate interpretations. Chapter 3 of this thesis explores whether perceived social skill abilities, including emotion decoding, change as a function of in-person or online communication mediums.

1.8 Communication Mediums and SAD

A recent systematic review highlighted that socially anxious individuals prefer to communicate through technology-mediated platforms (O'Day & Heimberg, 2021; Weidman et al., 2012). O'Day and Heimberg (2021) found that individuals with social anxiety use online platforms like social media more intensely and frequently than non-anxious individuals. Consistent with these findings, several studies report that online modalities are preferred by those with social anxiety due to the increased ability to control self-presentation (Madell & Muncer, 2006) and enhanced sense of perceived safety (Kamalou, Shaughnessy & Moscovitch, 2018; McKenna & Bargh, 2000). Communicating through online platforms is equally attractive because of the many self-concealment features available, such as the use filters, asynchronous options, and the opportunities for anonymous interactions (Kamalou, Shaughnessy & Moscovitch, 2018). However, the *function* for using technology-mediated communication is unclear. Some researchers argue that communicating online is less socially threatening and therefore serves as a safety behaviour (Lee & Stapinski, 2012). Others have argued that a greater sense of mastery in social skill abilities in online contexts motivates the use of technology-mediated communication (Caplan, 2005). The research investigating these questions is quite limited.

One recently developed measure by Mantzouranis and colleagues (2019), titled the *Real and Electronic Communications Skills Questionnaire* (RECS), investigated whether particular social skill abilities vary across in-person and online contexts in a normative young adult sample. A principal components analysis and confirmatory factor analysis revealed that a 36-item, four-factor model, comprised of the factors *sociability*, *self-disclosure*, *assertiveness*, and *emotion expression decoding* best captured the global social skill abilities construct.

No research to date has investigated whether perceived social skill abilities are influenced by communication context in a sample of socially anxious individuals. Assessing this in a sample with SAD or high-trait anxiety is important because these individuals have increased difficulty with approaching social interactions (Clark & Wells et al., 1995), disclosing information about themselves (Green et al., 2016), asserting themselves (Caballo et al., 2014), and accurately recognizing various facial expressions (Lacombe et al., 2023). This research question is pointedly addressed in Study 2 of this thesis, whereby individuals with high-trait social anxiety are asked to self-evaluate whether these various social skill abilities differ across communication contexts.

1.9 Social Skill Abilities

Individuals with SAD and high-trait social anxiety often perceive themselves to have poor social skills (Segrin & Kinney, 1995). On self-report measures, individuals with social anxiety consistently rate themselves as having lower verbal and non-verbal communication abilities, and difficulties appearing socially adept and confident (Ashbaugh et al., 2005; Riggio, 1986; Stopa & Clark, 1993; Hofmann, 2007). In Stopa and Clark (1993), the authors asked individuals with SAD to engage in a brief video-recorded conversation with a confederate. Compared to anxious and non-anxious control groups, those with SAD rated themselves as engaging in significantly less positive behaviours (e.g., friendly, self-assured, warm) and more negative behaviours (e.g.,

blushing, hands shaking, awkward) during the conversation task. Similar results were also reported among non-clinical samples of individuals with high-trait social anxiety (Ashbaugh et al., 2005). Not surprisingly, Moscovitch and colleagues (2013) found a positive correlation between self-portrayal concerns and safety behaviour use. The authors highlighted that socially anxious individuals with higher self-portrayal concerns (e.g., worries about stuttering, sweating, etc.) in social situations made greater use of safety behaviours.

However, the evidence regarding whether socially anxious individuals truly have a social skills deficit is mixed. Ashbaugh and colleagues (2005) asked high and low socially anxious groups to give a speech and evaluate their perceived performance. These video-recorded speeches were then evaluated by an independent observer who was blind to the study purpose. The authors found that observers rated the high social anxiety group as having a significantly worse performance and presenter impression (e.g., appeared incompetent) and displayed significantly greater overt signs of anxiety. Although other studies using comparable methodologies have also found similar results (Stopa & Clark, 1993), others have found that social skill abilities do not differ from control groups (Clark & Arkowitz, 1975). As a result, researchers have sought to investigate under what contexts verbal (i.e., emotional expressivity) and non-verbal (i.e., emotional expression sensitivity) social skill abilities tend to suffer (Riggio & Carney, 2003).

Hofmann (2005) argues that it is exclusively in social situations that these deficits come to light. However, other variables that may be impacting this relationship need to be explored to better understand this issue. To date, much of the research investigating the relationship between SAD, safety behaviours, and perceived social skill deficits has been done in the context of *in-vivo* or in-person interactions. This is problematic given that we live in an era where communicating via online platforms has become the norm (Kamalou et al., 2019). As a result, one must wonder what

impact this may be having on verbal and non-verbal communication abilities in populations with social anxiety.

1.9.1 Summary and Research Aims

An abundance of research has established that individuals with social anxiety perceive themselves to have worse social skill abilities in in-person contexts (Ashbaugh et al., 2005; Riggio, 1986; Stopa & Clark, 1993; Hofmann, 2007). Their beliefs about their social aptitudes influence the use of safety behaviours (Moscovitch, 2013). Over the years, researchers have also observed that individuals with SAD comparatively prefer to communicate through online platforms (Kamalou, Shaughnessy & Moscovitch, 2018; O'Day & Heimberg, 2021). However, very little research to date has investigated the relationships between perceived social skill abilities and communication medium.

The research presented in Chapter 3 evaluates the interactions between communication context (in-person, online) and social skill abilities in a group of socially anxious individuals. This work aimed to assess whether individuals with high-trait social anxiety and SAD perceive themselves to have better verbal and non-verbal abilities in certain environments. The findings from this study should give us insight into the functional use of various communication mediums among this population. Understanding whether specific modalities are being used because of a perceived sense of mastery, or as a safety behaviour can help guide treatments.

1.10 State Anxiety and SAD

Regardless of the modality used when interacting with others, individuals with social anxiety experience significant fear of negative evaluation when approaching social situations (O'Day & Heimberg). As such, individuals with social anxiety often enter social situations in a state of high arousal. This increased arousal is often characterized by multiple distress-related

physiological signs including increased heart rate and heart rate variability, and elevated skin conductance levels (Schulz et al., 2008).

Researchers have been able to influence state anxiety levels in socially anxious populations through various creative experimental designs. State anxiety is often manipulated through mood induction paradigms, where researchers have used conversation tasks with a trained confederate to activate fears of negative evaluation (Ashbaugh et al., 2005; Kelly-Turner & Radomsky, 2020; Ferguson et al., 2023; Stopa & Clark, 1993). During these tasks, participants are informed that they can expect to interact with another participant or lab member (i.e., the trained confederate) at some point throughout the study. To maximize the efficacy of mood induction paradigms, confederates may be trained to appear cold and uninterested (Kelly-Turner & Radomsky, 2020), or to leave long pauses in conversations (Stopa & Clark, 1993). Similarly, participants may be informed that their conversations will be recorded and evaluated (Ferguson et al., 2023; Stopa & Clark, 1993), which may also elevate rejection or judgment-related fears.

To assess state anxiety, subjective measures like the Subjective Units of Distress Scale (Wolpe, 1958) are generally administered prior to, and after engaging in, the mood induction procedure. Significant increases in anticipatory and post-mood induction distress from baseline largely suggest that state anxiety was successfully raised. Increased state anxiety among a population with high-trait social anxiety has been associated with a higher intensity of negative cognitions (Schulz et al., 2008), decreased eye contact (Howell et al., 2015), and avoidance of negative emotional facial expressions (Singh et a., 2015). In non-anxious samples, state anxiety has also been shown to impact emotional facial recognition abilities (Attwood et al., 2017; Dyer et al., 2021; Schmidt & Mast, 2010; Manierka et al., 2021).

1.11 State Anxiety and FER

Emotion processing theories like the Emotions as Social Information (EASI) model suggest that emotional facial expression recognition is influenced by the affective state of the observer (van Kleef & Côté, 2022). Authors van Kleef and Côté (2022) argue that observers interpret emotional expressions based on their *own affective reaction* to the expressor. Therefore, an individual entering a social interaction in an anxious state may make biased assumptions when interpreting the expressors emotion. Through experimental paradigms, researchers have been able to influence a participant's state anxiety and observe its impact on emotion recognition abilities. Dyer and colleagues (2021) directly manipulated state anxiety in healthy participants by altering carbon dioxide (CO_2) intake concentrations. Elevated CO_2 concentrations have previously been shown to induce physiological symptoms of autonomic arousal (i.e., increased systolic blood pressure and heart rate), and have been positively correlated with subjective anxiety and fear (Bailey et al., 2005). Using this approach, Dyer et al. (2021) observed that increases in state anxiety, as opposed to trait anxiety, led to global emotion recognition deficits. Other researchers using the same CO_2 paradigm found comparable results (Attwood et al., 2017). Attwood and colleagues (2017) found that inducing state anxiety in healthy adults not only led to an overall decrease in emotion recognition accuracy but was also associated with a greater bias towards interpreting facial expressions as angry. Similar to previous studies (Cooper, Rowe & Penton-Voak, 2008; Dyer et al., 2021), Attwood et al. (2017) found no relationship between trait anxiety and emotional facial recognition.

The authors Attwood et al. (2017) and Dyer et al. (2021) argue that their results have important implications for understanding the relationship between emotion recognition deficits and anxiety disorders. The authors report that in addition to having high trait anxiety, individuals

with anxiety disorders experience multiple intense surges of state anxiety throughout the day, which may be impacting their ability to accurately recognize emotional facial expressions.

1.11.1 Correlates of State Anxiety, SAD, and FER: Summary and Research Aims

Few studies have investigated the relationships between state anxiety and emotion recognition in a sample of individuals with social anxiety. Mullins and Duke (2004) conducted an emotion recognition task using four different mood induction procedures. To induce state anxiety, the authors randomly assigned participants with high-trait social anxiety to either an observer condition, a presentation condition, an observer plus presentation condition, or a control condition. In the observer condition, participants completed the emotion recognition task while a confederate stood beside them to "monitor their progress." In the presentation condition, participants were informed that they would need to prepare and present a 5–7-minute speech to two psychology faculty members before completing the experimental task. In the final threatening condition, participants were both asked to prepare a speech and have a confederate watch them complete the emotion recognition task. Mullins and Duke (2004) observed that although the presentation conditions effectively increased state anxiety, they did not impact emotion recognition abilities for either positive or negative emotions. However, the authors did find a significant effect of state anxiety on reaction times. Under social threat conditions, participants were quicker to recognize negative emotional facial expressions. Similar results were also observed by Leber et al. (2009) who employed the same speech-preparation mood induction paradigm. Leber and colleagues (2009) found that although participants with high social trait anxiety were quicker to classify negative facial expressions under the social-threat condition, state anxiety did not influence error rate classification.

A particular limitation with both of these studies is that the authors only assessed post-mood induction emotion recognition accuracy rates. As such, no conclusions could be made about how accuracy rates *change* as a function of state anxiety. Additionally, both studies used similar mood induction procedures and found no impact on emotion recognition rates (Leber et al., 2009; Mullins & Duke, 2004).

The research presented in Chapter 4 investigates the impact of state anxiety on emotion recognition abilities in a sample with high trait social anxiety. The goal of this work was to implement a pre-post design to directly observe how emotion recognition abilities change as a result of state anxiety. We aimed to alter state anxiety by implementing the conversation task with a confederate, which has been adapted from Stopa and Clark (1993). This project also adds to the literature by not only assessing accuracy rates but also other outcome measures like perceived emotional saliency and intensity. In doing so, we will also be able to obtain a greater appreciation for how emotional expressions are recognized and interpreted among this population.

1.12 The Costs of FER Deficits in SAD

Individuals with SAD experience significant distress in their daily lives; they are at risk of experiencing less satisfaction and greater impairment in establishing relationships (Stentz & Couple, 2022). Their prominent fear of negative evaluation in social situations increases their chance of facing isolation and loneliness (Masi et al., 2011; Meltzer, 2013). In the past decade, an abundance of research has found that perceived loneliness is a significant risk factor for developing chronic inflammatory conditions, cardiovascular disease, and premature mortality (Eisenberger & Cole, 2012; Holt-Lunstad, 2021). As such, efforts need to be made to help understand the factors rendering individuals with SAD vulnerable to such experiences.

Comprehensive cognitive models of SAD have identified safety behaviours and negative attentional biases to threat stimuli as maintaining factors of the disorder (Clark & Wells, 1995; Rapee & Heimberg, 1997). Among these threatening stimuli are emotional facial expressions (Rapee & Heimberg, 1997). The ability to rapidly identify a threatening facial expression adaptively signals whether to approach or avoid what could be a costly interaction. Therefore, quick and preferential attention to threat cues is an evolutionary advantage (Dyer et al., 2021). However, this system goes askew when there is a hyper-sensitivity to threat cues. Hypervigilance of threat cues leads to biased interpretations. For instance, individuals with social anxiety demonstrate a greater sensitivity towards angry and disgust facial expressions (Gutierrez-Garcia & Calvo, 2017). This interpretive bias becomes even more problematic when coupled with avoidance.

Avoiding crucial areas of the face like the eyes and mouth significantly interferes with the ability to accurately recognize emotional facial expressions (Günther et al., 2021). Researchers have found that individuals with high trait social anxiety avoid eye contact regardless of the emotion expressed (e.g., positive, neutral, negative). Therefore, avoiding eye regions may not only bias emotion recognition to reinforce negative beliefs but may also limit the ability to recognize positive social cues (e.g., smiles) (Howell et al., 2015). This negative cycle not only perpetuates distress but keeps the disorder stable over time (Rapee & Heimberg, 1997).

Through this thesis, we hope to provide clarity on the relationship between emotional expression processing and social anxiety. Understanding whether individuals with SAD have emotion recognition deficits, and what factors may be influencing this relationship, will not only help us build on already existing models of SAD but hopefully help guide treatment as well.

1.13 Treatments in SAD

The most widely recognized treatment for SAD is Cognitive Behavioural Therapy (CBT; Warnock-Parkes et al., 2020). In line with Clark and Wells (1995) cognitive model, CBT aims to alleviate emotional distress by identifying and testing negative beliefs through behavioural experiments, other-focused attention training, and the elimination of safety behaviours (Warnock-Parkes, 2020). To illustrate, an individual who fears coming across as 'boring' and predicts that others will roll their eyes in conversation may avoid eye contact and keep their head down. To test this prediction, a facilitator may suggest a behavioural experiment where the individual maintains eye contact and purposefully discusses something mundane (e.g., house chores). Once tested, an individual can learn that their prediction was incorrect, feel less anxious, and a more adaptive interpretation of the situation can be considered (example adapted from Warnock-Parkes et al., 2020). CBT is therefore an effective treatment for modifying conscious thoughts and reducing unhelpful safety behaviours. However, despite being a first-line treatment (Yang et al., 2019), CBT post-treatment remission rates continue to be high (Loerinc et al., 2015; Springer et al., 2018). In a recent meta-analysis, Bandelow and colleagues (2018) found that 48% of patients continue to be symptomatic in as little as two years post-therapy. One possible explanation for these high remission rates is that CBT fails to address other factors that may be maintaining the disorder over time.

Attentional biases to threat cues like emotional facial expressions are another maintaining factor of SAD (Rapee & Heimberg, 1997, Wong & Rapee, 2016). However, treatments altering attentional biases in this population are less commonly researched and used in clinical settings. Cognitive Bias Modification (CBM) training techniques have been used to alter a range of biases, including attention, interpretation, and memory of various cues (Adams et al., 2013). For instance,

Rapee, MacLeod and others (2013) implemented a CBM procedure into a standard CBT protocol to retrain attention allocation away from threatening stimuli in a sample of individuals with SAD. In this study, the authors used a dot-probe paradigm and instructed participants to redirect their attention away from socially threatening words (e.g., foolish) towards neutral words (e.g., pillow). To date, CBM procedures have almost exclusively used word stimuli to alter attentional biases and have found mixed results (Cristea et al., 2015). Although Rapee et al. (2013) found no additional benefit to implementing CBM to standard CBT, others have found that CMB training has reduced attentional biases to threatening stimuli and reduced social anxiety symptom severity (Amir et al., 2009). One possibility for these mixed results is the use of word stimuli.

A key component of emotion processing is the recognition of emotional facial expressions. Even though faces and facial expressions alike are encountered regularly and are a crucial feature of interpersonal interactions, CBM procedures using facial stimuli are extremely limited. To date, two randomized control trials have implemented a CBM procedure using emotional facial expressions (Penton-Voak et al., 2020; Rawdon et al., 2018). In Rawdon et al., (2018), a group of adolescents with high-trait anxiety were provided with four training sessions while asked to categorize images of happy and disgust emotional facial expressions. On each trial, participants were provided feedback and informed as to whether the image was correctly categorized. The authors found that at a two-week follow-up, participants who received the training were more likely to categorize ambiguous faces as happy as opposed to disgusted. Although a shift in emotion recognition bias was observed, the training did not appear to influence social anxiety severity according to self-report measures. A similar protocol was implemented in a group of individuals with high depressive symptoms. Penton-Voak and colleagues' (2020) participants were asked to categorize a series of happy, fearful, and sad facial expressions to their respective groups. The

authors found that, although depressive symptoms did not decrease, the CBM intervention significantly reduced negative emotion recognition bias at a 6-week follow up (Penton-Voak et al., 2020). However, the results of two studies are insufficient to determine whether CBM procedures yield any clinical utility. Future research is needed to understand whether emotion recognition training would benefit clinical samples and populations with attentional biases to negative facial expressions, such as those with SAD and high-trait social anxiety.

In addition to investigating whether new interventions may benefit those with SAD, factors that impact the accurate appraisal of facial expressions similarly need to be considered when conceptualizing barriers to effective therapeutic outcomes. Emotion dysregulation or emotional states marked by high distress influence whether one approaches or avoids a situation, how attention is allocated, how information is appraised, and how one responds to a given situation. When experiencing states of emotional distress, individuals with SAD may unintentionally allocate attention towards more socially threatening stimuli and draw catastrophic conclusions (e.g., viewing ambiguous faces as threatening). As such, employing emotion regulation strategies may allow those with SAD to reframe the meaning of stimuli that generate such an emotional reaction. Cognitive and mindfulness-based strategies (e.g., perspective-taking, challenging interpretations, present-moment attentional focus) have been shown to effectively and reliably decrease state anxiety and improve emotional reactivity (Jazaieri et al., 2015). In a study by Doll and colleagues (2016), participants were instructed to practice mindfulness in 20-minute blocks, daily for two weeks. After two weeks of training, participants were presented with negative aversive stimuli and asked to regulate their emotions using the learned mindfulness practice. The authors found that participants who underwent mindfulness training rated the aversive images less negatively (Doll et al., 2016). Although the impact of these strategies on emotion recognition

abilities has not been explored, emotion regulation can reduce fear, avoidance of negative stimuli, and improve meaning making (Doll et al., 2016; Jazaieri et al., 2015), all of which may improve the ability to accurately recognize emotions.

A considerable barrier to obtaining support among those with SAD is the modality through which care is accessed. O'Day and Heimberg (2021) note in their systematic review that individuals with social anxiety will preferentially seek support through online modalities. Various features of technology-mediated communication (TMC) platforms render their use attractive as it reduces perceptions of social threat and state anxiety (Kamalou et al., 2019; McKenna & Bargh, 2000). Similarly, some research suggests that individuals with SAD perceive themselves to be more socially competent when using TMC (Moscovitch & Huyder, 2011). Whether individuals with SAD use TMC because they feel less distressed or because they feel more confident in their social skill abilities, both can positively influence emotion recognition and in turn, possibly influence SAD prognosis.

Particularly since the global COVID-19 pandemic, great strides have been made in researching the efficacy of virtual therapy options on various mental health disorder outcomes. Warnock-Parkes and colleagues (2020) developed an in-depth protocol for virtually-delivered cognitive therapy for SAD. In follow-up studies, Leigh and Clark (2023) found that a 14-week online cognitive therapy delivered to adolescents was effective at significantly reducing social anxiety severity compared to waitlist controls. Among the 22 adolescents who initially met DSM-5 criteria for SAD and received treatment, 77% no longer met diagnostic criteria at the 6-month follow-up. Similar results have been found in replication studies (Vagos et al., 2023) and when using other evidence-based interventions like virtual exposure therapy (Arnberg et al., 2014;

Bouchard et al., 2017; Kampmann et al., 2016). Clearly, TMC can be beneficial for groups of individuals with SAD or high-trait anxiety.

In summary, multiple factors influence treatment efficacy in SAD. Through this thesis, we explore one such factor that, according to Rapee and Heimberg (1997), may be maintaining the symptoms of the disorder over time. By focusing on emotional facial expression recognition, a comparatively understudied field in the SAD literature, we will be able to hopefully further refine current models, generate new discussions and ideas, and encourage new avenues for future research. As such, this thesis examines not only the relationship between SAD and FER, but other variables like communication mediums and state anxiety, which may also be influencing this relationship.

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CHAPTER 2: STUDY 1

The Impact of Social Anxiety Disorder on Emotional Expression Recognition: A Meta-Analysis

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2.1 Abstract

Impaired processing of emotional expression recognition (EER) has been theorized to be a maintaining factor of social anxiety disorder (SAD). However, the evidence suggesting a decreased ability to recognize emotional facial expressions in this population is mixed. We performed a systematic review and meta-analysis investigating the relationship between SAD and EER. We included English peer-reviewed full-text articles with (1) a primary diagnosis of SAD, (2) an EER task using a validated face database, and (3) accuracy and/or reaction time as outcome measures. Risk of Bias was assessed using the RoBANS, and results were synthesized using Comprehensive Meta-Analysis. The literature search took place between April 17, 2020 to January 26, 2022. Sixteen articles (*N*=788) were selected from a search of six databases. EER was assessed through accuracy and reaction time, with stimulus duration and comorbidity considered as moderators. Our results indicate that individuals with SAD may have difficulty recognizing emotional expressions overall, and when presenting with a comorbidity demonstrate poorer performance at recognizing happy facial expressions. Individuals with SAD also take a greater amount of time to recognize happy facial expressions. Our results suggest that individuals with SAD demonstrate poorer performance in accurately recognizing various expressions, such as happy facial expressions. Given the narrow aim of this study, some results are underpowered.

Keywords: Social anxiety disorder, emotion recognition, emotional expressions, systematic review, meta-analysis

The Impact of Social Anxiety Disorder on Emotional Expression Recognition: A Meta-Analysis

2.2 Introduction

Social anxiety disorder (SAD) is among the most prevalent anxiety disorders, with lifetime prevalence rates ranging from 12 to 16% (Stein et al., 2017) characterized by the fear of social situations where individuals believe they may be scrutinized or negatively evaluated by others (APA, 2013). Social situations cause significant distress and impairment in functioning and may be endured with anxiety or avoided altogether (Spence & Rapee, 2016).

Cognitive models suggest that fear of negative evaluation and judgement by others can lead to excessive monitoring of potential threat cues (Rapee & Heimburg, 1997; Spence & Rapee, 2016). This type of monitoring is known as *negative attentional bias* (Wong & Rapee, 2016). A review by Wong and Rapee (2016) suggested that a negative attentional bias to social evaluative threats is a key maintaining factor of SAD. A social evaluative threat is a stimulus that is judged to indicate a form of negative evaluation. Prominent among these stimuli are negative (e.g., angry or disgusted expressions) and ambiguous (neutral) facial expressions (Cooney et al., 2006; Wong & Rapee, 2016). Bantin and colleagues' systematic review (2016) investigating attentional biases to emotional facial expressions via the dot-probe paradigm found individuals with SAD to be more vigilant regarding negative emotional expressions. When presented with negative-neutral facial expression pairings, individuals with SAD responded more quickly in threat-congruent trials compared to incongruent ones. This effect was not found among control participants nor across positive-neutral pairings (Bantin et al., 2016).

Attentional biases towards threatening and ambiguous facial expressions have also been captured through psychophysiology studies. In a recent meta-analysis, Günther and colleagues

(2021) found that individuals with SAD exhibit heightened attention allocation towards angry faces, followed by gaze aversion of the eye region. These results support previous reviews, which have also found a combined hypervigilance-avoidance behavioural pattern towards emotional facial stimuli (Gomes e Claudino et al., 2019). However, Günther and colleagues (2021) highlight that this eye-movement pattern is observed in the early processing stages. Avoiding critical regions of the face, like the eyes, in the early stages of processing may explain emotion misidentification and categorization errors. Individuals who focus their attention on the top half of the face (eye region) have been shown to categorize sadness, anger, and fear more accurately. In contrast, a tendency to fixate on the lower half of the face (mouth region) has been associated with poorer emotional expression recognition (EER) of negative emotions (Beaudry et al., 2014; Yitzhak et al., 2020). Cooney and colleagues (2006) also found that neutral faces are processed differently among individuals with SAD. Using event-related functional magnetic resonance imaging (fMRI), the authors observed that individuals with SAD experience greater right amygdala activation when viewing neutral facial expressions. Increased right amygdala lateral activation has previously been positively correlated with enhanced state anxiety (as cited in Cooney, 2006).

Assessing whether an attentional bias to negative emotions extends to poor emotion categorization is imperative because accurately recognizing emotional facial expressions is crucial for communication in social interaction (Plutchick, 2001; Rapee & Heimburg, 1997). Through EER, individuals can infer others' internal states and feelings (Calvo & Nummenmaa, 2016) and appraise the presence of social threats, like negative evaluation (Günther et al., 2021). Safety behaviours like gaze avoidance, which inhibits the correct appraisal of emotional facial expressions, can be addressed in psychotherapy (Günther et al., 2021). Integrating attention modification training into cognitive behavioural therapy has been shown to effectively reduce

attention biases toward threatening stimuli among individuals with anxiety disorders (Hang et al., 2021). However, no studies to our knowledge have evaluated the impact of attention modification training on emotion categorization. Therefore, synthesizing the literature to assess whether deficits in EER are present may allow us to explore future avenues for treatment.

The current meta-analysis is also warranted by the heterogeneity of the existing literature. There is conflicting evidence regarding whether individuals with SAD show impaired abilities in emotion categorization tasks (Kleberg et al., 2019; Klumpp et al., 2013; Xing, Fitzgerald, & Klumpp, 2020). This conflicting evidence may be due to a lack of uniformity across studies. For instance, individuals with SAD often present with comorbidities like depression or other anxiety disorders, which have also been associated with poor EER (Dalili et al., 2015; Demenescue et al., 2010; Gray et al., 2020). There are also inconsistencies in experimental factors—such as stimulus duration and the number and type of emotional expressions presented to participants. Investigating the impact of these factors will allow us to better understand the relationship between social anxiety disorder and EER. No systematic reviews or meta-analyses have examined whether individuals with SAD show impaired behavioural performance in categorizing facial expressions of emotion or what factors may contribute to such an impairment.

The goal of the current systematic review and meta-analysis was thus three-fold: First, we aimed to synthesize existing literature on EER and SAD by reviewing the behavioural data (accuracy and reaction time) from facial expression categorization tasks. In doing so, we sought to determine to what degree individuals with SAD can accurately and efficiently categorize facial expressions of emotion. Investigating these outcome measures will further our knowledge of the relationship between SAD and attention toward emotional facial expressions. Accuracy measures provide an index of voluntary attention, while reaction time measures provide an index of

involuntary attention (Prinzmetal et al., 2005; van Ede et al., 2012). Second, we sought to assess to what degree such differences in performance might vary across the various emotional expressions. Third, we aimed to evaluate whether covariates such as mental health comorbidity and stimulus duration moderate the relationship between performance in EER and SAD.

Taking into consideration the findings from the reviews above and keeping in mind the hypervigilance-avoidance effect, we formulated the following two hypotheses: (1) individuals with SAD will demonstrate hypervigilance through faster reaction times for negative/threatening (e.g., angry) emotional expressions compared to controls; (2) individuals with SAD will have lower accuracy rates leading to an overall deficit in the ability to correctly categorize facial expressions of emotion compared to controls. We did not predict any differences in reaction times for non-threatening emotional expressions between individuals with SAD and the control group.

2.3 Method

2.3.1 Protocol and Registration

The proposed review and meta-analysis were tailored to the guidelines presented on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) website (http://www.prisma-statement.org/). As recommended by PRISMA, a review protocol was created and registered on the open-access *international prospective register of systematic reviews* (PROSPERO) database under the title "The impact of social anxiety on emotion recognition: A meta-analysis" (ID number: CRD42020170484).

2.3.2 Eligibility Criteria

Several criteria were considered for article eligibility. First, only peer-reviewed full-text articles or dissertation formats available in English were considered for inclusion. Second, only

articles that included participants with a primary diagnosis of SAD or clinically significant social anxiety were included. This was done because a previous review suggested that attentional biases may be more readily observed in individuals that hold a diagnosis of SAD, as opposed to individuals with high social anxiety (Bantin et al., 2016). Chen and colleagues (2017) also suggest that although social anxiety occurs on a continuum, individuals with SAD and those with high levels of social anxiety are not synonymous. The authors argue that individuals holding a diagnosis of SAD must have significant interference in their daily life, which can include interference with behaviours like EER (Chen et al., 2017). For these reasons, we decided only to include studies comparing individuals who had clinically significant social anxiety symptoms to those who did not. Studies were only included if participants with a SAD diagnosis were identified using a validated diagnostic tool, such as a structured interview. Similarly, studies were only included if participants with clinically significant symptoms of SAD (sub-clinical SAD) were identified using a validated measure that assesses social anxiety symptoms, such as a clinician-reported or self-reported questionnaire. Third, only studies including an EER task using a validated face database were included. Validated face databases consist of image banks with photographs of faces displaying some or all the six basic emotions, namely, anger, disgust, fear, happiness, sadness, and surprise (Ekman, 1972), where the creators of the database have determined that most participants correctly categorize the facial expressions. Lastly, only studies that included accuracy and/or reaction time as outcome measures were included. Qualitative and case studies, reviews, and meta-analyses were excluded. Year of publication, participant age, and number or type of emotional facial expressions were not used as discriminating factors for inclusion.

Our primary dependent variables were accuracy and reaction time. Accuracy represents the number of correctly categorized emotional expressions. Accuracy is often represented as a

proportion or converted into a proportion by dividing the number of correctly identified emotional expression stimuli by the total number of emotional expression stimuli presented. Accuracy values can be obtained from common EER tasks, like forced-choice EER tasks (Russell, 1993) and emotional expression face-match tasks (Chen et al., 2011; Levy & Bentin, 2008). Reaction time is represented by latency (in milliseconds) to make the emotion categorization decision. Our primary independent variables were the status of SAD and the emotional facial expression category (i.e., angry, happy, sad, disgusted, fearful, or surprised).

In undertaking this review and meta-analysis, we are primarily interested in the relationship between having SAD and EER. Therefore, only a select number of validated instruments were considered appropriate for evaluating clinical levels of social anxiety symptoms. The measures that were deemed to be valid for diagnosing SAD are: The Anxiety and Related Disorders Interview Schedule (ADIS), the Structured Clinical Interview for DSM Disorders (SCID), the Mini-International Neuropsychiatric Interview (MINI), and the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS). These diagnostic instruments have good-to-excellent psychometric properties and excellent clinical utility (Ambrosini, 2000; Hunsley & Mash, 2018; Sheehan, 1998; Townsend et al., 2020).

We decided to include studies in our sample that assessed sub-clinical SAD by identifying individuals that met the threshold for clinically significant symptoms of social anxiety. We, therefore, decided to include studies using the following measures to assess social anxiety symptom severity: The Liebowitz Social Anxiety Scale (LSAS), Liebowitz Social Anxiety Scale for Children and Adolescents (LSAS-CA), Social Phobia Inventory (SPIN), Screen for Child Anxiety and Related Disorders (SCARED), Brief Social Phobia Scale (BSPS), Social Phobia

Anxiety Inventory (SPAI), Social Phobia Anxiety Inventory for Children (SPAI-C), Social Phobia Scale (SPS), and Social Interaction Anxiety Scale (SIAS) measures.

Each of these instruments is widely recognized as valid for assessing symptom severity and has good-to-excellent psychometrics properties (Beidel et al., 2000; Birmaher et al., 1999; Hale et al., 2011; Hunsley & Mash, 2018; Letamendi et al., 2009; Storch et al., 2006). Although the Brief Fear of Negative Evaluation is a widely used tool for assessing symptom severity in SAD, it was not included due to its poor discriminant validity regarding other anxiety disorders (Hunsley & Mash, 2018; Letamendi et al., 2009). Furthermore, to be included in the meta-analysis, studies had to identify their sub-clinical social anxiety group using the threshold score stated in the referenced test manual. Participants who met or surpassed the threshold score for a given test were considered individuals with clinically significant symptoms. Studies that identified this group using another method, such as a median split, were not included in the meta-analysis.

2.3.3 Literature Search and Information Sources

A systematic literature search was conducted on the electronic databases PsycINFO, MEDLINE, Scopus, Web of Science, Cochrane OVID, and ProQuest (including Dissertations & Theses Global). The literature search began on April 17, 2020, with the last search date being January 26, 2022. Only published, full-text articles and dissertations were of interest; therefore, a gray literature search was not performed. The University of Ottawa's librarian was consulted to develop the search strategy to ensure an effective and complete database search. A sample description of the search strategy for the electronic database PsycINFO is presented in Appendix A of the supplementary materials. A complete description of the search strategy by database can be found at the registered PROSPERO protocol link.

https://www.crd.york.ac.uk/PROSPEROFILES/170484_STRATEGY_20200508.pdf.

2.3.4 Study Selection

The literature search was performed by the primary investigator (CL). The primary investigator then imported the articles for screening into the Covidence reference manager. Once imported, article duplicates were automatically removed by the Covidence software. Article screening and selection occurred in two phases. The first phase consisted of a title and abstract screen (phase 1) performed by two independent reviewers (CL and KE). Titles and abstracts were reviewed to ensure that articles included keywords on social anxiety, facial expressions or emotion recognition.

Following phase 1, two independent reviewers (CL and KS) reviewed the full-text articles and manuscripts (phase 2). Only articles that met eligibility criteria were considered. Articles were excluded if manuscripts were non-English, data was unavailable or insufficient data was available, social anxiety was not a clinical threshold, absence of a control group, EER was not assessed, accuracy and/or reaction time were not included as outcome variables, or emotional facial expressions presented were not from a validated face database. Next, risk of bias (phase 3) was performed by two independent reviewers (CL and KS). Study quality was assessed among the articles retained from phase 2 of screening. Only articles refereed to have a low risk of bias within and across domains were included for analysis. A third independent reviewer (CC) resolved conflicts between reviewers arising in phases 1 and 2. Inter-rater reliability was assessed for phase 1 and phase 2 of the study selection using Cohen's kappa.

2.3.5 Risk of Bias in Individual Studies

Risk of bias in individual studies was performed by the reviewers' CL and KS at the study level. Here, study quality was assessed using the Risk of Bias Assessment tool for Non-randomized Studies (RoBANS). This assessment tool evaluates several domains of bias, including bias due to

participant selection, confounds, inadequate measurement of exposure, inadequate blinding of outcome assessment, missing data, and selective reporting (Kim et al., 2013). Details of the risk of bias assessment can be found in Appendix C of the supplementary materials. Only studies at low risk of bias within and across domains were included for analysis.

2.3.6 Data Collection Process

Once the final screening phase and risk of bias assessment were complete, the primary investigator began data collection. Data storing and analysis were completed using Comprehensive Meta-Analysis (CMA) software. The primary outcome measures evaluated were accuracy and reaction time of emotional expression categorization. We assessed the standardized mean differences (g) in accuracy and reaction time across emotion expression types within and across the SAD and control groups.

Additional variables were collected and summarized in **Table 2.1**: author, year of publication, sample characteristics, method of symptom and diagnosis assessment for social anxiety, face database used, stimulus duration, number and type of emotional expression, and presence of a comorbidity. Comorbidity here refers to whether a study excluded or included individuals diagnosed with SAD and had a secondary (comorbid) mental health diagnosis, such as different anxiety disorders (e.g., panic, generalized) or depression. We were interested in evaluating if results varied when comparing studies that excluded participants with comorbidities to those that included them. Therefore, sub-group analyses were performed using comorbidity and stimulus duration for the results that yielded heterogeneity. Heterogeneity was assessed using prediction intervals, Tau, Tau2, I2 and the Q-statistic.

Comorbidity is a potentially viable moderator because EER is also impaired in other disorders (Dalili et al., 2015). A 2015 meta-analysis by Dalili and colleagues revealed that

individuals with major depressive disorder showed EER deficits. Other psychiatric disorders, including schizophrenia (Lecomte et al., 2019), PTSD, OCD, and other anxiety-related disorders, have also shown impairments in EER (Davies et al., 2016). Finally, there is no uniform stimulus duration across studies. For instance, in the studies included in our analysis, Maoz and colleagues (2016) reported using a stimulus duration of 200ms, while Xing et al. (2020) used a stimulus duration of 5000ms. Given this lack of uniformity, stimulus duration may also be a viable moderator, as short presentation times could contribute to emotion misidentification (Esteves & Öhman, 1993).

Other sample characteristics like age were not considered moderators because the DSM-5 criteria used to diagnose SAD do not vary across ages (APA, 2013). While brain maturation has been shown to impact EER sensitivity (Thomas et al., 2007), there is little evidence to suggest that age impacts the ability to accurately categorize emotional facial expressions (Taylor et al., 2015). Studies have shown that by age 5, children can recognize happy and sad emotional facial expressions as accurately as adults. The accurate recognition of complex emotions like fear, anger, and disgust is also successfully achieved by age 11 (as cited in Wong et al., 2012). As such, we did not anticipate any meaningful age-related differences in symptom presentation or manifestation that could influence the relationship between SAD and EER.

Corresponding authors were contacted by email if additional information was needed to retrieve and interpret the published results. Studies were abandoned if the authors did not reply within three weeks of our request.

2.3.7 Synthesis of Results

In this meta-analysis, we evaluated between-group comparisons of standardized means differences (Hedge's g) encompassed by 95% confidence intervals in (1) emotional expression

categorization accuracy and (2) reaction time across emotion expression categories. Six emotion categories were selected for the analyses, namely angry, happy, neutral, disgust, sad and fear. Analysis contrasting positive and negative emotions and combining all emotions was also conducted. The combined emotion category represents the mean of all emotions presented within a given study. This was done to assess general EER abilities across all emotion categories.

Statistical heterogeneity of the outcome measures was evaluated using Tau2, the Q-statistic, I2 and prediction intervals (Borenstein, 2009; Borenstein, 2019). Tau2 equates to the between-study variance, and the Q-statistic is synonymous to the sum of squared deviations. Meanwhile, I2 gauges the proportion of variability due to sampling error. Importantly, the prediction interval is a measure of dispersion for a given effect size (Borenstein, 2019). Collectively, these measurements can be used to evaluate heterogeneity and the practical significance of the effect size. Given the strict inclusion criteria for this meta-analysis, we did not anticipate substantial inconsistency across studies. Nevertheless, we did expect a degree of variability across the studies due to differences in stimulus duration and comorbidity. Sub-group analyses and meta-regression were performed to assess possible interaction effects exclusively for the analyses that yielded heterogeneity. Furthermore, since only studies with a low summative risk of bias were included in the meta-analysis, we did not conduct a sensitivity analysis.

Funnel plots were used to assess for publication bias. If the funnel plots indicated asymmetry, then Duval and Tweedie's Trim and Fill procedure was used to compute an unbiased estimate of the effect size (as cited in Borenstein, 2009). Funnel plots and Trim and Fill analyses for each of the accuracy and reaction analyses can be found in Appendix B of the supplementary materials.

2.3.8 Power Analysis

A posteriori power analysis was conducted using Borenstein and colleagues' (2009) guidelines for a random-effects model. For accuracy, we estimated an average effect size of 0.25 using an average of 27 participants across studies. There was an average of thirteen studies included per analysis and an estimated small level of heterogeneity. Together, the yielded power for a one-tailed test was 0.89. A one-tailed test was used because a directional hypothesis was assumed. Similarly, we estimated an average effect size of 0.25 using an average of 17 participants across studies for reaction time. An average of 13 studies was included per analysis, with an estimated moderate heterogeneity level. Together, the yielded power for a one-tailed test was 0.73.

2.4 Results

The literature search was completed on January 26, 2022, returning a total of 6541 studies. An overview of the workflow (presented according to PRISMA guidelines) can be seen in **Figure 2.1**. Inter-rater reliability was computed at the identification and eligibility phases of screening. The identification phase consisted of an abstract and title screening, which returned moderate agreement (*K*=.56). The eligibility phase consisted of a full-text screening and yielded substantial agreement between raters (*K*=.74). After assessing study quality, 16 studies (*N*=788) were included in the meta-analysis. Some studies conducted multiple experiments; as a result, there is a greater number of effect sizes included in the analyses. Here, k is the number of effect sizes, and N is the total number of participants summed across all 16 studies. Because some studies reported only one of the two outcome measures, different studies were included in the analysis for accuracy and reaction time (see **Table 2.1**). The analyses evaluated accuracy indices (percentage of correctly identified emotions) and reaction time (latency in ms of correctly identified emotions) across groups for various emotion categories. Only emotion categories that had sufficient power were

included in the primary analyses. These included angry and happy categories, as well as a combined category that included angry, happy, neutral, disgusted, fearful, sad, and surprised. Although emotion categories like fearful, sad, disgusted, and neutral were analyzed, their results are tentative as they are considerably underpowered. Because only one study among our sample investigated the effects of the surprise emotion category, performance related to this expression could not be evaluated.

The datasets and risk of bias assessments generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Figure 2.1

Overview of workflow chart

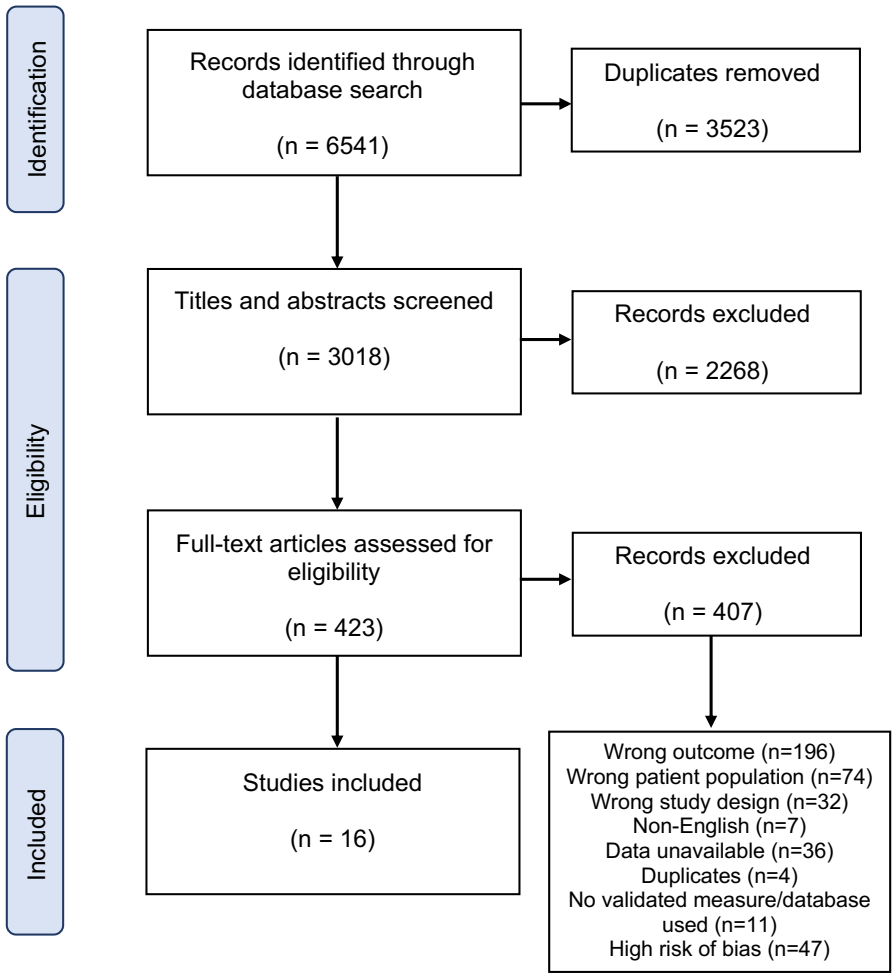


Table 2.1

Summary of studies included in meta-analysis and their associated characteristics

Study	*K*	Accuracy	Reaction time	Samples	Comorbidity	*N*	Mean age	Measures	Face database	Expression Categories	Stimulus duration	Task	Results
Binelli et al., 2015	3	X	X	SAD; HC	None	20; 20	SAD: 25 HC: 25	DSM-IV-TR, MINI, LSAS	Validated emotional face-matching task	Angry, happy, fearful	5000ms	Emotional face-matching task	NS differences in reaction time across emotions or groups.
Demenescu et al., 2013	3		X	SAD; HC	None	17; 16	SAD: 36 HC: 33	Composite International Diagnosis Interview (CIDI) — lifetime; DSM-IV	Karolinska Directed Emotional Faces	Angry, happy, fearful, sad, neutral	2500ms	Emotion recognition task	NS differences in accuracy and reaction time across groups.
Gilboa et al., 1999	9		X	SAD; HC	None	16; 17	SAD: 31 HC: 34	SCID-IV; DSM-IV	Ekman's face database	Angry, happy, neutral, disgust	Unlimited	Face in the crowd paradigm	HC recognized angry faces in a neutral crowd more quickly than SAD. Both groups recognize angry faces in a neutral crowd more quickly than happy faces.
Kleberg et al., 2019	3	X		SAD; HC	None	27; 23	SAD: 15 HC: 15	MINI	Karolinska Directed Emotional Faces	Angry, happy	4000ms	Emotion recognition task	NS differences in accuracy across groups
Klumpp et al., 2013	6	X	X	SAD; HC	None	29; 27	SAD: 24 HC: 24	SCID-IV; DSM-IV; LSAS	Emotional facial expression was validated in an independent study by Gur et al. (2001)	Angry, happy, fearful	4000ms	Emotional Faces Shifting Attention Task	NS differences in accuracy and reaction time across groups.

Kolassa et al., 2006	3		X	SAD; HC	None	19; 19	Total: 23	SCID-IV	Karolinska Directed Emotional Faces	Angry, happy, neutral	1000ms	Emotion recognition task	Both groups recognized happy faces more quickly than angry and neutral faces.
Maoz et al., 2016	3		X	SAD; HC	None	27; 21	SAD: 28 HC: 25	MINI; LSAS;	NimStim	Angry, happy	200ms	Emotion recognition task	SAD recognized happy faces more quickly than angry faces. NS differences in reaction time across emotions for the control group. NS difference in reaction time across groups.
Melfsen & Florin, 2002	6	X	X	SAD; HC	None	17; 25	SAD: 10 HC: 10	SPAI-C; ADIS; DSM-IV; DIPS-K	Japanese and Caucasian Facial Expressions of Emotions	Angry, happy, sad, disgust	60ms	Emotion recognition task	NS difference in accuracy and reaction time across groups.
Mohlman et al., 2007	3	X		SAD; HC	DD, MDD, GAD, PD, SP	26; 26	SAD: 21 HC: 21	SCID-IV; FNE	Emotional facial expression was validated in an independent study by Hortsmann (2002)	Angry, happy, sad, neutral	Unlimited	Emotion recognition task; Emotion card sorting task	NS difference in accuracy across groups.
Oh et al., 2018	6	X	X	SAD; HC	PD, SUD	56; 56	SAD: 27 HC: 25	MINI; DSM-IV; LSAS-SR	Ekman and Friesen's photographs	Angry, happy, fearful, sad, neutral, surprise, disgust	10,000ms	Emotion recognition task	SAD recognized fear, surprise, neutral, and happy faces less accurately than HC. NS difference in accuracy for angry, sad, and disgust faces across groups.

Peschard et al., 2013	6	X	X	HSA; LSA	None	18; 18	HSA:19 LSA:20	LSAS	Karolinka Directed Emotional Faces	Angry, happy, neutral	800ms	Facial expression naming task	Both groups recognized happy faces more accurately than neutral faces. NS differences in accuracy between angry and happy faces across groups.
Ran & Chen, 2017	2	X	X	HSA; LSA	None	17; 17	HSA: 21 LSA: 21	LSAS-SR	Chinese Facial Affective Picture System	Angry, happy	500ms	Emotion recognition task	SAD recognized angry faces more accurately than happy faces. NS differences in accuracy in HC. NS differences in reaction time across emotions or group.
Straube et al., 2004	6	X	X	SAD; HC	None	10; 10	SAD: 25 HC: 23	SCID-IV	MacBrain Face Stimulus Set	Angry, neutral	1000ms	Emotion recognition task	NS differences in accuracy or reaction time across groups.
Tseng et al., 2017	3	X		SAD; HC	MDD, PTSD, PD, Agoraphobia, OCD, SP	31; 31	SAD: 54 HC: 54	MINI; DSM-IV; CIDI; LSAS-SR; HAM-D	Diagnostic Analysis of Non-verbal Accuracy 2-Taiwan version	Angry, happy, fearful, sad, neutral	500ms	Emotion recognition task	Overall (collapsed across emotions) accuracy rates were lower for SAD than HC. SAD recognized fear less accurately than HC.
Wong et al., 2012	12	X	X	SAD; HC	GAD, Selective mutism, SA	17; 21	SAD: 9 HC: 10	SPAI-C	Standardized Penn Emotion Recognition set	Angry, happy, fearful, sad, neutral, disgust	Not specified	Emotion recognition task	NS differences in accuracy across groups or emotions. Both groups recognized happy faces more quickly

													than other emotions.
Xing et al., 2020	4	X	X	SAD; HC	None	48; 46	SAD: 25 HC: 25	SCID-5; LSAS; HAM-A; HAM-D	Validated emotional face-matching task	Angry, happy, fearful	5000ms	Emotional face-matching task	Both groups took more time to recognize fearful faces compared to other emotions. Both groups recognize happy faces more accurately than threatening angry and fearful faces. NS difference in reaction time across groups.

K: Number of total effect sizes collapsed across accuracy, reaction time, and emotional expression; N: sample size; SAD: Social Anxiety Disorder; HC: Health Controls; HSA: High Social Anxiety; LSA: Low Social Anxiety; MDD: Major Depressive Disorder; PTSD: Post-traumatic Stress Disorder; PD: Panic Disorder; SP: Specific Phobia; GAD: Generalized Anxiety Disorder; SA: Separation Anxiety; SUD: Substance Use Disorder; DD: Dysthymic Disorder; DSM-IV-TR: Diagnostic and Statistical Manual of Mental Disorders-4th ed.-Text Revision; MINI: Mini-international neuropsychiatric interview; LSAS: Liebowitz Social Anxiety Scale; SCID-IV: Structured Clinical Interview for DSM-IV; SCID-5: Structured Clinical Interview for DSM-5; SPAI-C: Social Phobia and Anxiety Inventory for Children; HAM-D: Hamilton Depression Rating Scale; HAM-A: Hamilton Anxiety Rating Scale; NS: Not significant

2.4.1 Accuracy

Positive vs. Negative vs. Neutral Emotions. An analysis comparing recognition accuracy of positive, negative, and neutral emotions yielded statistically significant differences (see **Table 2.2**). These results indicate group differences in EER accuracy across these emotion categories. Only neutral and happy facial expressions were used to form the neutral and positive categories, respectively. Regarding neutral expressions, only a small number of studies were included in the analysis. These tentative results indicated a moderately decreased ability to recognize neutral emotional expressions.

Studies that displayed fear, disgust, and anger were combined to form a negative category. Even when combining various negative facial expressions, there were no observed differences in the ability to accurately recognize negative emotions. Forest plots for each of the individual emotion categories are included in Appendix B of the supplementary materials.

Table 2.2

Results of main analyses for accuracy

Analysis	*k*	*N*	*g*	95% CI	$T^2(T)$	I^2%	*Q*(*df*)
Positive vs. Negative vs. Neutral	28	596	-0.126*	-0.226 – -0.025	0	0	23.865(27)*
Negative	12		-0.070	-0.225 – 0.085	0	0	4.692(11)
Neutral	5		-0.307	-0.548 – -0.065	0	0	3.351(4)
Positive	11		-0.106	-0.264 – 0.052	0.023(0.043)	23.668	13.101(10)
Neutral	5	276	-0.307*	-0.548 – -0.065	0	0	3.351(4)
Happy	11	576	-0.096	-0.280 – 0.088	0.023 (0.150)	23.688	13.101(10)
Angry	11	502	-0.093	-0.261 – 0.074	0	0	3.663(10)
Disgust	4	192	0.022	-0.235 – 0.279	0	0	2.772(3)
Fear	5	268	-0.098	-0.463 – 0.268	0.102(0.320)	59.950	9.987(4)*
Sad	6	306	0.031	-0.178 – 0.241	0	0	2.388(5)
Combined	13	636	-0.139	-0.290 – 0.012	0	0	9.671(12)

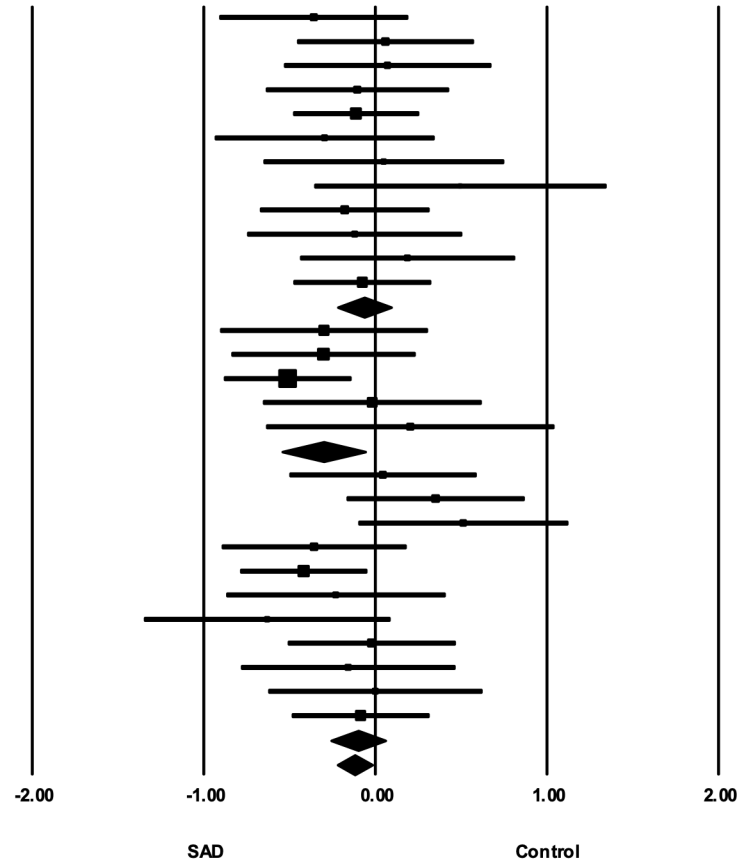
k number of studies; *N* number of participants; *g* hedges g; 95% CI Confidence interval; T^2 between-study variance; *T* standard deviation; I^2 variability due to sampling error; *Q*-statistic synonymous to sum of squared deviations

*$p<.05$

Figure 2.2

Summary effect sizes for accuracy across positive, negative, and neutral emotion

Study name	Subgroup within study		Hedges's g	Lower limit	Upper limit	p-Value
Kleberg (2019)	Negative	Angry	-0.359	-0.911	0.193	0.203
Klumpp (2013)	Negative	Combined	0.059	-0.458	0.577	0.822
Melfsen (2002)	Negative	Combined	0.072	-0.535	0.678	0.817
Mohlman (2006)	Negative	Combined	-0.105	-0.641	0.431	0.702
Oh (2018)	Negative	Combined	-0.113	-0.482	0.257	0.550
Peschard (2013)	Negative	Angry	-0.296	-0.938	0.347	0.367
Ran (2020)	Negative	Angry	0.049	-0.654	0.752	0.891
Straube (2004)	Negative	Angry	0.495	-0.358	1.349	0.255
Tseng (2017)	Negative	Combined	-0.178	-0.674	0.317	0.481
Wong (2012) a	Negative	Combined	-0.120	-0.748	0.508	0.707
Wong (2012) b	Negative	Combined	0.187	-0.440	0.815	0.558
Xing (2020)	Negative	Threat	-0.076	-0.479	0.327	0.712
			-0.070	-0.225	0.085	0.377
Melfsen (2002)	Neutral	Neutral	-0.299	-0.907	0.309	0.335
Mohlman (2006)	Neutral	Neutral	-0.302	-0.841	0.236	0.271
Oh (2018)	Neutral	Neutral	-0.512	-0.885	-0.138	0.007
Peschard (2013)	Neutral	Neutral	-0.018	-0.657	0.621	0.956
Straube (2004)	Neutral	Neutral	0.204	-0.638	1.046	0.635
			-0.307	-0.548	-0.065	0.013
Kleberg (2019)	Positive	Happy	0.044	-0.504	0.591	0.876
Klumpp (2013)	Positive	Happy	0.351	-0.170	0.872	0.187
Melfsen (2002)	Positive	Happy	0.512	-0.102	1.127	0.102
Mohlman (2006)	Positive	Happy	-0.357	-0.896	0.183	0.195
Oh (2018)	Positive	Happy	-0.418	-0.790	-0.046	0.028
Peschard (2013)	Positive	Happy	-0.230	-0.871	0.411	0.482
Ran (2020)	Positive	Happy	-0.630	-1.350	0.091	0.087
Tseng (2017)	Positive	Happy	-0.021	-0.512	0.471	0.934
Wong (2012) a	Positive	Happy	-0.158	-0.785	0.469	0.621
Wong (2012) b	Positive	Happy	0.000	-0.626	0.626	1.000
Xing (2020)	Positive	Happy	-0.086	-0.490	0.317	0.675
			-0.106	-0.264	0.052	0.189
			-0.126	-0.226	-0.025	0.014



Impact of Comorbidity on Happy Expression Recognition. A mixed-effects sub-group analysis investigating the impact of comorbidity on EER accuracy was performed. The two sub-groups consisted of individuals with SAD presenting with a secondary mental health diagnosis and those with SAD alone. We did not have the statistical power to investigate the impact related to the type of comorbidity (e.g., anxiety disorder, major depressive disorder, etc.). As such, comorbidity was all-inclusive. A list of the comorbidities included in the analysis can be found in **Table 2.1**.

The sub-group analysis was only performed for the happy emotion category as it was one of the only emotion category analyses that returned heterogeneity in the results. As seen in **Table 2.3**, the analysis revealed a small estimated mean effect size for the SAD group with no comorbidity, suggesting that individuals with SAD alone perform just as well as controls in recognizing happy facial expressions (**Figure 2.3**). Interestingly, SAD individuals with a comorbidity were significantly worse at accurately recognizing happy facial expressions compared to controls. Although the fear emotion category yielded heterogeneity, there were too few studies to be able to run a sub-group analysis.

Table 2.3

Results of sub-group analyses for accuracy and reaction time

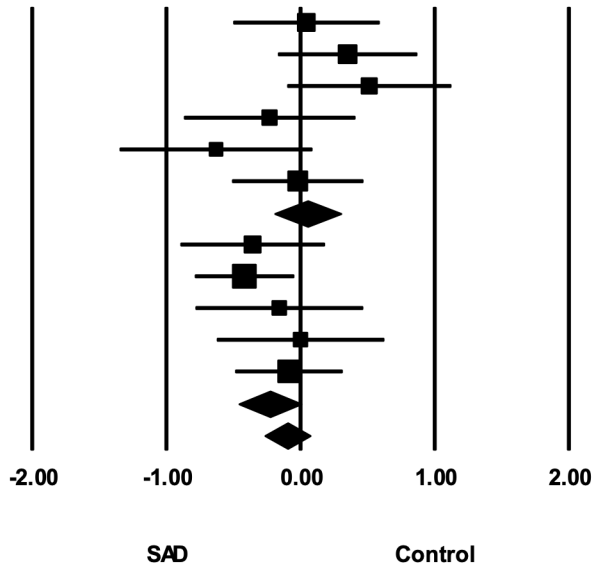
	k	*N*	*g*	95% CI	*Q(df)*
Accuracy					
Happy					2.697(1)
Without comorbidity	6	280	0.049	-0.197 – 0.294	
With comorbidity	5	296	0.233*	-0.462 – -0.003	
Reaction time					
Happy					.001(1)
Without comorbidity	11	304	0.588*	0.038 – 1.137	
With comorbidity	4	244	0.606	-0.299 – 1.510	
Angry					0.100(1)
Without comorbidity	12	380	0.390	-0.193 – 0.972	
With comorbidity	3	150	0.180	-0.978 – 1.338	
Combined					0.197(1)
Without comorbidity	12	380	0.436	-0.037 – 0.908	
With comorbidity	4	244	0.225	-0.577 – 1.027	

k number of studies; *N* number of participants; *g* hedges g; 95% CI Confidence interval; *Q*-test omnibus test of differences across between sub-groups
*$p<.05$

Figure 2.3

Summary effect sizes for accuracy across happy emotion and comorbidity sub-group

Group by Comorbidity	Study name	Outcome	Statistics for each study			
			Hedges's g	Lower limit	Upper limit	p-Value
Absent	Kleberg (2019)	Happy	0.044	-0.504	0.591	0.876
Absent	Klumpp (2013)	Happy	0.351	-0.170	0.872	0.187
Absent	Melfsen (2002)	Happy	0.512	-0.102	1.127	0.102
Absent	Peschard (2013)	Happy	-0.230	-0.871	0.411	0.482
Absent	Ran (2020)	Happy	-0.630	-1.350	0.091	0.087
Absent	Tseng (2017)	Happy	-0.021	-0.512	0.471	0.934
Absent			0.049	-0.197	0.294	0.696
Present	Mchlman (2006)	Happy	-0.357	-0.896	0.183	0.195
Present	Oh (2018)	Happy	-0.418	-0.790	-0.046	0.028
Present	Wong (2012) a	Happy	-0.158	-0.785	0.469	0.621
Present	Wong (2012) b	Happy	0.000	-0.626	0.626	1.000
Present	Xing (2020)	Happy	-0.086	-0.490	0.317	0.675
Present			-0.233	-0.462	-0.003	0.047
Overall			-0.101	-0.269	0.066	0.236



Impact of Stimulus Duration. A random-effects meta-regression was performed to investigate the impact of stimulus duration on accuracy for the happy emotion category. The analyses revealed that stimulus duration could not explain the relationship between group (SAD, control) and accuracy. A meta-regression for the fear emotion category could not be computed, as there were too few studies.

2.4.2 Reaction Time

Positive vs. Negative vs. Neutral Emotions. An analysis comparing recognition reaction time of positive, negative, and neutral emotions yielded statistically significant differences (see **Table 2.4**). Here, a positive standard deviation represents a higher (i.e., slower) reaction. These results indicate group differences in latency to recognize emotional facial expressions across the emotion categories. Similar to the accuracy result, only neutral and happy facial expressions were used to form the neutral and positive categories, respectively. The results for happy and neutral facial expressions suggest that individuals with SAD take significantly more time to recognize these facial expression categories. As seen in **Figure 2.4**, studies that displayed fear, sadness, disgust, and anger were combined to form a negative category. When combining various negative facial expressions, a moderate but statistically non-significant difference in the latency to accurately recognize negative emotions was observed. Reaction time results for each of the emotion categories are included in Appendix B of the supplementary materials. Significant heterogeneity was observed. Because the emotions were grouped to form categories, a prediction interval could not be computed.

Table 2.4

Result of main analyses for reaction time

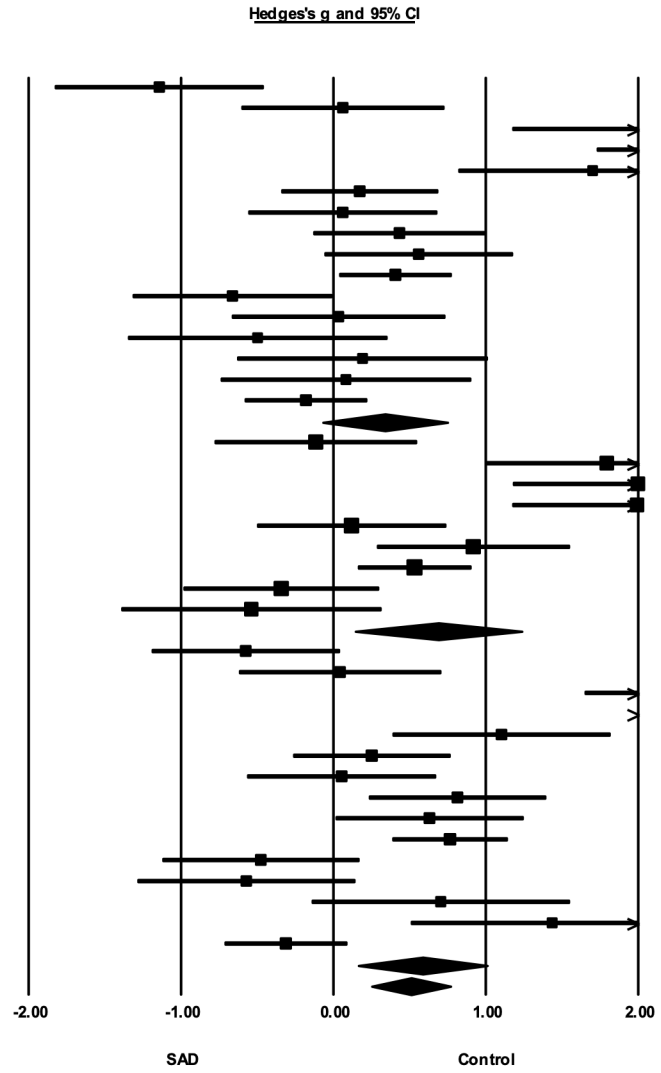
Analysis	*k*	*N*	*g*	95% CI	$T^2(T)$	I^2%	*Q*(*df*)
Positive vs. Negative vs. Neutral	40	624	0.505***	0.247 – 0.864	0.545(0.738)	84.508	251.739(39)***
Negative	16		0.334	-0.075 – 0.743	0.480(0.693)	82.488	85.657(15)***
Neutral	5		0.684***	0.138 – 1.230	0.622(0.789)	85.082	53.626(8) ***
Positive	11		0.581***	0.159 – 1.003	0.641(0.800)	86.636	104.755(14) ***
Neutral	9	278	0.686**	0.120 – 1.251	0.622(0.787)	85.082	53.626(8) ***
Happy	15	604	0.586**	0.144 – 1.029	0.641(0.8)	86.636	104.755(14) ***
Angry	15	530	0.342	-0.142 – 0.827	0.781(0.884)	87.535	112.313(14) ***
Disgust	7	225	0.872*	0.084 – 1.660	0.979(0.989)	55.382	55.382(6) ***
Fear	6	279	0.194	-0.037 – 0.424	0	0	3.993(5)
Sad	4	192	0.483*	0.108 – 0.857	0.047(0.217)	31.666	4.390(3)
Combined	16	624	0.378	-0.009 – 0.764	0.497(0.705)	83.017	88.325(15) ***

Note. k number of studies; *N* number of participants; *g* hedges g; 95% CI Confidence interval; T^2 between-study variance; *T* standard deviation; I^2 variability due to sampling error; *Q*-statistic synonymous to sum of squared deviations
*p<.05, **p<.01, *** p<.001

Figure 2.4

Summary of effect sizes for reaction time across conditions showing positive, negative, and neural expressions

Study name	Subgroup within study	Outcome	Statistics for each study			
			Hedges's g	Lower limit	Upper limit	p-Value
Binelli (2015)	Negative	Combined	-1.142	-1.830	-0.454	0.001
Demenescu (2012)	Negative	Combined	0.062	-0.605	0.730	0.855
Gilboa (1999) a	Negative	Combined	2.070	1.171	2.969	0.000
Gilboa (1999) b	Negative	Combined	2.650	1.726	3.573	0.000
Gilboa (1999) c	Negative	Combined	1.701	0.818	2.585	0.000
Klumpp (2013)	Negative	Combined	0.173	-0.345	0.691	0.513
Kolassa (2006)	Negative	Angry	0.062	-0.561	0.684	0.846
Maoz (2016)	Negative	Angry	0.434	-0.134	1.001	0.134
Melfsen (2002)	Negative	Combined	0.560	-0.061	1.180	0.077
Oh (2018)	Negative	Combined	0.407	0.035	0.779	0.032
Peschard (2013)	Negative	Angry	-0.662	-1.319	-0.005	0.048
Ran (2017)	Negative	Angry	0.034	-0.668	0.737	0.923
Straube (2004)	Negative	Angry	-0.496	-1.350	0.357	0.254
Wong (2012) a	Negative	Combined	0.191	-0.634	1.016	0.650
Wong (2012) b	Negative	Combined	0.083	-0.741	0.907	0.844
Xing (2020)	Negative	Threat	-0.180	-0.584	0.224	0.383
			0.334	-0.075	0.743	0.110
Demenescu (2012)	Neutral	Neutral	-0.115	-0.782	0.551	0.735
Gilboa (1999) a	Neutral	Neutral	1.794	1.000	2.588	0.000
Gilboa (1999) b	Neutral	Neutral	1.999	1.177	2.821	0.000
Gilboa (1999) c	Neutral	Neutral	1.993	1.172	2.815	0.000
Kolassa (2006)	Neutral	Neutral	0.119	-0.504	0.743	0.707
Melfsen (2002)	Neutral	Neutral	0.918	0.283	1.554	0.005
Oh (2018)	Neutral	Neutral	0.533	0.159	0.907	0.005
Peschard (2013)	Neutral	Neutral	-0.342	-0.985	0.302	0.298
Straube (2004)	Neutral	Neutral	-0.538	-1.393	0.318	0.218
			0.684	0.138	1.230	0.014
Binelli (2015)	Positive	Happy	-0.575	-1.195	0.046	0.069
Demenescu (2012)	Positive	Happy	0.044	-0.622	0.710	0.897
Gilboa (1999) a	Positive	Happy	2.553	1.646	3.461	0.000
Gilboa (1999) b	Positive	Happy	3.324	2.282	4.367	0.000
Gilboa (1999) c	Positive	Happy	1.103	0.386	1.821	0.003
Klumpp (2013)	Positive	Happy	0.252	-0.267	0.771	0.341
Kolassa (2006)	Positive	Happy	0.054	-0.569	0.677	0.865
Maoz (2016)	Positive	Happy	0.814	0.230	1.398	0.006
Melfsen (2002)	Positive	Happy	0.631	0.012	1.251	0.046
Oh (2018)	Positive	Happy	0.766	0.384	1.147	0.000
Peschard (2013)	Positive	Happy	-0.476	-1.124	0.172	0.150
Ran (2017)	Positive	Happy	-0.571	-1.288	0.147	0.119
Wong (2012) a	Positive	Happy	0.705	-0.144	1.554	0.104
Wong (2012) b	Positive	Happy	1.436	0.506	2.365	0.002
Xing (2020)	Positive	Happy	-0.311	-0.717	0.094	0.132
			0.581	0.159	1.003	0.007
			0.505	0.247	0.764	0.000



Impact of Comorbidity. A mixed-effects sub-group analysis investigating the impact of comorbidity on reaction time was performed for the combined, happy, and angry emotion categories (see **Table 2.3**). The analysis evaluating the happy category exclusively estimated a moderate mean effect size for the SAD group with comorbidity (see Appendix B in supplementary material). A positive standard deviation suggests a higher (i.e., slower) reaction time for the SAD group. Interestingly, SAD individuals without a comorbidity had a significantly higher reaction time (i.e., slower) compared to controls. This suggests that individuals with SAD alone took more time to recognize happy facial expressions than controls, but those with SAD and a comorbidity did not. The test for the difference between means was not statistically significant.

Sub-group analyses for combined and angry facial expressions yielded no significant differences for SAD groups with and without a comorbidity compared to controls. Although heterogeneity was present in the neutral and disgusted emotion categories, there were too few studies to conduct a sub-group analysis.

Impact of Stimulus Duration. Similar to accuracy, a random-effects meta-regression investigating the impact of stimulus duration on reaction time was performed for each emotion category that yielded heterogeneity (combined, angry, happy, and neutral). The analyses suggested that stimulus duration could not explain the relationship between group and reaction time. Although the analysis for the disgust and sad emotion category yielded heterogeneity, there were too few studies to be able to run a meta-regression.

2.5 Discussion

Social anxiety disorder (SAD) is a prevalent and impairing mental health issue that affects individuals across the lifespan (Stein et al., 2017). Associated with this impairment is an inaccurate appraisal of social evaluative threats. Among these social evaluative threats are emotionally expressive facial stimuli. The aetiological and maintenance model of SAD by Wong and Rapee (2016) suggests that individuals with this disorder overinterpret and misidentify angry, neutral, and disgusted faces as threatening. Previous research has shown that exhibiting heightened attention allocation followed by immediate avoidance of crucial areas of the face, like the eyes (Günther et al, 2021), results in an inaccurate appraisal of emotional facial expressions (Beaudry et al., 2014; Yitzhak et al., 2020) Misinterpreting facial expressions as threatening can potentially reinforce fear of negative evaluation (Günther et al. 2021)—a primary symptom of SAD. This may, in part, be a factor in helping us understand why post-therapy remission rates remain high. Bandelow and colleagues (2018) found in a recent meta-analysis that 48% of patients' symptoms return in as little as two years post-therapy. This suggests that unknown or poorly understood factors maintain the disorder, prevent symptom reduction and lead to its relapse. Understanding what maintains the disorder can have crucial implications for treatment. However, the literature testing for an EER deficit in this population is mixed. This systematic review and meta-analysis aimed to synthesize the existing literature to provide more insight regarding whether EER is impaired among individuals with SAD. EER was assessed through accuracy (proportion of emotions correctly identified) and reaction time (time to categorize emotions). In line with the hypervigilance-avoidance effect, we hypothesized that individuals with SAD would have lower accuracy rates overall and faster (lower) reaction times for threatening faces compared to controls.

Our accuracy results did not support our hypotheses. The accuracy results comparing negative, neutral and positive emotion categories suggest no impaired ability to recognize negative (i.e., fearful, angry, sad, disgusted) emotions. Although the effect size was in the predicted direction, the results indicate no reliable evidence of an impaired ability in EER accuracy among individuals with SAD. Importantly, a posteriori power analysis may help explain why our results did not reach statistical significance. Statistical power in a random-effects analysis is influenced by the number of participants in each study, within-study variance, the number of studies included in the analysis, and between-study variance (Borenstein, 2009; Borentstein, 2019). This may be the case due to the small number of studies included in the analysis.

Our results also suggested an especially small effect size in terms of accuracy for recognizing angry facial expressions. Even when collapsing all negative facial expressions together (sad, angry, disgust, fear), our results suggested no impaired ability to recognize negative expressions. Although this result aligns with some of the literature (Bantin et al., 2016; Boll et al., 2016; Kleberg et al., 2019; Rawdon et al., 2018; Xing et al., 2020), we anticipated finding a greater effect based on the well documented attentional bias towards threatening facial expressions among individuals with SAD (Günther, 2021).

Interestingly, our results suggested an impaired ability to accurately recognize neutral facial expressions. Although these results are tentative due to limited power, individuals with SAD take significantly longer to recognize neutral facial expressions and are worse at categorizing them accurately. These results align with Wong and Rapee's (2016) model of SAD, which predicts that individuals with SAD will tend to misidentify neutral facial expressions.

We further analyzed findings from past research by examining the effects of two moderators: 1) the presence of comorbidities in the SAD sample and 2) the duration of facial

expression stimulus presentation. Because of a lack of heterogeneity across studies or an insufficient number of studies in a given moderation analysis, we could not examine the impact of comorbidity for the neutral, disgust and sad conditions or stimulus duration in the disgust and sad conditions. Our results revealed that stimulus duration did not impact performance. This aligns with previous research by Bar-Haim and colleagues (2007), who found equally no impact of stimulus duration on attentional bias toward threatening stimuli among anxious individuals. However, a sub-group analysis investigating the impact of comorbidity was performed for the happy emotion category.

Comorbidity influenced both accuracy and reaction time. SAD individuals with a comorbid mental health disorder were significantly worse at categorizing happy facial expressions than SAD alone. This result was not unexpected. Demenescu and colleagues (2010) revealed in their meta-analysis that adults with major depressive disorder show overall significant EER deficits compared to controls. EER deficits have also been documented in other anxiety and trauma-related disorders (Plana et al., 2014). This suggests that difficulties in recognizing happy facial expressions may be accounted for, in part, by other mental health disorders.

Similar analyses were carried out on reaction time data. We anticipated that individuals with SAD would have faster reaction times to angry faces, demonstrating hypervigilance towards threatening facial expressions (Mogg et al., 2004). However, our results do not support this hypothesis. Instead, we found no significant differences in reaction time between individuals with SAD and controls for the negative emotion category. Indeed, the effect was in the opposite of the predicted direction. Our results suggest that individuals with SAD take longer to recognize non-threatening emotion categories.

In contrast with negative emotion conditions, individuals with SAD were significantly slower at categorizing neutral and happy expressions. In retrospect, these findings were not unexpected, as many of the studies included in our analysis revealed that individuals with SAD took longer to categorize neutral and happy facial expressions. Similarly, a meta-analysis by Kivity and Huppert (2016) investigating self-reported emotional reactions toward facial expressions found that individuals with high social anxiety rated happy facial expressions as less approachable than individuals with low social anxiety. Interestingly, a sub-group analysis revealed that this effect was even more pronounced for individuals with SAD presenting without a comorbid mental health disorder.

In fact, these results may be understood by the growing body of research that suggests that individuals with social anxiety exhibit decreased prosocial behaviours (Hudd & Moscovitch, 2020) and decreased ability to recognize and perceive socially rewarding cues (Hudd & Moscovitch, 2023). Authors Hudd and Moscovitch (2020) explain that following social rejection experiences, most individuals experience increased motivation to approach social interactions as a way of mending social pain. This increase in approach motivation results in an enhanced ability to recognize socially rewarding cues. However, individuals with high trait SA fail to exhibit these prosocial behaviours. Rather, individuals with SA exhibit greater avoidance behaviours, like avoiding eye contact, and thus have an impaired ability to recognize socially rewarding cues. These cues may include happy facial expressions (Cremers et al., 2015). Although avoiding crucial areas of the face, like the eyes, serves as an emotion regulation strategy (Kashdan et al., 2013), it inhibits the ability to accurately appraise emotional facial expressions (Beaudry et al., 2014; Yitzhak et al., 2020). As a result, individuals with SA get stuck in a negative feedback loop, perpetuating social

pain (Hudd & Moscovitch, 2020) and thwarting their ability to experience a sense of belongingness (Hudd & Moscovitch, 2023).

Given that our analyses suggest that comorbidity impacts the ability to accurately recognize happy facial expressions, and that individuals with SAD alone (without comorbidity) also take more time to recognize happy facial expressions, our results suggest that continued efforts in improving treatment for SAD are warranted. Integrating attention bias modification (ABM) training in interventions like cognitive behavioural therapy may benefit individuals with SAD (Fistikci et al., 2015). While cognitive behavioural therapies address top-down processing, ABM focuses on bottom-up processing, which is necessary for addressing hypervigilance related to early-stage processing (Hang et al., 2021). In a recent meta-analysis, Hang and colleagues (2021) found that integrating ABM into cognitive behavioural therapy improved attentional bias to threat and clinician-rated anxiety symptoms. It is unclear whether improved attentional bias would extend to improve emotional recognition accuracy. However, Högström and colleagues (2019) found that difficulty disengaging from emotional facial stimuli predicted post-CBT outcomes in youth with SAD. Youth with SAD who had difficulty "detaching" from emotional facial expressions were predicted to have worse outcomes following a 12-week course of CBT. There is a clear need and benefit to further understanding the relationship between SAD and emotion processing.

2.5.1 Limitations

Several limitations must be considered when interpreting this meta-analysis. First, the sample sizes and the number of studies included in the analysis were small, resulting in low power. This low power limits the interpretability of the results. Additionally, we could not examine the effects of surprise expressions as there was only one study that investigated EER abilities related

to this facial expression. Power was equally affected when conducting the sub-group analysis. Within our comorbidity moderator, we did not have the statistical power to segment and analyze the influence of different types of comorbidity (e.g., depression vs. generalized anxiety) on EER abilities. This again limits our ability to understand how comorbidity affects SAD and its impact on EER.

Other variables could have also been considered. For instance, Torro-Alves et al. (2016) found that presenting dynamic videos of emotional facial expressions elicits greater accuracy in EER tasks than static images. Thus, the degree of motion in presented stimuli would be an interesting factor to consider in future analyses. Demenescu et al. (2010) suggested in their meta-analysis that illness severity may be an important moderator to consider. Lastly, our study inclusion criteria were quite strict. Only studies at low risk of bias were included in our analyses. As a result, we may have over-excluded studies, resulting in underpowered results. Conducting a sensitivity analysis evaluating the impact of risk of bias on our results would have been optimal.

2.5.2 Conclusion

The studies analyzed in this meta-analysis suggest that individuals with SAD have EER deficits when viewing neutral and happy facial expressions. This was revealed by their lower accuracy rates and increased reaction time to categorizing these expressions. More data is needed to further our ability to interpret our results on accuracy and reaction time for other emotion categories. Future meta-analyses should investigate the impact of dynamic versus static facial expressions, the impact of illness severity and further examine whether the type of comorbidity influences EER abilities. Further, since the onset of the COVID-19 pandemic, people have been mandated and/or encouraged to adopt face masks to limit the contagion of the virus. A recent exploratory review by Saint and Moscovitch (2021) suggests that the increased use of mask-

wearing may have implications for those with SAD. The authors report that mask-wearing may further interfere with their ability to accurately recognize emotional facial expressions and may serve as a safety behaviour as it reduces the perceived likelihood that their appearance will be negatively evaluated. Given the novelty of the COVID-19 pandemic, no studies have experimentally evaluated the impact of mask-wearing on EER abilities in SAD. With our results suggesting that individuals with SAD demonstrate an impaired ability to recognize some emotional facial expressions, future studies should explore the direct impact of mask-wearing on EER abilities.

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2.8 Supplementary Materials

2.8.1 Supplementary Tables

Table S2.1

Search strategy for PsycINFO electronic database

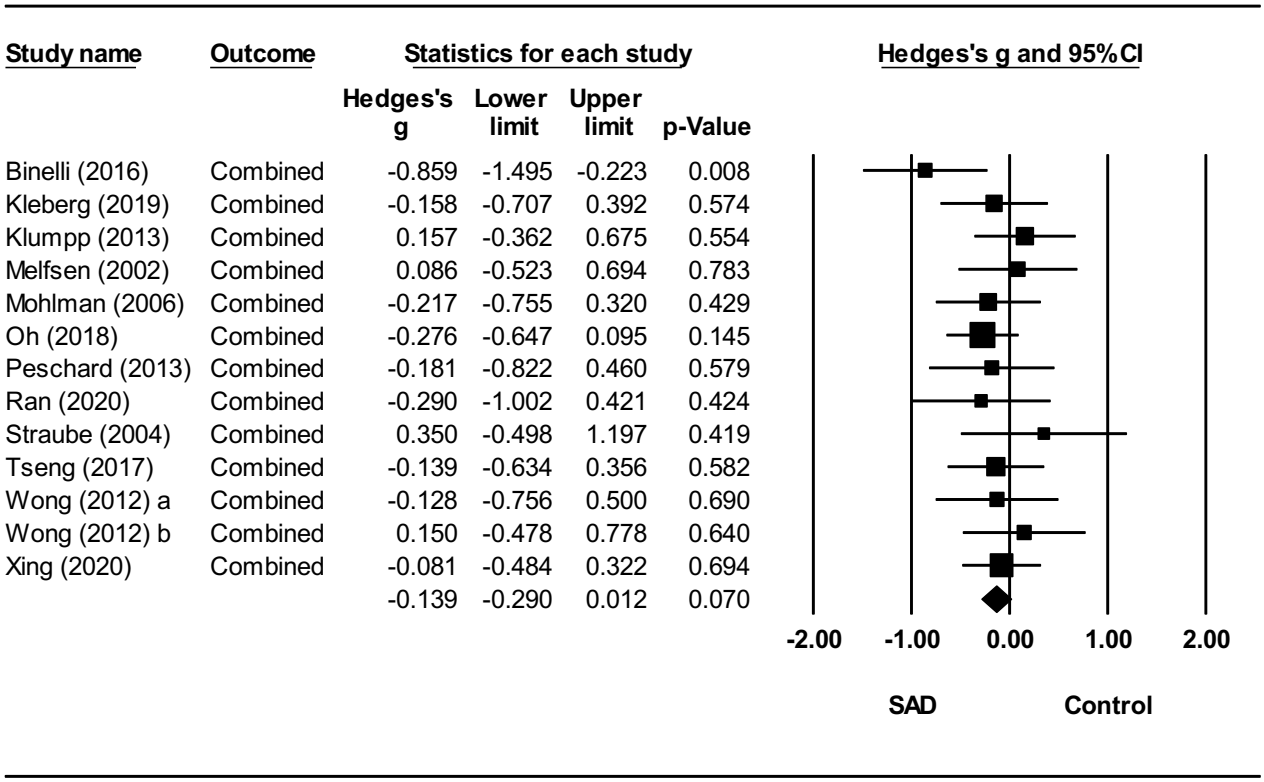
1	Social anxiety/
2	Social phobia/
3	Phobic avoidance.ti,ab
4	Social* adj3 (anxi* or avoid* or stress* or distress* or phob* or disorder*).ti,ab
5	(fear* adj3 "negative evaluation").ti,ab
6	OR/1–5
7	Exp facial expressions/
8	Exp emotion recognition/
9	Face perception/
10	((face* or facial*) adj3 (recogni* or percept* or perceiv* or emotion* or expressi*)).ti,ab.
11	(emotion* adj3 (recogni* or percept* or perceiv*)).ti,ab.
12	OR/7–11
13	6 AND 12

2.8.2 Supplementary Figures

Accuracy

Figure S2.1

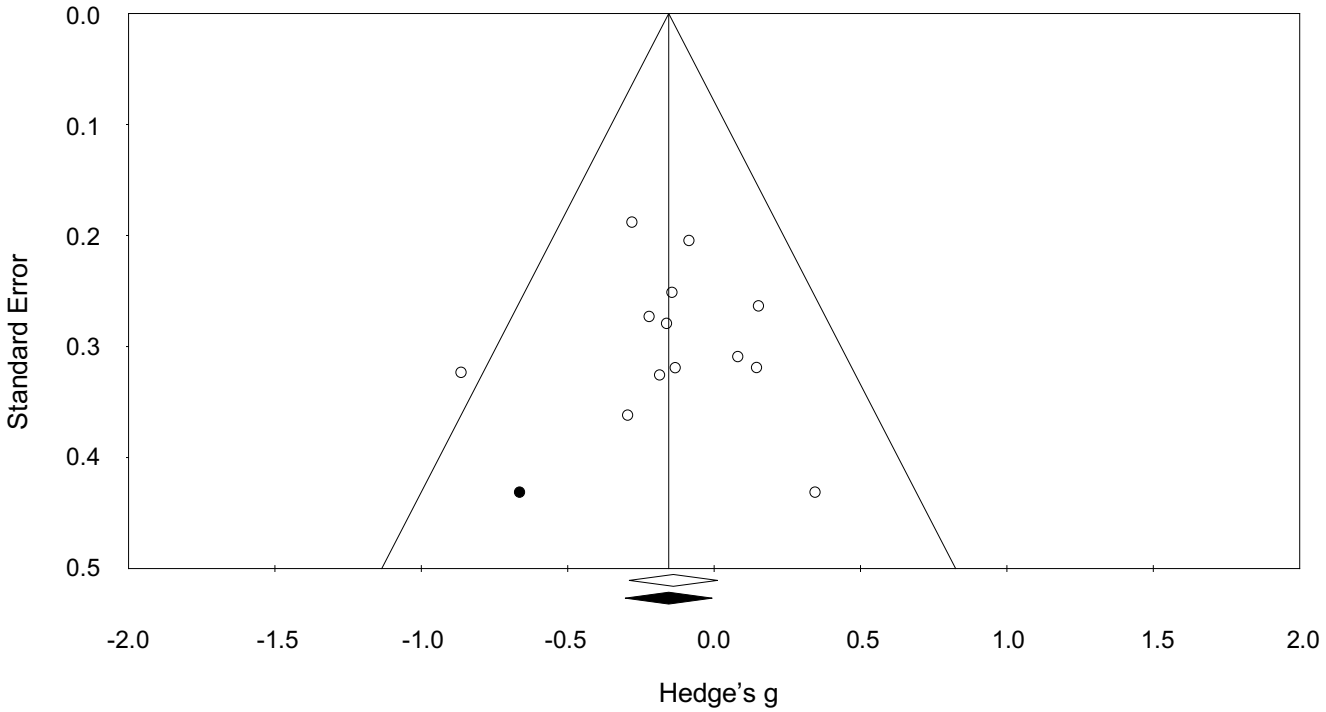
Summary effect sizes for accuracy across combined (happy, angry, neutral, disgust, fear, and surprise) emotions



Note. This random-effects analysis yielded the results from all emotional expressions combined. An analysis combining all emotional expressions was performed to assess whether individuals with SAD present with general EER deficits. Figure S2.1 shows the distribution of effect size. The mean effect size is small and not statistically significant, indicating no reliable differences in the ability to categorize emotional facial expressions across groups accurately. However, the 95% confidence interval is substantial, indicating that the mean effect size estimate is imprecise.

Figure S2.2

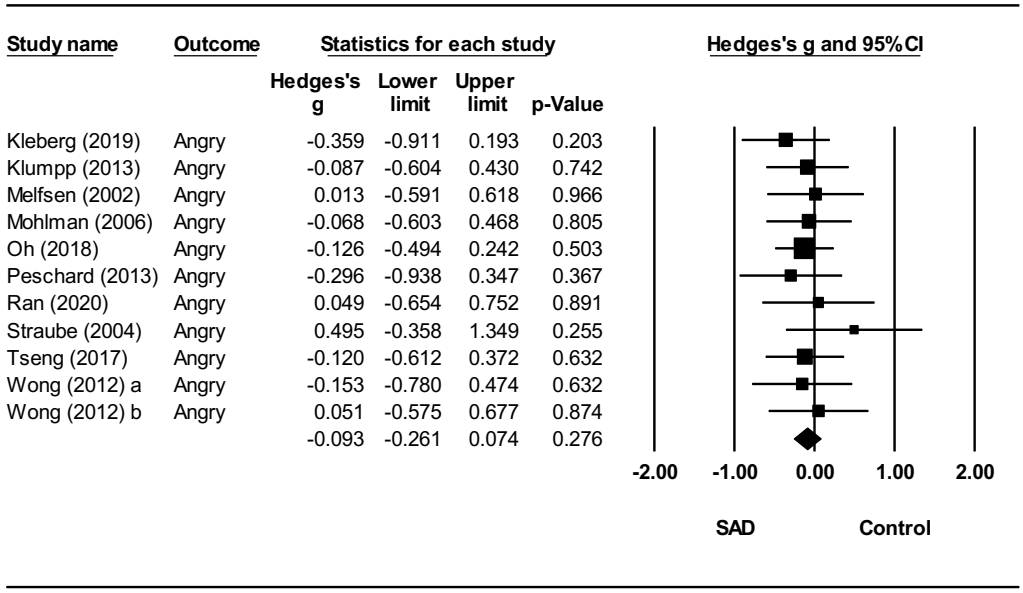
Funnel plot for accuracy across combined emotions displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there may be one study missing from the analysis. However, if we impute an effect size for this missing study into the analysis, the adjusted effect size would shift from -0.139 to -0.155. This difference of 13.4% between the initial estimate and the adjusted estimate is not substantial and thus not clinically important.

Figure S2.3

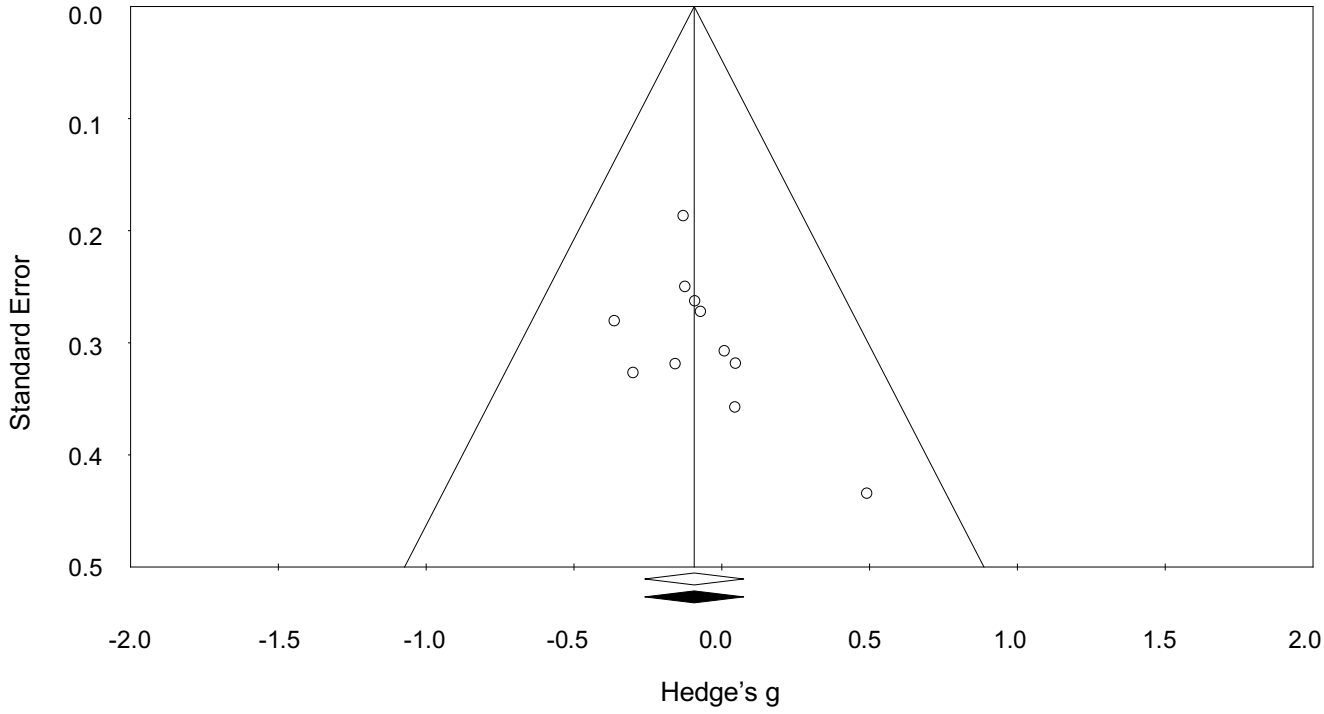
Summary effect sizes for accuracy across angry emotion



Note. This analysis evaluated results from conditions, where angry expressions were shown to participants (k=11). The estimated mean effect size for anger was g=-0.093 (95% CI= [-0.261, 0.074], p=.276), which suggests that individuals with SAD perform just as well in recognizing angry facial expressions as controls. No heterogeneity was observed (T^2=0, T=0, I^2 =0%, Q=3.663, df=10, p=.961).

Figure S2.4

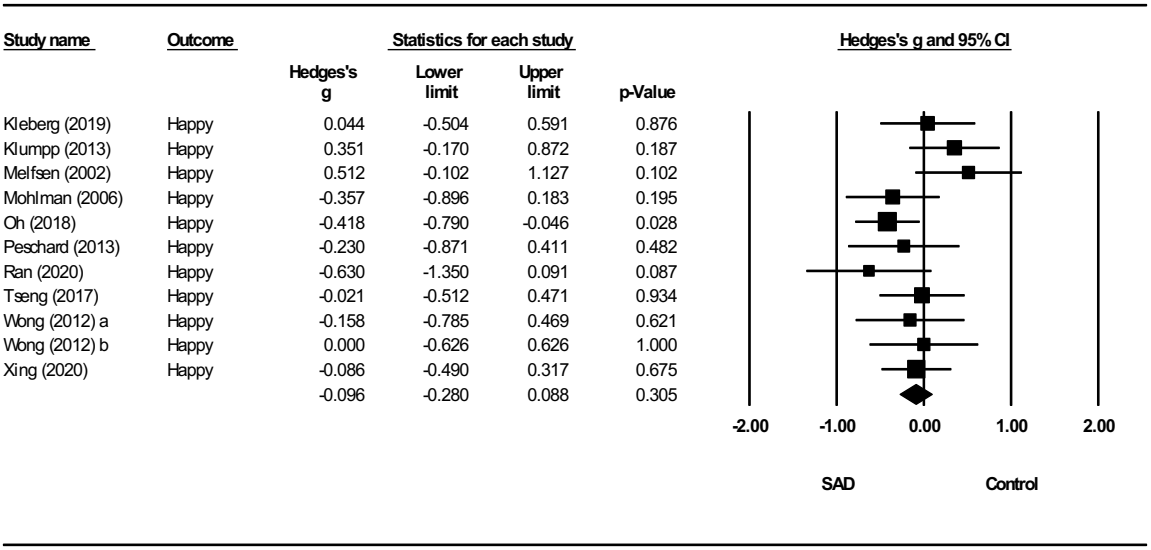
Funnel plot for accuracy across angry emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there are no studies missing from the analysis.

Figure S2.5

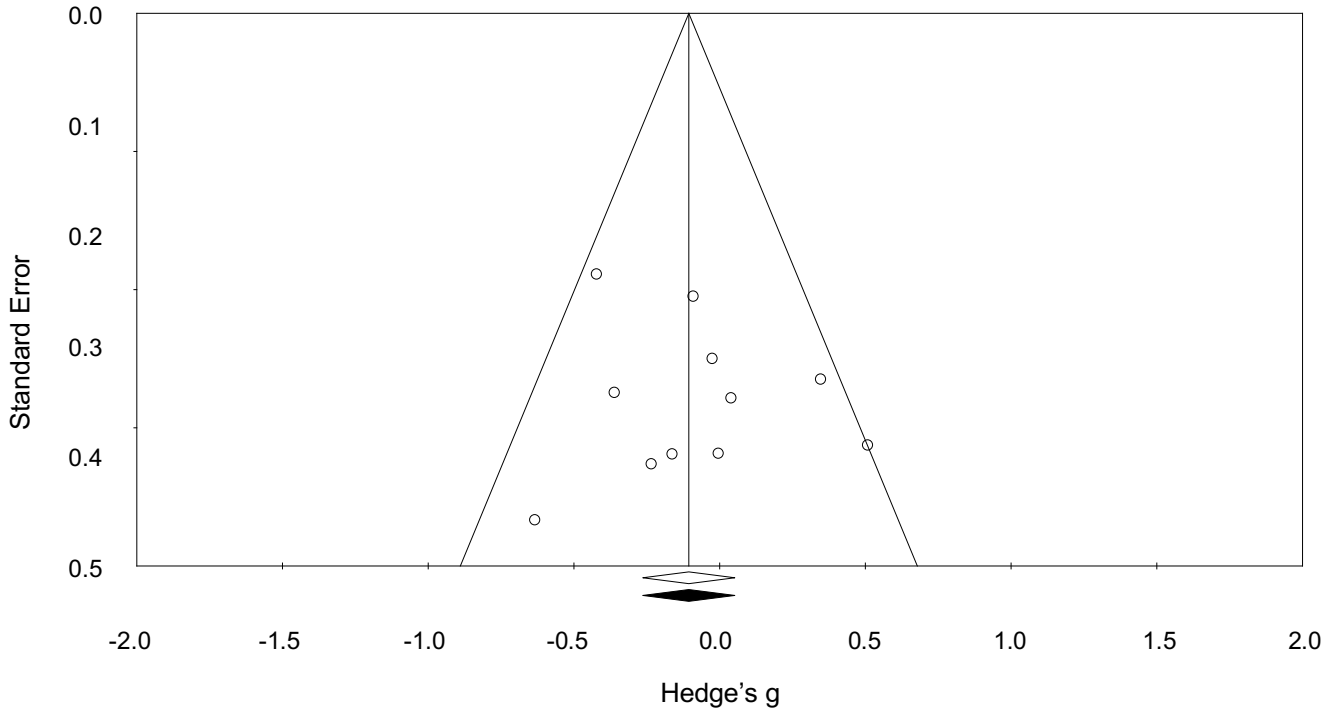
Summary effect sizes for accuracy across happy emotion



Note. The results from the conditions where happy expressions were shown (*k*=11) to participants indicated a small estimated mean effect size, which suggests that no difference in the ability to accurately recognize happy facial expressions across groups. (*g*=-0.096, 95% CI= [-0.280, 0.088], *p*>.05) Heterogeneity was observed and thus followed up with moderation analyses. The 95% prediction interval is -0.495 to 0.303, indicating that the true effect size in 95% of cases of similar studies falls within this range.

Figure S2.6

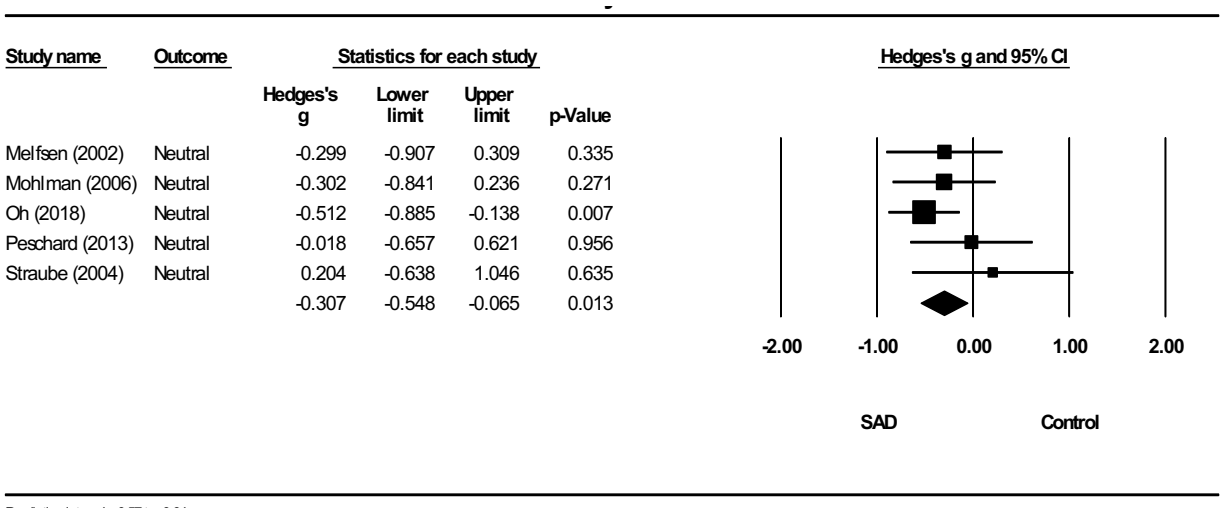
Funnel plot for accuracy across happy emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggests that there are no studies missing from the analysis. The magnitude of the initial and adjusted effect size did not change.

Figure S2.7

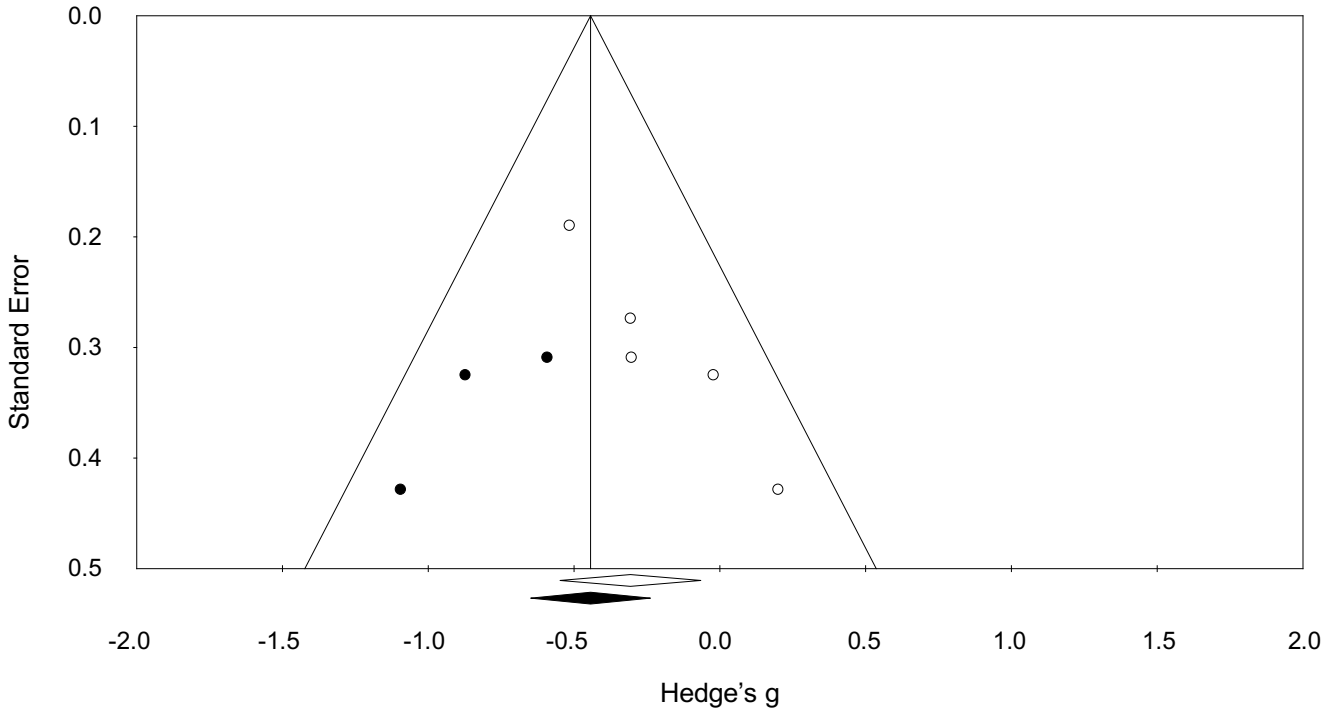
Summary effect sizes for accuracy across neutral emotions



Note. The results from the conditions where neutral expressions were shown (k=5) to participants tentatively indicated that individuals with SAD are worse at accurately recognizing neutral facial expressions compared to the control group (g=-0.307, 95% CI= [-0.548, -0.065], p=.013). Note, these results were underpowered. No heterogeneity was observed (T^2=0, T=0, I^2 =0%, Q=3.351, df=4, p=.501).

Figure S2.8

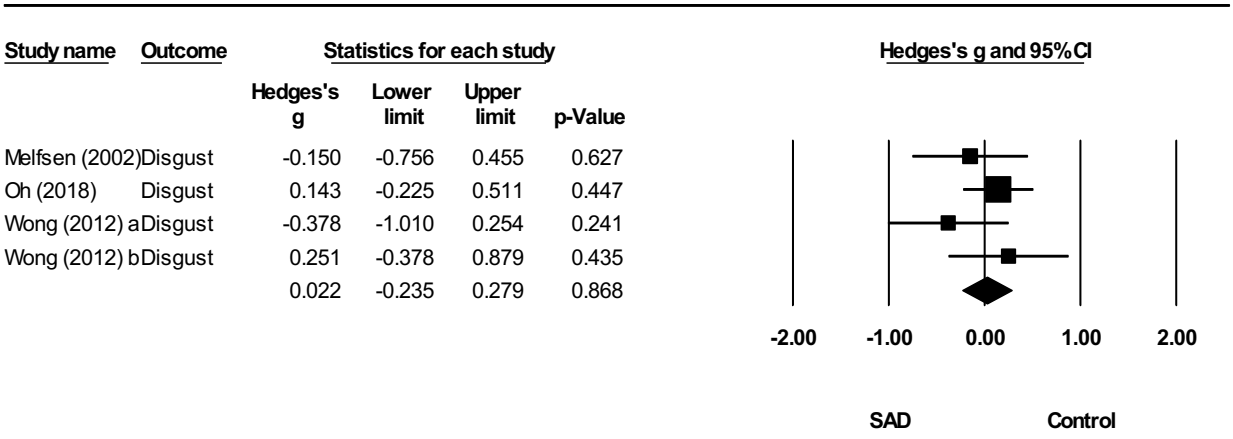
Funnel plot for accuracy across neutral emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there may be three studies missing from the analysis. If we impute an effect size for this missing study into the analysis, the adjusted effect size would shift from -0.307 to -0.443, yielding a 36.2% difference.

Figure S2.9

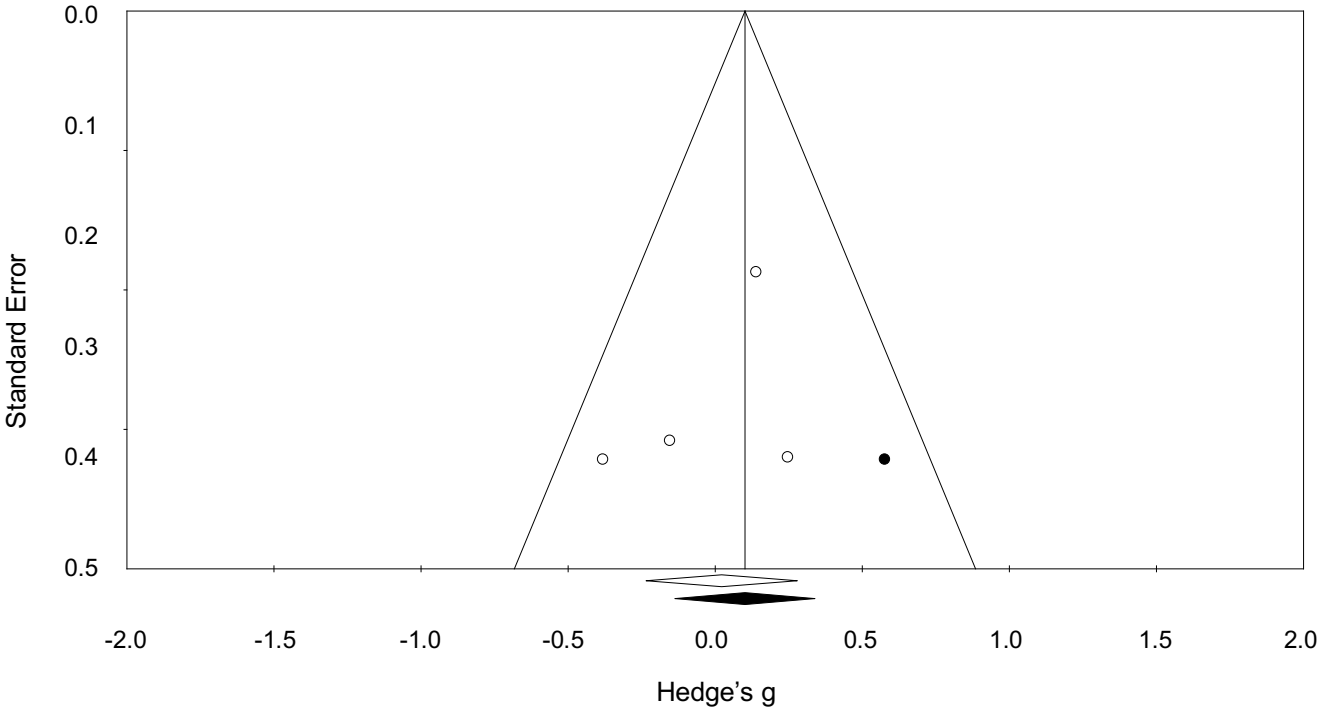
Summary effect sizes for accuracy across disgust emotion



Note. The results from the conditions where disgusted faces were shown (k=4) tentatively indicated no differences in the ability to recognize these emotional expressions (g=0.022, 95% CI= [-0.235, 0.279], p=.868). Figure S2.9 shows the distribution of effect sizes. Note, this analysis is underpowered. No heterogeneity was observed (T^2=0, T=0, I^2 =0%, Q=2.772, df=3, p=.428).

Figure S2.10

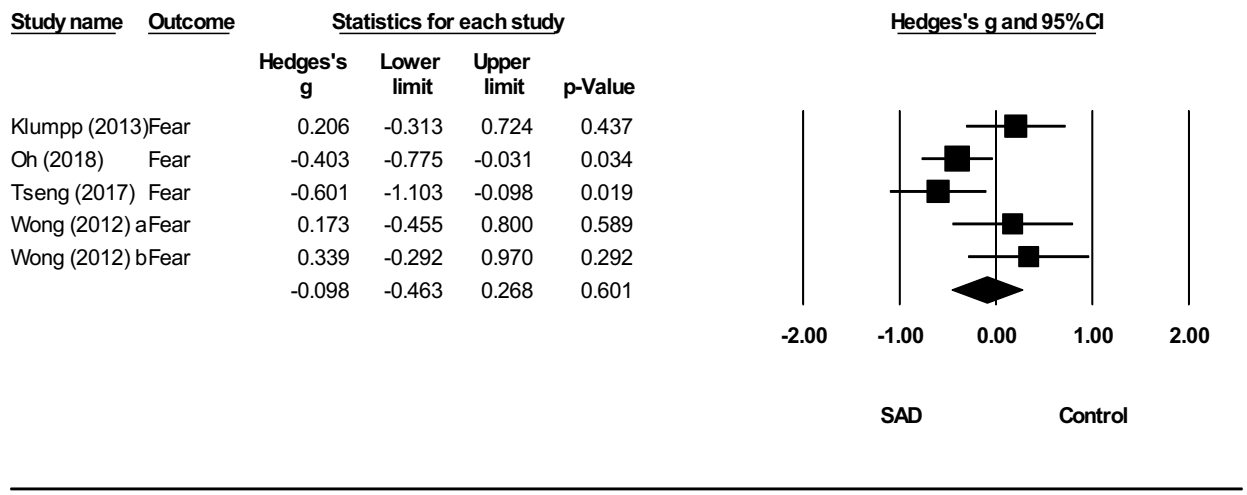
Funnel plot for accuracy across disgust emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there may be one study missing from the analysis. However, if we impute an effect size for this missing study into the analysis, the adjusted effect size would shift from 0.022 to 0.101. This difference of 128.5% between the initial estimate and the adjusted estimate is substantial.

Figure S2.11

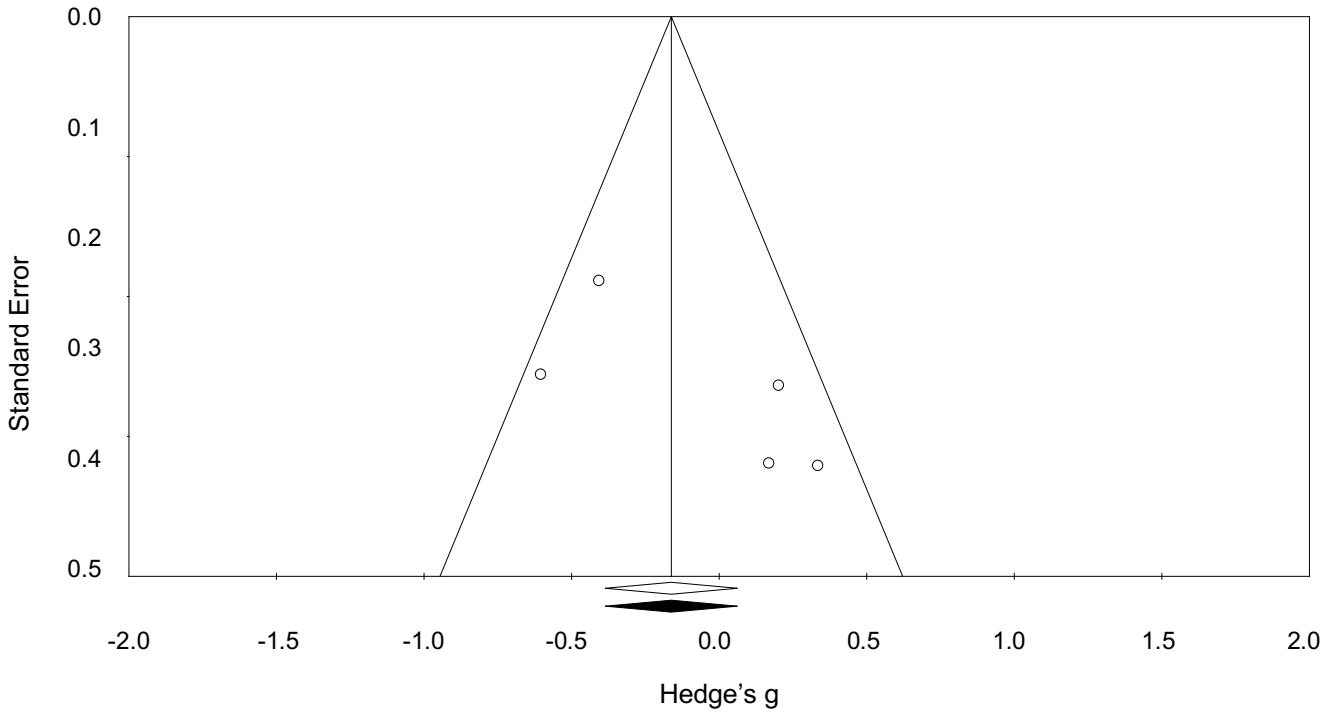
Summary effect sizes for accuracy across fear emotion



Note. The results from the conditions where fearful faces were shown (k=5) tentatively indicated no differences in the ability to recognize these emotional expressions (g=-0.098, 95% CI= [-0.463, 0.268], p=.601). Figure S2.11 shows the distribution of effect sizes. Note, this analysis is underpowered. Moderate heterogeneity was observed (T^2=0.102, T=0.320, I^2 =59.950%, Q=9.987, df=4, p=.041). The 95% prediction interval is -0.36 to 0.17.

Figure S2.12

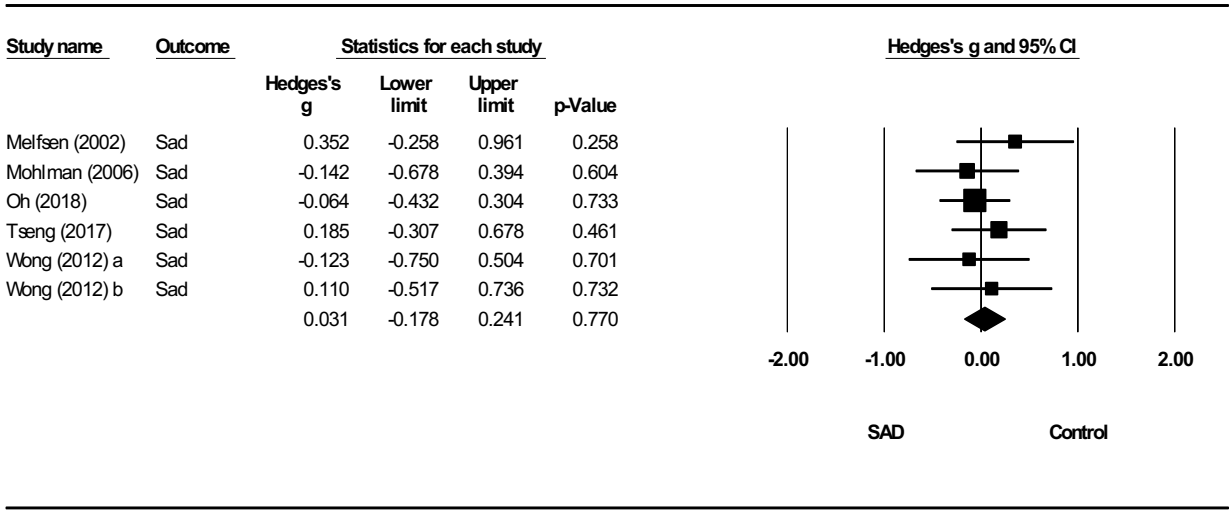
Funnel plot for accuracy across fearful emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there no studies missing from the analysis.

Figure S2.13

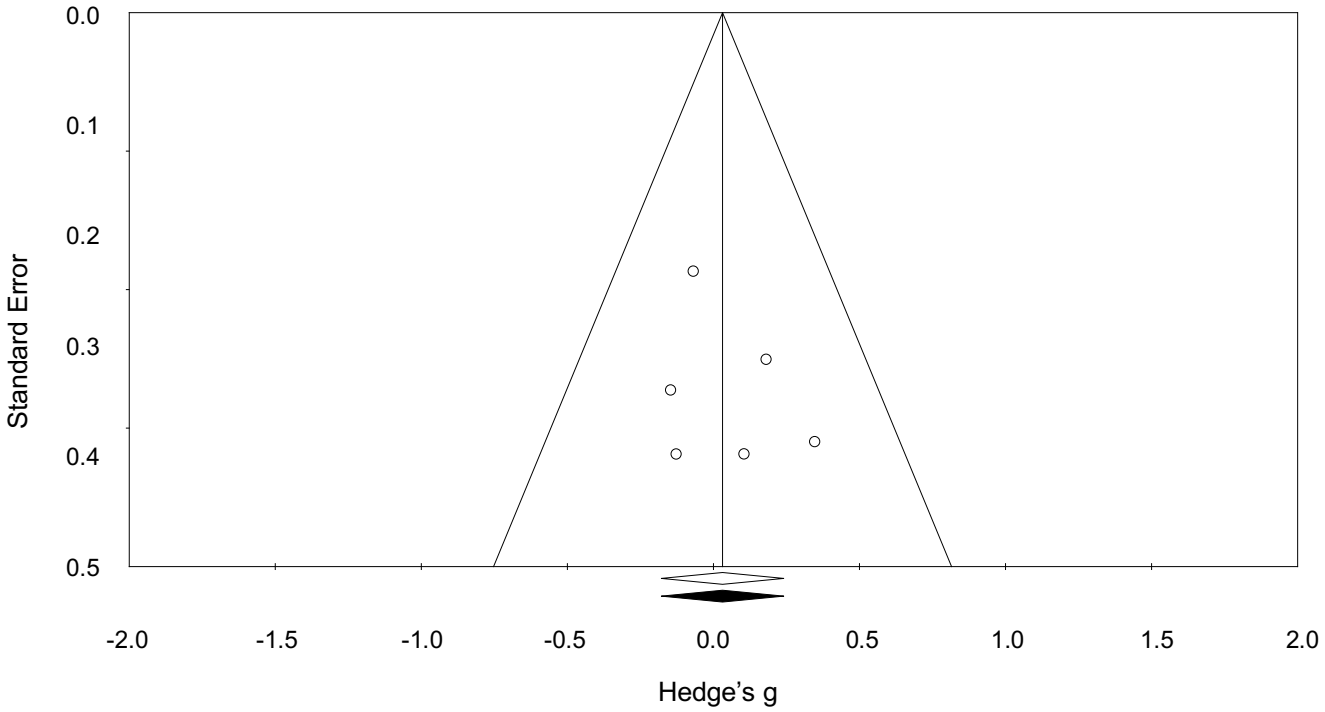
Summary effect sizes for accuracy across sad emotion



Note. The results from the conditions where sad faces were shown (k=6) tentatively indicated no differences in the ability to recognize these emotional expressions (g=0.031, 95% CI= [-0.178, 0.241], p=.770). Figure S2.13 shows the distribution of effect sizes. Note, this analysis is underpowered. No heterogeneity was observed (T^2=0, T=0, I^2 =0%, Q=2.388, df=5, p=.793).

Figure S2.14

Funnel plot for accuracy across sad emotion displaying adjusted effect size

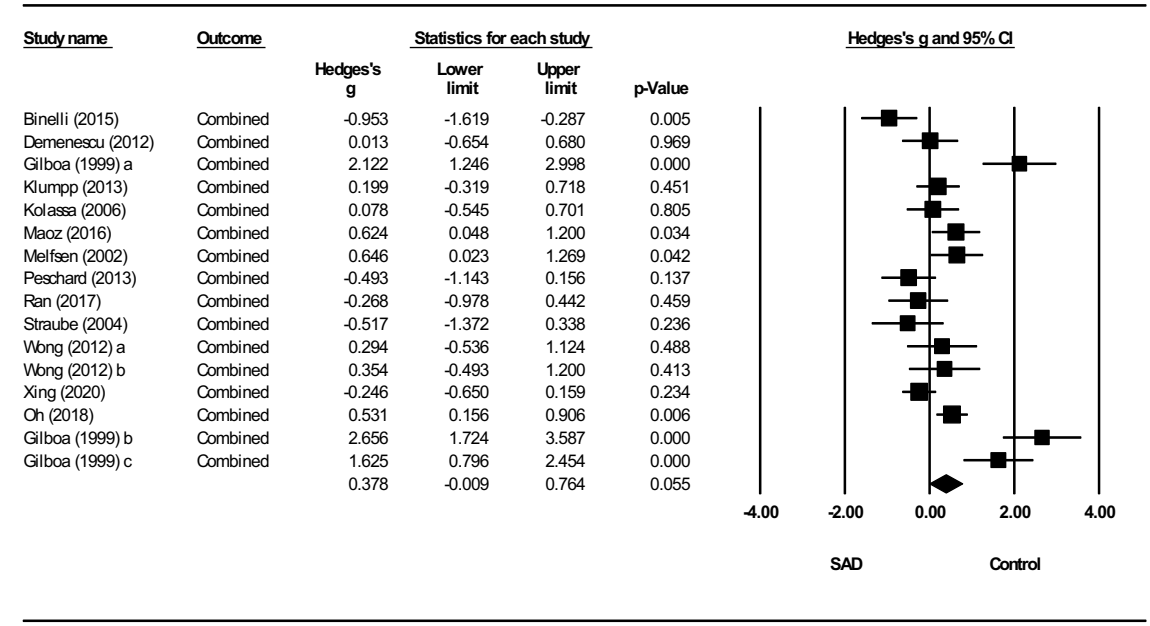


Note. The Trim and Fill analysis and plot suggest that there no studies missing from the analysis.

Reaction Time

Figure S2.15

Summary effect sizes for reaction time across combined emotions



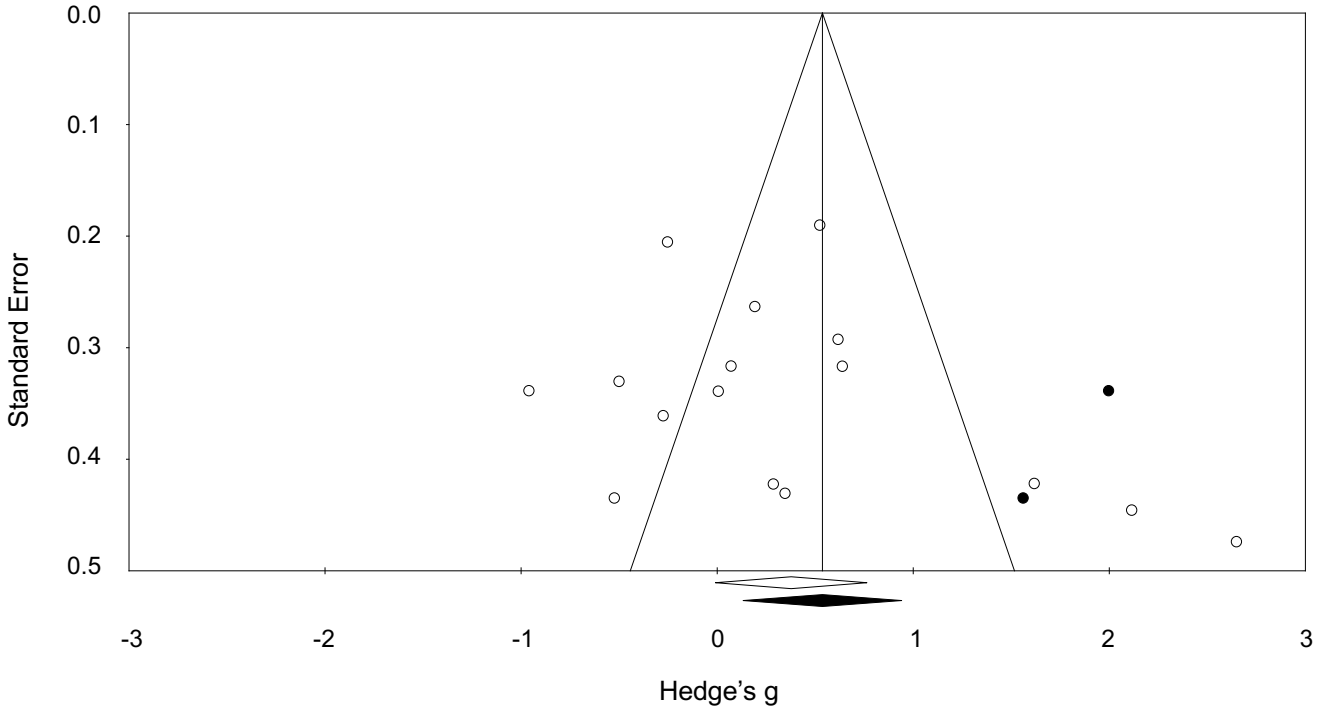
Study name	Outcome	Hedges's g	Lower limit	Upper limit	p-Value
Binelli (2015)	Combined	-0.953	-1.619	-0.287	0.005
Demenescu (2012)	Combined	0.013	-0.654	0.680	0.969
Gilboa (1999) a	Combined	2.122	1.246	2.998	0.000
Klumpp (2013)	Combined	0.199	-0.319	0.718	0.451
Kolassa (2006)	Combined	0.078	-0.545	0.701	0.805
Maoz (2016)	Combined	0.624	0.048	1.200	0.034
Melfsen (2002)	Combined	0.646	0.023	1.269	0.042
Peschard (2013)	Combined	-0.493	-1.143	0.156	0.137
Ran (2017)	Combined	-0.268	-0.978	0.442	0.459
Straube (2004)	Combined	-0.517	-1.372	0.338	0.236
Wong (2012) a	Combined	0.294	-0.536	1.124	0.488
Wong (2012) b	Combined	0.354	-0.493	1.200	0.413
Xing (2020)	Combined	-0.246	-0.650	0.159	0.234
Oh (2018)	Combined	0.531	0.156	0.906	0.006
Gilboa (1999) b	Combined	2.656	1.724	3.587	0.000
Gilboa (1999) c	Combined	1.625	0.796	2.454	0.000
		0.378	-0.009	0.764	0.055

Prediction interval -1.21 to 1.96

Note. This analysis was based on the results from all emotional expression conditions combined (k=16). The mean effect size (g=0.378, 95% CI= [-0.009, 0.764], p=0.55) indicates that the controls' reaction time to categorize facial expressions was 0.378 standard deviations lower than individuals with SAD. A significant amount of heterogeneity was observed (T^2=0.497, T=0.705, I^2=83.017%, Q= 88.325, df= 15, p<.001). The 95% prediction interval is -1.21 to 1.96, indicating that the true effect size in 95% of cases of similar studies falls within this range.

Figure S2.16

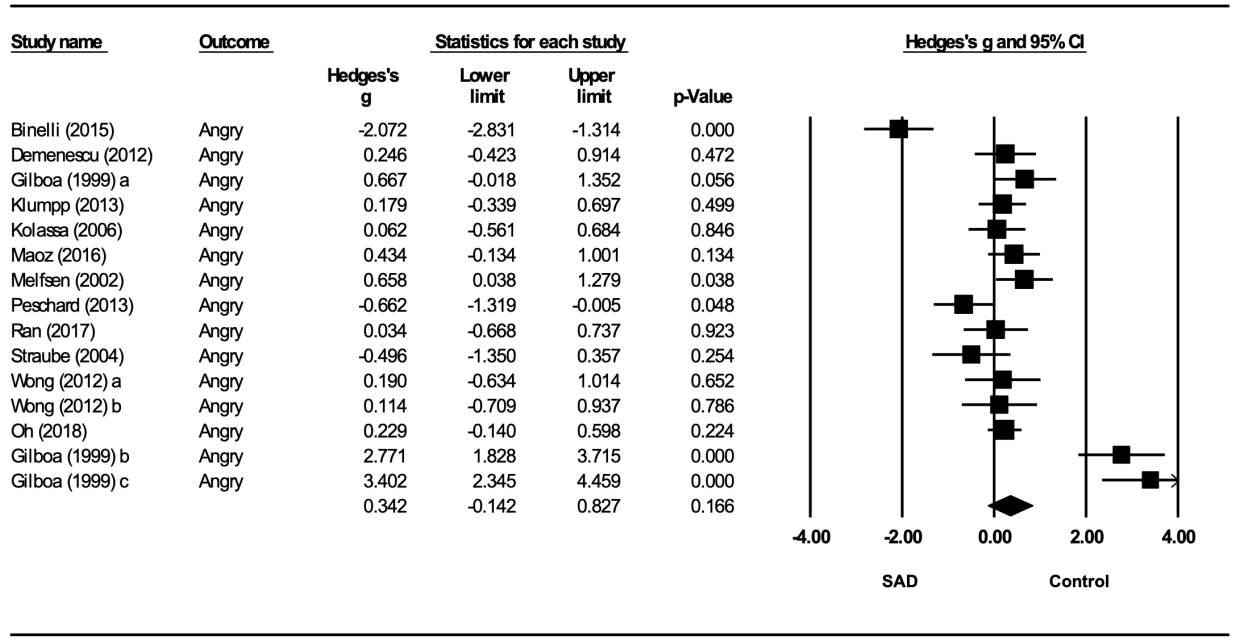
Funnel plot for reaction time across combined emotions displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there may be two studies missing from the analysis. If we impute an effect size for these missing studies into the analysis, the adjusted effect size will shift from 0.378 to 0.537, a percent difference of 34.75%.

Figure S2.17

Summary effect sizes for reaction time across angry emotion



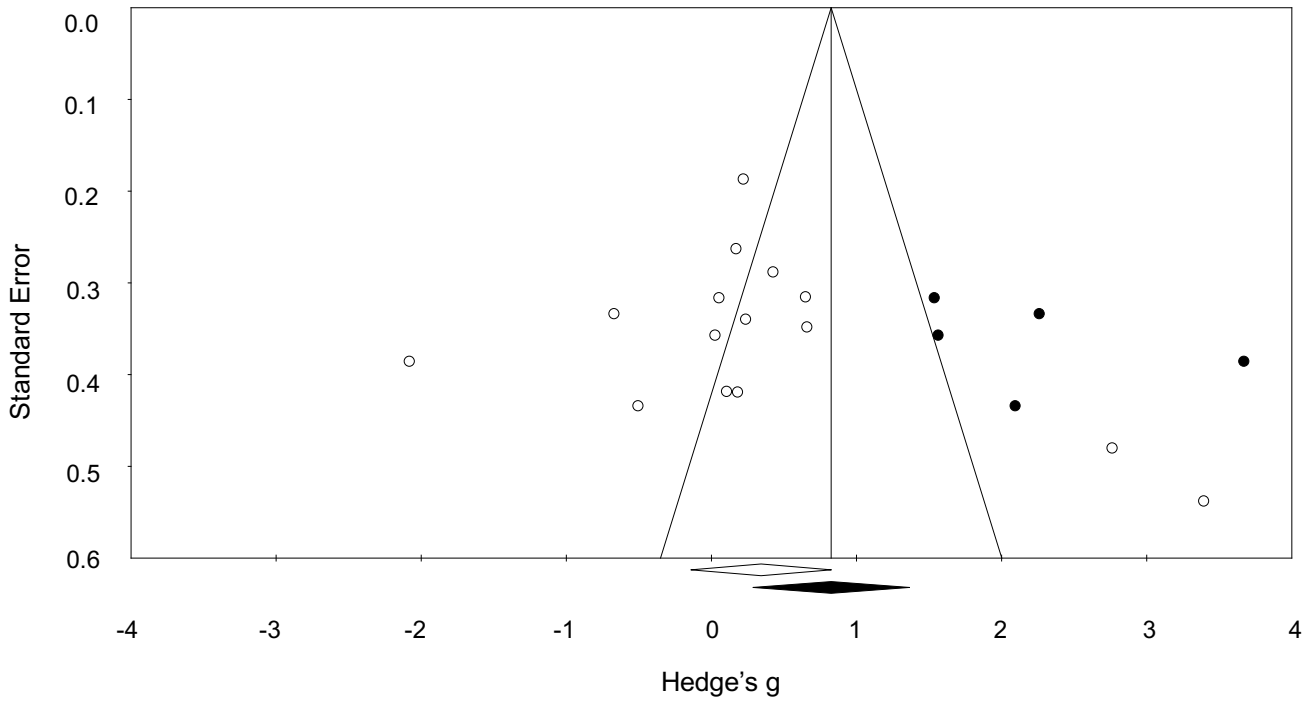
Study name	Outcome	Hedges's g	Lower limit	Upper limit	p-Value
Binelli (2015)	Angry	-2.072	-2.831	-1.314	0.000
Demenescu (2012)	Angry	0.246	-0.423	0.914	0.472
Gilboa (1999) a	Angry	0.667	-0.018	1.352	0.056
Klumpp (2013)	Angry	0.179	-0.339	0.697	0.499
Kolassa (2006)	Angry	0.062	-0.561	0.684	0.846
Maoz (2016)	Angry	0.434	-0.134	1.001	0.134
Melfsen (2002)	Angry	0.658	0.038	1.279	0.038
Peschard (2013)	Angry	-0.662	-1.319	-0.005	0.048
Ran (2017)	Angry	0.034	-0.668	0.737	0.923
Straube (2004)	Angry	-0.496	-1.350	0.357	0.254
Wong (2012) a	Angry	0.190	-0.634	1.014	0.652
Wong (2012) b	Angry	0.114	-0.709	0.937	0.786
Oh (2018)	Angry	0.229	-0.140	0.598	0.224
Gilboa (1999) b	Angry	2.771	1.828	3.715	0.000
Gilboa (1999) c	Angry	3.402	2.345	4.459	0.000
		0.342	-0.142	0.827	0.166

Prediction interval -1.64 to 2.32

Note. An analysis exclusively evaluating reaction time to angry facial expressions (k=15) yielded an estimated mean effect size of g=0.342 (95% CI= [-0.142, 0.827], p=.165). This result suggests no difference in the latency to accurately recognize angry facial expressions across groups. A significant amount of heterogeneity was observed (T^2=0.781, T=0.884, I^2 =87.535%, Q=112.313, df=14, p<.001). The 95% prediction interval is -1.64 to 2.32.

Figure S2.18

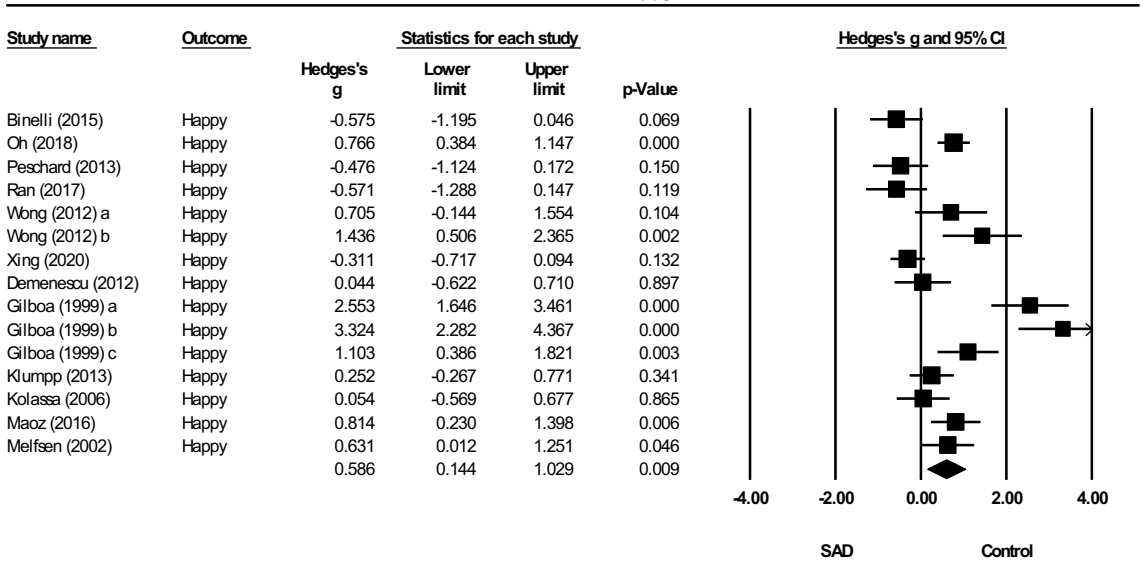
Funnel plot for reaction time across angry emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggests that there may be five studies missing from the analysis. If we impute an effect size for this missing study into the analysis, the adjusted effect size would shift from 0.342 to 0.825. Similarly, this difference of 82.3% between the initial estimate and adjusted estimate due to publication bias is quite substantial.

Figure S2.19

Summary of effect sizes for reaction time across conditions showing faces with happy expressions



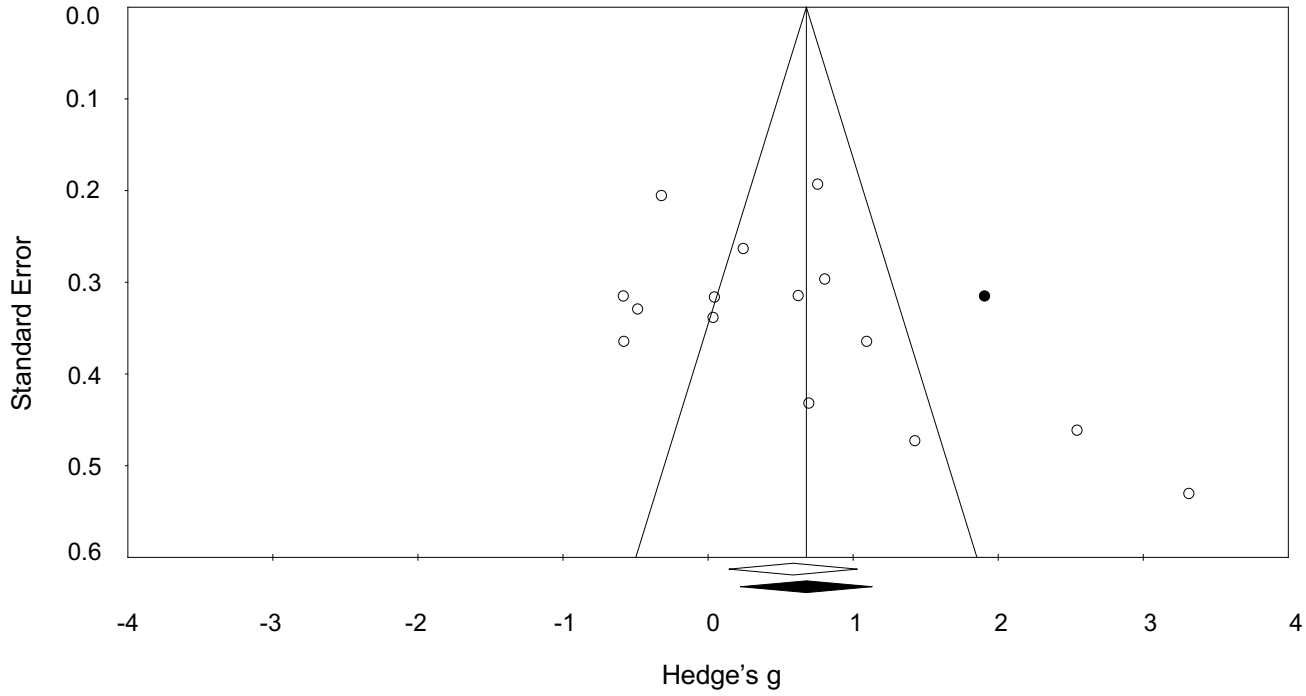
Study name	Outcome	Hedges's g	Lower limit	Upper limit	p-Value
Binelli (2015)	Happy	-0.575	-1.195	0.046	0.069
Oh (2018)	Happy	0.766	0.384	1.147	0.000
Peschard (2013)	Happy	-0.476	-1.124	0.172	0.150
Ran (2017)	Happy	-0.571	-1.288	0.147	0.119
Wong (2012) a	Happy	0.705	-0.144	1.554	0.104
Wong (2012) b	Happy	1.436	0.506	2.365	0.002
Xing (2020)	Happy	-0.311	-0.717	0.094	0.132
Demenescu (2012)	Happy	0.044	-0.622	0.710	0.897
Gilboa (1999) a	Happy	2.553	1.646	3.461	0.000
Gilboa (1999) b	Happy	3.324	2.282	4.367	0.000
Gilboa (1999) c	Happy	1.103	0.386	1.821	0.003
Klumpp (2013)	Happy	0.252	-0.267	0.771	0.341
Kolassa (2006)	Happy	0.054	-0.569	0.677	0.865
Maoz (2016)	Happy	0.814	0.230	1.398	0.006
Melfsen (2002)	Happy	0.631	0.012	1.251	0.046
		0.586	0.144	1.029	0.009

Prediction interval -1.67 to 2.37

Note. An analysis exclusively evaluating reaction time to happy facial expressions (k=15) yielded an estimated mean effect size of g=0.586 (95% CI= [0.144, 1.029], p=.009). This result suggests that individuals with SAD take significantly longer to accurately recognize happy facial expressions. A significant amount of heterogeneity was observed (T^2=0.641, T=0.800, I^2 =86.636%, Q=104.755, df=14, p<.001). The 95% prediction interval is -1.67 to 2.37.

Figure S2.20

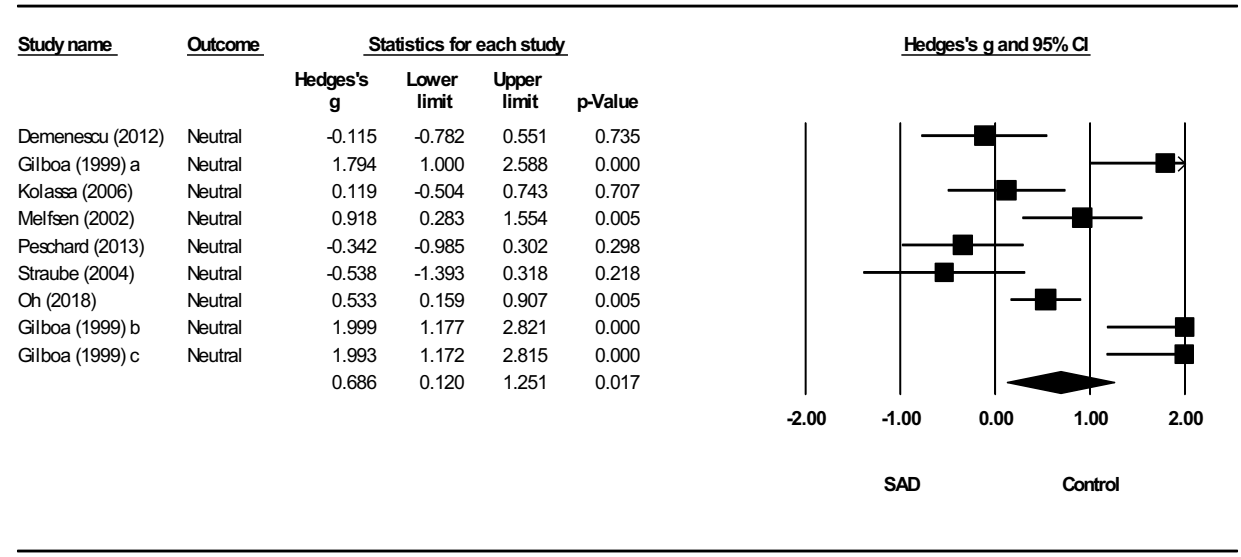
Funnel plot for reaction time across happy emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that one study may be missing from the analysis. After imputing an effect size for this missing study into the analysis, the adjusted effect size shifts from 0.586 to 0.678. This difference of 14.6% between the initial estimate and the adjusted estimate.

Figure S2.21

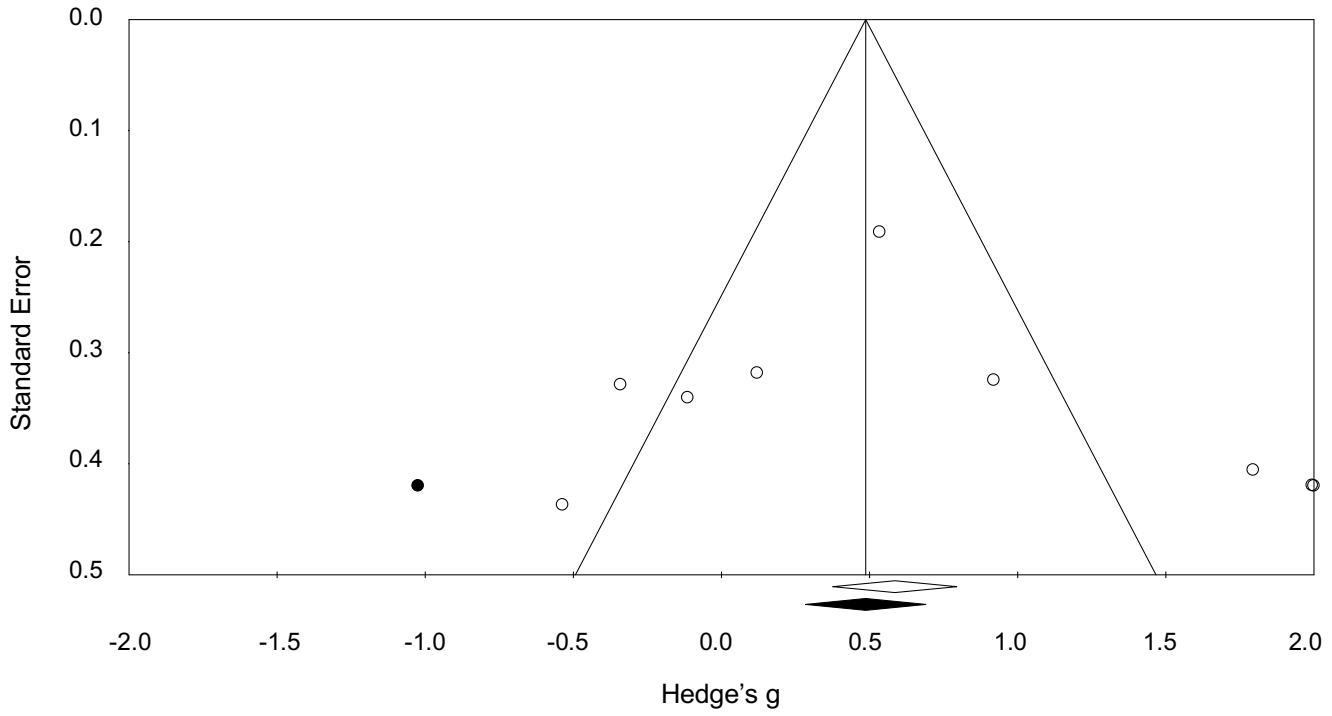
Summary of effect sizes for reaction time across conditions showing faces with neutral expressions



Note. The results from the conditions where neutral expressions were shown (k=9) to participants tentatively indicated that individuals with SAD took more time to accurately recognize neutral facial expressions compared to the control group (g=0.686, 95% CI= [0.120, 1.251], p=.017). Note, these results were underpowered. Heterogeneity was observed and thus followed up with moderation analyses. The 95% prediction interval is -1.15 to 2.52, indicating that the true effect size in 95% of cases of similar studies falls within this range.

Figure S2.22

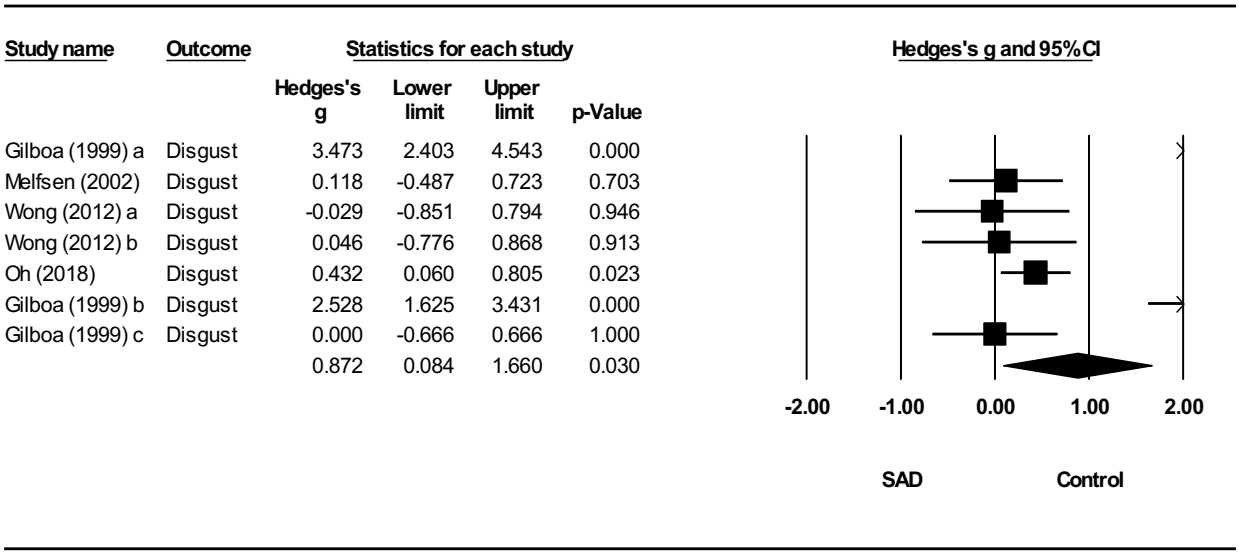
Funnel plot for reaction time across neutral emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that one study may be missing from the analysis. After imputing an effect size for this missing study into the analysis, the adjusted effect size shifts from 0.585 to 0.492, yielding a 17.3% difference.

Figure S2.23

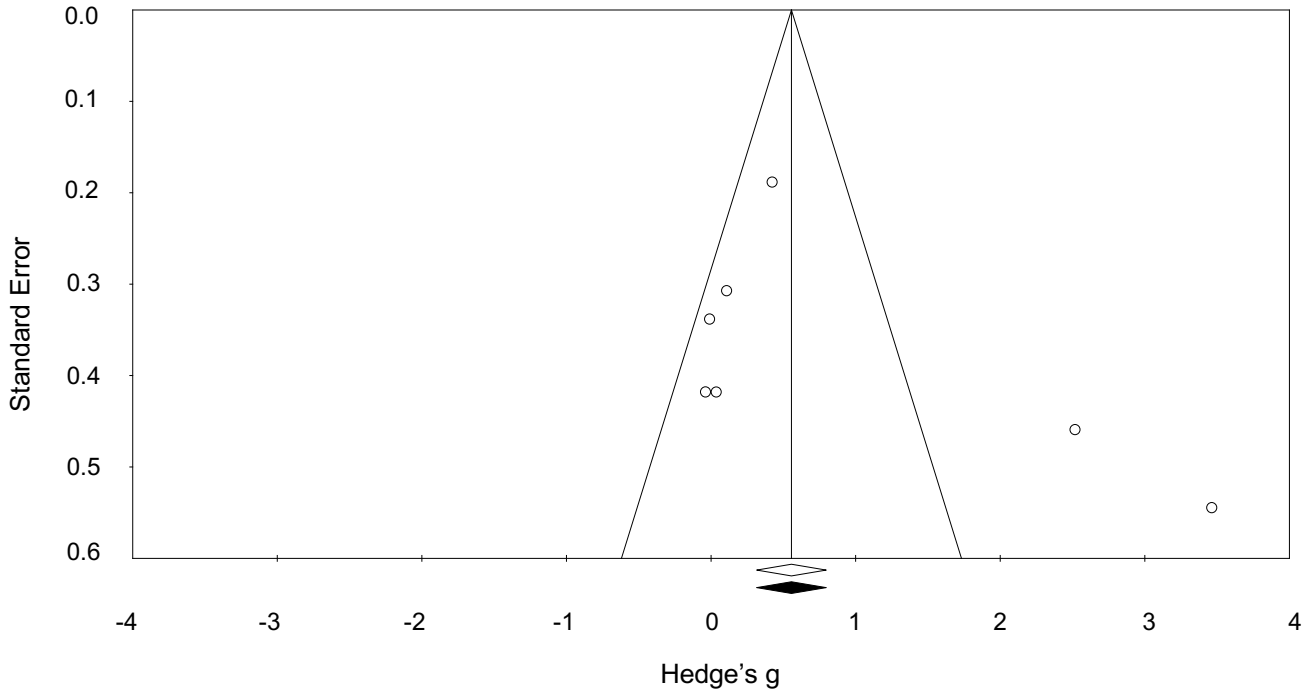
Summary effect sizes for reaction time across disgust emotion



Note. The results from the conditions where disgusted facial expressions were shown (k=7) tentatively indicated statistically significant differences in the latency to accurately recognize these emotional expressions (g=0.872, 95% CI= [0.084, 1.660], p=.0.030). Note, this analysis is underpowered. A significant amount of heterogeneity was observed (T^2=0.979, T=0.989, I^2 =89.166%, Q=55.382, df=6, p<.001). The 95% prediction interval is -0.156 to 0.330.

Figure S2.24

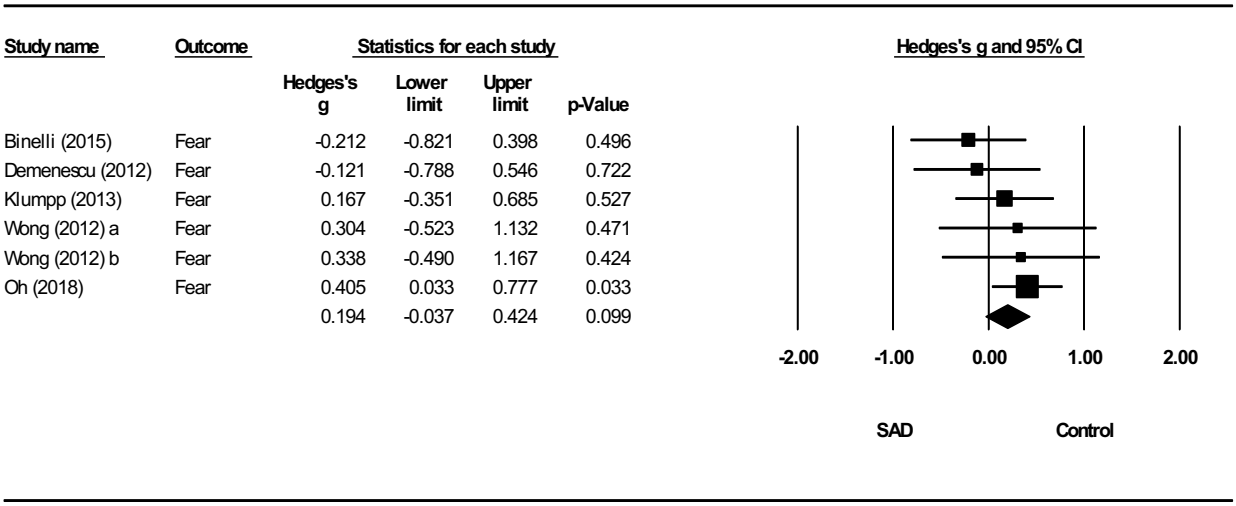
Funnel plot for reaction time across disgust emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there no studies missing from the analysis.

Figure S2.25

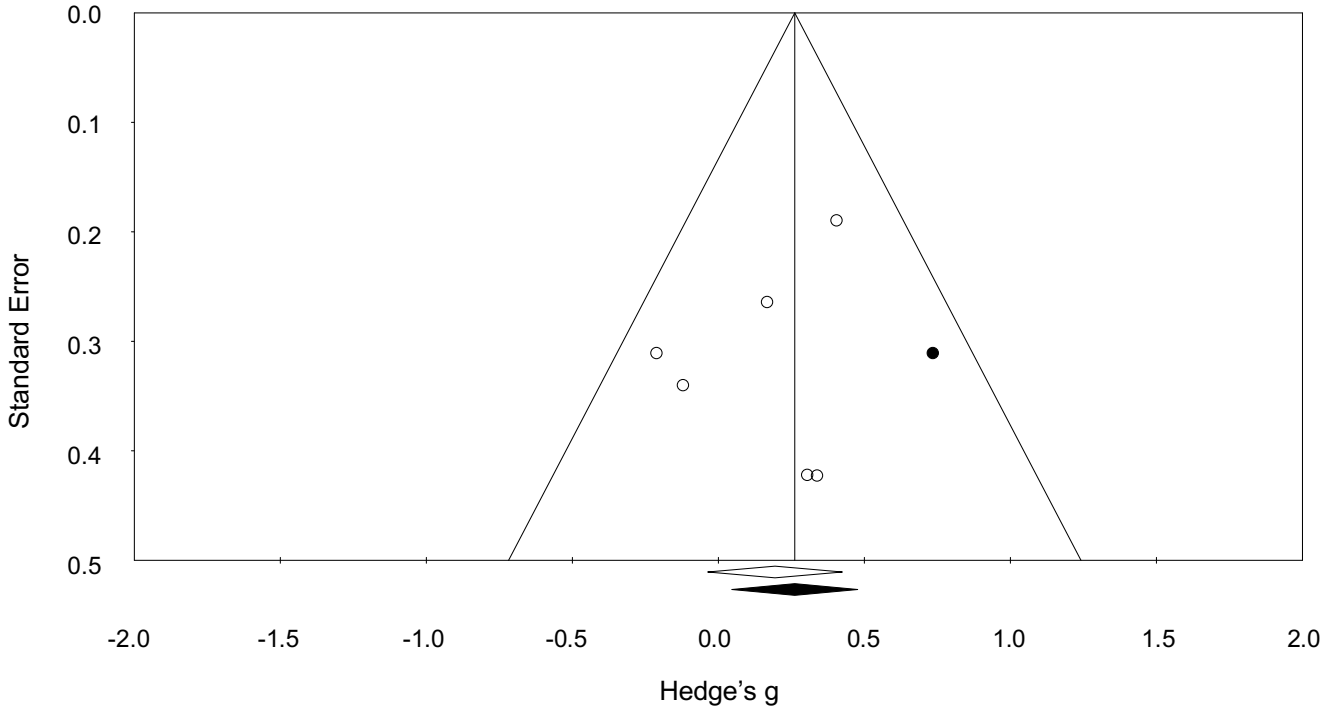
Summary effect sizes for reaction time across fear emotion



Note. The results from the conditions where fearful facial expressions were shown (k=6) tentatively indicated no significant differences in the latency to accurately recognize these emotional expressions (g=0.194, 95% CI= [-0.037, 0.424], p=.0.099). Figure 25 shows the distribution of effect sizes. Note, this analysis is underpowered. No heterogeneity was observed (T^2=0, T=0, I^2 =0%, Q=3.993, df=5, p=.550).

Figure S2.26

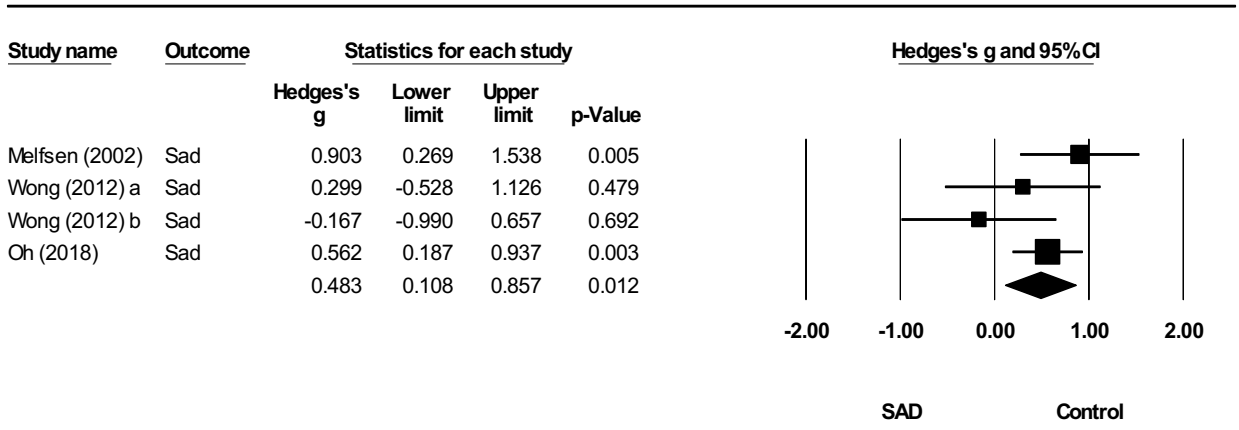
Funnel plot for reaction time across fear emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggests that there may be one study missing from the analysis. However, if we impute an effect size for this missing study into the analysis, the adjusted effect size would shift from 0.194 to 0.262. This results in a difference of 29.8% between the initial estimate and adjusted estimate.

Figure S2.27

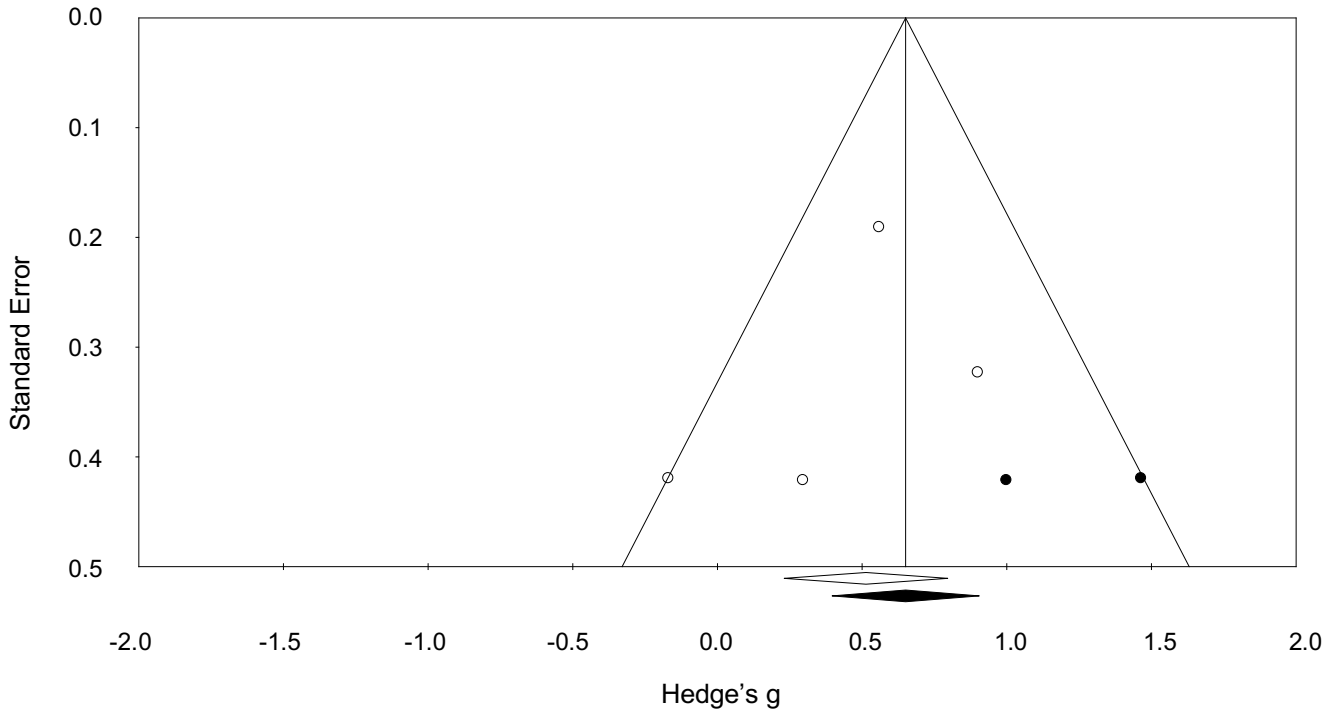
Summary effect sizes for reaction time across sad emotion



Note. The results from the conditions where sad facial expressions were shown (k=4) tentatively indicated statistically significant differences in the latency to accurately recognize these emotional expressions (g=0.483, 95% CI= [0.108, 0.857], p=.0.012). Note, this analysis is underpowered. Although heterogeneity was observed (T^2=0.047, T=0.217, I^2 =31.666%, Q=4.390, df=3, p=.222), it was not statistically significant. The 95% prediction interval is -0.125 to 1.09.

Figure S2.28

Funnel plot for reaction time across sad emotion displaying adjusted effect size



Note. The Trim and Fill analysis and plot suggest that there may be two studies missing from the analysis. If we impute an effect size for this missing study into the analysis, the adjusted effect size would shift from 0.483 to 0.650. This results in a difference of 29.48% between the initial estimate and the adjusted estimate.

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CHAPTER 3: STUDY 2

Impact of Social Anxiety on Communication Skills in Face-to-face vs. Online Contexts

Corina Lacombe, Karine Elalouf, Charles Collin

3.1 Abstract

Individuals with social anxiety have been shown to prefer communicating through online platforms. Part of this preference may be accounted for by their self-perceived level of social skill ability in online modalities. However, it is unclear whether perceived social skill abilities change across in-person and online contexts. Therefore, this study investigated whether specific social skills, like sociability, assertiveness, self-disclosure, and non-verbal emotion recognition vary across online and face-to-face settings. We first validated the *Real and Electronic Communications Skills* (RECS) questionnaire using a confirmatory factor analysis in a sample of 780 participants, who completed the survey through Qualtrics. We then conducted a series of correlations and a doubly multivariate GLM to evaluate whether perceived social skills abilities are influenced by communication medium and social anxiety. Our results indicated that we were able to validate the RECS, and that specific social skills like sociability and assertiveness are influenced by communication medium. Specifically, higher social anxiety scores were associated with decreased in-person sociability, emotion recognition, and assertiveness. The results highlight a potential perceived barrier to approaching in-person interactions, which may exacerbate avoidance of social interaction, thus resulting in social isolation and loneliness.

Keywords: Social anxiety, social skills, online, in-person, communication, technology-mediated communication

Highlights

- Real and Electronic Communication Skills questionnaire validated in a sample with social anxiety
- Communication medium (in-person vs. online) influences social skills in a sample with social anxiety
- Sociability and assertiveness are influenced by communication medium
- Communication medium does not influence self-disclosure or non-verbal emotion recognition

Impact of Social Anxiety on Communication Skills in Face-to-face vs. Online Contexts

3.1 Introduction

To date, it has not been established if the perceived social skills of those with social anxiety disorder (SAD) differ between online and in-person interactions. Investigating this is important because poor self-perceived social skills may influence the use of safety behaviours like avoidance of interpersonal interactions (Warnock-Parkes et al., 2020), resulting in decreased social connections, and poorer mental health outcomes. The current study evaluated whether perceived social skills, like sociability, assertiveness, self-disclosure and non-verbal emotion perception differed across online and in-person contexts in a sample of individuals with social anxiety.

3.1.1 Communication Importance

It is well-established that communication is a key factor in the formation and maintenance of meaningful social connections (Allen et al., 2014; Baumeister & Leary. 1995). Perceived social connectedness, which is defined as satisfaction with relationship quantity and quality, has been shown to have multiple adaptive functions, such as decreasing loneliness and isolation (Hawkley, Kozloski & Wong, 2017) and improving overall well-being (Holt-Lunstad, 2021). Similarly, perceived social connection has also been shown to predict health outcomes (Eisenberger & Cole, 2012; Holt-Lunstad, 2021). Eisenberger and Cole (2012) note that feeling socially disconnected is a social threat that may result in hypothalamus-pituitary-adrenal (HPA) axis-related overactivation, which promotes inflammation and a myriad of chronic conditions like Type II diabetes and cardiovascular disease, among others (Holt-Lunstad, 2021). For these reasons alone, investigating the variables that may influence perceived social connection is critical, especially in populations that may be at greater risk of social isolation. Among these populations are those who exhibit

impairing levels of shyness or fear of rejection in social situations, such as those with social anxiety disorder (Lim et al., 2016).

3.1.2 Social Anxiety

Social anxiety disorder (SAD) is primarily characterized by a fear of one or more social situations where an individual may be exposed to negative evaluation or scrutiny by others (APA, 2013). SAD, a disorder that has a lifetime prevalence ranging between 12–16% (Stein et al., 2017), can have multiple adverse effects. Common features among those with social anxiety are increased sensitivity to social threats and maladaptive cognitions (Masi et al., 2011). These include beliefs that they will be negatively judged by peers and ultimately rejected (Wells et al., 1995). As a result, individuals with social anxiety may socially isolate themselves and thus increase their risk of feeling lonely (Lim et al., 2016; Masi et al., 2011). The social costs of loneliness and isolation in this population are extensive. Individuals with social anxiety have been found to have less satisfaction and greater impairment in establishing romantic relationships and friendships (Stentz & Cougle, 2022). A longitudinal study by Lim and colleagues (2016) observed a cycle whereby trait social anxiety significantly predicted loneliness and loneliness exacerbated future social anxiety severity. Indeed, other studies have found that social anxiety disorder was the leading predictor of loneliness compared to other mental health disorders like major depression disorder, obsessive-compulsive disorder, generalized anxiety disorder, etc. (Meltzer, 2013). These psychosocial problems put individuals at risk of engaging in safety behaviours that follow their maladaptive cognitions (Warnock-Parkes et al., 2020). Some of these behaviours include avoiding in-person communication or activities, and increased use of technology, such as social media (O'Day & Heimberg, 2021).

3.1.3 Impact of Technology Use as a Communication Medium in SAD

Individuals with SAD have been shown to be less inclined to communicate in Face-to-Face (FtF) contexts. O'Day and Heimberg (2021) highlight in their recent systematic review that individuals with SAD may be using technology-mediated communication (TMC) platforms to compensate for their social fears and to compensate for their limited FtF social contact (Lee & Stapinski, 2012). Several studies have documented that individuals with social anxiety prefer to communicate via online modalities due to the increased ability to control self-presentation (Madell & Muncer, 2006), the enhanced sense of perceived safety that it provides (Kamalou, Shaughnessy & Moscovitch, 2018; McKenna & Bargh, 2000), and because it reduces the perceived social threat within their environment (Lee & Stapinski, 2012). Caplan (2005) suggests that although these attractive features may perpetuate online communication, it is social skills deficits that predispose individuals to use TMC. Here, social skills refer to one's ability to engage in interpersonal interactions effectively and appropriately (Segrin & Givertz, 2003). Riggio (1986) pioneered a framework and measure (Riggio & Carney, 2003) to identify and assess core social skill domains required for a successful in-person interaction. These include emotional expressivity, emotional sensitivity, emotional control, social expressivity, social sensitivity, and social control, which can be assessed using the Social Skills Inventory (SSI). Each of the named factors touch on important abilities ranging from communicating via nonverbal cues, verbal speaking skills, understanding social norms, appearing socially adept and confident, etc. (see Riggio 1986 for detailed definitions to these constructs). Importantly, Riggio (1986) noted that lower social skills on the SSI significantly correlated negatively with the social anxiety, lending support for the social-skill-deficit-vulnerability hypothesis.

According to the social-skill-deficit vulnerability hypothesis, individuals with social skills deficits are at risk of decreasing their psychosocial well-being (Caplan, 2005; Davis, 2001). This is especially problematic for individuals with social anxiety, as they have been shown to negatively misperceive their own social skill abilities (Segrin & Kinney, 1995). However, whether their perception of social skill abilities is influenced by a communication medium (i.e., TMC or FtF) remains unstudied. This is possibly due to the limited measures available to evaluate such a question.

Mantzouranis and colleagues (2019) developed a tool titled *The Real and Electronic Communications Skills Questionnaire* (RECS) to evaluate whether specific social skill domains vary across FtF and online communication mediums. These domains include sociability, self-disclosure, assertiveness, and emotion decoding. In Mantzouranis et al. (2019), the authors compared the nomological validity of their measure to the Social Skills Inventory (Riggio & Carney, 2003) and found that each of the domains on the RECS correlated significantly with the SSI factors. Given that the SSI only evaluates in-person social skills, Mantzouranis and colleagues (2019) noted that it is not surprising the measure correlated more strongly with the FtF subscale of the RECS. Individually, each of the RECS domains was deemed an important component of a successful interaction. For instance, high sociability suggests the tendency to prefer affiliating or interacting with, joining and approaching social activities. Similarly, self-disclosure involves the ability to take chances on divulging personal information such as values, needs, fears, and personal beliefs without experiencing an impairing fear of judgment (Green et al., 2016; Mantzouranis, 2019). Self-disclosure may also require asserting oneself in social interactions (Caballo et al., 2014). Assertiveness is the ability to appropriately, respectfully and honestly stand up for our beliefs, thoughts, emotions and rights (Hargie, 2022). Individuals may want to express

disagreement, refuse a request, demand change or end a particular interaction – all of which are considered *negative assertions*. In contrast, *positive assertions* include prosocial behaviours like initiating a social interaction or accepting a compliment. Outside of verbal social skills lies the ability to interpret and integrate non-verbal forms of communication, like emotion decoding through emotional facial expression recognition, voice prosody, or body movement expressions (Mantzouranis, 2019). Moreover, together these four domains are hypothesized to reflect one's global communication skills.

Although each of these social skill domains varies by degree across a general population, studies have suggested that individuals with social anxiety have increased difficulty with approaching social interactions (Wells et al., 1995), disclosing information about themselves (Green et al., 2016), asserting themselves (Caballo et al., 2014), and accurately recognizing various facial expressions (Lacombe et al., 2023)

3.1.4 Current Study

In the present study, we evaluated whether perceived social skills are influenced by communication medium (TMC, FtF) in a sample of individuals with social anxiety. We used the RECS to assess which social skill domains are influenced by communication medium. We conducted a bifactor confirmatory factor analysis, validating the RECS in the current sample. We hypothesized that we would find the same bifactor structure that was identified by the test developers (Mantzouranis et al., 2019). Additionally, we conducted correlational analyses and implemented a doubly multivariate general linear model to explore the relationship between social anxiety, communication medium, and the four specific social skills domains. Internal consistencies for each of the selected measures were assessed. The state of the current literature suggests that individuals with social anxiety may have a biased perception of their own social skills (Segrin &

Kinney, 1995), influencing their increased use of TMC (Caplan, 2005; Lee & Stapinski, 2012; O'Day & Heimberg, 2021). Therefore, we hypothesized that FtF social skills would be most affected by social anxiety and that perceived social skills would be less affected in TMC compared to FtF contexts.

3.2 Method

3.2.1 Participants

A sample of 780 participants from Canada completed the online survey through Qualtrics (see **Table 3.1** for detailed demographic information). The sample mostly consisted of undergraduate students from the University of Ottawa's Integrated System for Participation in Research (n = 766), with a smaller number coming from a community sample (n = 14). The community sample was recruited from an ongoing study (https://osf.io/gq4vj). In that study, participants were recruited through flyers posted in the greater-Ottawa area in Ontario, Canada, and advertisements posted on social media platforms (e.g., Facebook, Kijiji). All potentially eligible participants completed a screening questionnaire. Participants with a severe psychiatric disorder, mood disorder, traumatic brain injury or with epilepsy were excluded at the screening phase. Eligible participants were then invited to complete a virtual diagnostic interview using the semi-structured Anxiety Disorders Interview Schedule (ADIS-5; Brown & Barlow, 2014), which was conducted by a trained senior Clinical Psychology PhD student (under the supervision of a licensed Clinical Psychologist). Participants from the community sample who met the DSM-5 criteria for social anxiety disorder and who agreed to be contacted for future research opportunities were invited to participate in this study. Participants from a community sample were recruited to enhance diversity with regard to age and social anxiety symptom severity. From the entire sample, 78 participants were excluded because more than 5% of the survey items were not completed.

Participants' ages in the undergraduate (M = 19.45, SD = 2.84) and community samples (M = 31.57, SD = 10.55) ranged from 16–52 and 20–59 years old, respectively. All participants (100%) reported currently using an electronic device to communicate and socialize with peers. The majority (86%) of the sample reported using their device daily. On average, they reported spending about 3–5 hours per day on their device to socialize with peers.

3.2.2 Procedure

The study was completed online, and hosted through the Qualtrics™ survey system. The undergraduate samples accessed the survey through the Integrated System of Participation in Research, an undergraduate subject pool, where they received course credit as compensation for their participation. Participants from the community sample database who had agreed to be contacted for future research opportunities were invited to participate in an online survey, where they had a chance to win one of three Amazon e-gift cards valued at $20, $30, or $50. All participants were provided with a URL link, which redirected them to the online survey "Validation of the Real and Electronic Communication Skills (RECS) Questionnaire". Subsequently, they were then instructed to complete the RECS, the self-report Liebowitz Social Anxiety Disorder Scale (LSAS-SR), and a brief demographics questionnaire. This study was approved by the University of Ottawa's Research Ethics Board (REB). This study was supported by the University of Ottawa.

3.2.3 Measures

Demographics. Participants answered various questions relating to their demographic characteristics (age, gender identification, ethnicity identification, occupation, etc.), details pertaining to their electronic device use (e.g., current use and use prior to COVID-19), and level of social anxiety (see **Table 3.1** summary statistics regarding their responses).

Table 3.1

Participant demographic characteristics

Variable		%	*M*	*SD*	Range
LSAS-SR score			62.02	27.31	0–144
Age			19.69	3.58	16–59
Gender					
	Female	71.37			
	Male	27.49			
	Transgender	0.14			
	Other	1.00			
Ethnicity					
	Arab	4.5			
	Arab (North Africa, Middle East, Central, Other)	5.2			
	Arab/African	1.4			
	Asian (East, South, Southeast, Central, Other)	8.4			
	Black – African	5.6			
	Black – Caribbean	1.1			
	Black – North American	0.1			
	Black (North American, African, Caribbean, Other)	6.7			
	East Asian	6.8			
	Hispanic/Latin American	0.5			
	Indian	0.4			
	Indian (India, Caribbean, Other)	1.1			
	Indigenous (First Nations, Métis, Inuit, Other)	0.4			
	Indigenous/Aboriginal	0.1			
	Latin American	1.2			
	Middle Eastern	1.4			
	Mixed Heritage	2.9			
	South Asian	3.7			
	Southeast Asian	2.9			
	White – European	6.8			
	White – North American	17.8			
	White (North America, European, Other)	16.8			
	Decline to answer	1.5			
	I don’t know	0.4			
	Other (nothing applies to me)	2.3			

Occupation	
Employed	3.70
Full-time student	94.73
Part-time student	1.13
Unemployed	0.40
Current electronic use for communication	
0 days per week	0.43
1–3 days per week	4.27
3–5 days per week	8.55
7 days per week	86.75
Less than 1 hour per day	6.27
1–2 hours per day	15.67
2–3 hours per day	24.07
3–5 hours per day	26.35
5–7 hours per day	14.10
7–9 hours per day	7.12
More than 9 hours per day	6.41
Pre-COVID-19 pandemic electronic use for communication	
0 days per week	0.43
1–3 days per week	7.41
3–5 days per week	15.81
7 days per week	76.35
Less than 1 hour per day	7.69
1–2 hours per day	20.66
2–3 hours per day	21.65
3–5 hours per day	25.36
5–7 hours per day	13.53
7–9 hours per day	5.98
More than 9 hours per day	5.128

N = 702
Note. LSAS-SR = Liebowitz Social Anxiety Disorder Scale Self-Report

Real and Electronic Communication Skills Questionnaire (RECS; Mantzouranis, Baudat & Zimmermann, 2019). Participants rated each of the 36 items (18 items per subscale) about four dimensions of perceived social communication skills (sociability, assertiveness, disclosure, and emotion decoding) using a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The perceived social skills were assessed across two communication medium subscales, namely Online (Electronic Communication Skills; ECS) and Face-to-Face (Real

Communication Skills; RCS). Responses for the four specific factors within the ECS and RCS subscales were summed to provide an index of their perceived social communication abilities for the respective category. The RECS is a relatively newly developed tool. It has been shown to have good internal consistency and reliability for the online and Face-to-Face subscales (Mantzouranis et al., 2019). In line with Kalkbrenner's (2023) recommendations, we used McDonald's Omega to evaluate the internal consistency of ordinal data. In the current study, the internal consistency was satisfactory for both the RCS ($\omega = 0.705$, 95% CI = [0.674, 0.737]) and the ECS ($\omega = 0.796$, 95% CI = [0.774, 0.818]) subscales. See Appendix A of supplementary materials to view a copy of the RECS.

Liebowitz Social Anxiety Scale – Self-report (LSAS-SR; Liebowitz, 1987). The self-report Liebowitz Social Anxiety Scale is a 24-item self-rated questionnaire that assesses key components of social anxiety (fear, and avoidance) experienced by the participant over the past week. Items on the fear dimension are individually scored on a scale four-point rating scale ranging from 0 (none) to 3 (severe). Similarly, avoidance is equally rated on a four-point rating scale ranging from 0 (never, 0%) to 3 (usually, 68–100%). A total score that ranges from 0–29 indicates no/low social anxiety, 30–59 indicates nongeneralized social anxiety, and 60+ indicates generalized social anxiety (Rytwinski et al., 2009). The current sample was screened using the LSAS-SR to assess for symptoms of social anxiety. Although we sought to only include participants that had a total score of 30 and above, no participants within our sample reported a score below 48. Therefore, no participant was excluded on the basis of their LSAS-SR score. The test reported excellent internal consistency for the fear and avoidance subscales (Oakman et al., 2003). The internal consistencies for the fear ($\omega = 0.943$, 95% CI = [0.837, 0.949]) and avoidance ($\omega = 0.890$, 95% CI = [0.878, 0.902]) subscales in the current sample were likewise excellent.

3.3 Results

3.3.1 Preliminary Results

Data screening revealed that 78 participants (10%) had more than 5% of their data missing at random. List-wise deletion was used to remove their data from the main analyses. The distribution of scores in histograms, QQ plots, and residual plots were visually inspected and revealed no apparent deviations from normality. Skewness and kurtosis were further evaluated and indicated no deviations from normality. No spurious univariate outliers were identified in this sample. To assess for multivariate outliers, Mahalanobis Distance statistic was investigated in SPSS, which identified 6 multivariate outliers ($p < .001$). Given that the outliers had no influence on the results, all multivariate outliers were retained.

3.3.2 Confirmatory Factor Analyses of the RECS

We conducted two Confirmatory Factor Analyses (CFA) following the factor structure identified by the test developers (Mantzouranis et al., 2019). The test developers retained a bifactor model in which a global factor (*Social Competence*) underlies four domain-specific latent factors (*Sociability*, *Assertiveness*, *Self-Disclosure*, and *Emotion Decoding*) for each distinct subscale (ECS, RCS). In line with our hypothesis, our results did support the model found by Mantzouranis and colleagues (2019). Using WLSMV in *MPlus* 8.6 (Muthén & Muthén, 2017; see supplementary materials for analysis plan), we found excellent fit for the ECS and bifactor models (see **Table 3.2**).

Most factor loadings were statistically significant (see **Table S3.2** and **Table S3.5** in supplementary materials). For the ECS subscale, two items among the general factor (i.e., item 8: $|\lambda| = .037$, item 18: $|\lambda| = .181$), and two items among the self-disclosure factor (i.e., item 10: $|\lambda| = .126$, item 17: $|\lambda| = .180$) were weaker. Similarly, for the RCS subscale, five items among the

general factor were weaker (i.e., item 2: $|\lambda|$ = .038, item 3: $|\lambda|$ = .190, item 5: $|\lambda|$ = .064, item 6: $|\lambda|$ = -.197, item 17: $|\lambda|$ = -.144). The results indicate that these specific items may not be relevant (statistically speaking) in measuring the respective latent variables.

Table 3.2

Model fit results for the ECS and RECS measurement models

	df	χ^2	CFI	TLI	RMSEA	95% CI	SRMR
Bifactor ECS	117	453.35***	0.937	0.918	0.064	0.058, 0.070	0.044
Bifactor RCS	116	478.63***	0.931	0.909	0.067	0.06, 0.073	0.049

Note. *** $p \leq .001$

3.3.3 Correlation Results

We examined the correlations between each summed factor score on the RECS with the LSAS-SR for both the RCS and ECS subscales. In line with our hypothesis that social skills would be more greatly affected by anxiety in FtF communication contexts, we found that LSAS-SR scores were significantly negatively correlated with three factors. Higher social anxiety scores were associated with decreased in-person sociability (r = -0.38, p < .001), emotion decoding (r = -0.134, p < .001), and assertiveness (r = -0.427, p < .001). In contrast, LSAS-SR scores were only significantly negatively correlated with two factors in TMC contexts, such that increased social anxiety scores were associated with decreased sociability (r = -0.095, p = .012) and assertiveness (r = -0.229, p < .001). Note that in both cases, the strength of the association for TMC scores was significantly weaker (sociability: z = 5.7, p < .0001; assertiveness: z = 4.2, p < .0001) than for the equivalent FtF score (see **Tables 3.3**–**3.4**).

Table 3.3

Correlations with confidence intervals for RCS subscale and LSAS-SR scores

			R (n = 702)		
Variable	1	2	3	4	5
1. Sociability	-				
2. Self-disclosure	.211***	-			
	[.281, .140]				
3. Emotion decoding	.196***	.010	-		
	[.266, .124]	[.800, .084]			
4. Assertiveness	.384***	.094*	.262***	-	
	[.446, .319]	[.013, .167]	[.329, .191]		
5. LSAS-SR	-.438***	-.017	-.134***	-.427***	-
	[-.376, -.496]	[.057, -.091]	[-.061, -.206]	[-.635, -.456]	

Note. *LSAS-SR* = Liebowitz Social Anxiety Disorder Scale Self-Report; *p < .05; **p < .01; ***p < .001

Table 3.4

Correlations with confidence intervals for ECS subscale and LSAS-SR scores

			R (n = 702)		
Variable	1	2	3	4	5
1. Sociability	-				
2. Self-disclosure	.438***	-			
	[.496, .377]				
3. Emotion decoding	.255***	.288***	-		
	[.323, .184]	[.354, .218]			
4. Assertiveness	.288***	.174***	.188***	-	
	[.355, .219]	[.245, .101]	[.258, .116]		
5. LSAS-SR	-.095*	.071	-.054	-.229***	-
	[-.021, -.168]	[.144, -.003]	[.020, -.127]	[-.158, -.298]	

Note. *LSAS-SR* = Liebowitz Social Anxiety Disorder Scale Self-Report; *p < .05; **p < .01; ***p < .001

Additionally, we examined whether overall perceived social skills differed across FtF and TMC contexts. We found that, overall, participants perceived themselves to have greater social skills in FtF (M = 59.392, SD = 7.819) compared to online (M = 53.682, SD = 8.811) contexts [t (701) = 15.209, p = < .001, d = 0.574]. In sum, although participants perceived themselves to have

greater social skills in FtF contexts (see **Table 3.5**), domain-specific skills like sociability, emotion decoding, and assertiveness are more severely impacted by social anxiety in FtF contexts among those who experience higher social anxiety. Conversely, domain-specific social skills in online contexts appear to be less impacted by social anxiety severity.

Table 3.5

Descriptive statistics for the ECS and RCS factors

Variables	*M*	*SD*
Electronic Communications Skills (ECS)		
Sociability	13.33	3.78
Self-Disclosure	14.16	3.54
Emotion Decoding	16.48	3.38
Assertiveness	9.71	2.12
Real Communications Skills (RCS)		
Sociability	15.02	3.55
Self-Disclosure	14.56	3.81
Emotion Decoding	19.46	2.85
Assertiveness	10.36	2.32

N = 702

3.3.4 Doubly Multivariate GLM Results

Using SPSS, a doubly multivariate GLM analysis was used to test whether communication medium (FtF, TMC) predicted social skills scores on the four specific factors (sociability, disclosure, emotion decoding, and assertiveness). We used social anxiety as a covariate to evaluate the variance accounted for by each of the four factors on overall self-rated social skills. The results summarized in **Table 3.6** indicated that social anxiety [F (480, 2324) = 1.589, $p < .001$, $\eta_p^2 = .247$] as measured by the LSAS-SR, and communication medium [F (4, 578) = 81.262, $p < .001$, $\eta_p^2 = .360$] predicted significant variance in overall perceived social skills. Similarly, we found a statistically significant interaction between communication medium and self-reported social

anxiety symptoms [F (480, 2324) = 1.190, p = .006, η_p^2 = .197] on overall social skill abilities. When evaluating this interaction across each of the four factors, we found that communication medium and social anxiety predicted significant variance for sociability [F (120, 581) = 1.447, p = .003, η_p^2 = .230] and assertiveness [F (120, 581 = 1.298, p = .028, η_p^2 = .211]. Thus, the results of the doubly multivariate GLM suggest that globally there is an effect of social anxiety and communication medium on general social skills ability. However, in examining this effect at the level of individual social skills factors, we find that this interaction impacts sociability and assertiveness but not self-disclosure and emotion decoding.

Table 3.6

Doubly multivariate regression predicting social anxiety scores and context on the RECS social skills

	RECS	
	F	η_p^2
LSAS-SR	1.589**	0.247
Context	81.262**	0.360
LSAS-SR*Context	1.190**	0.197
Sociability	1.447*	0.230
Self-disclosure	0.957	0.165
Assertiveness	1.298*	0.211
Emotion decoding	1.108	0.186

N = 702
Note. LSAS-SR = Liebowitz Social Anxiety Disorder Scale Self Report;
*p < .05;**p < .001

3.4. Discussion

The goal of this study was to evaluate to what degree social skills are influenced by the degree of social anxiety and communication medium (TMC vs. FtF) in a sample of individuals with social anxiety. This was achieved by validating and administering a recently developed self-

report questionnaire of perceived social skills ability in TMC vs. FtF contexts, the RECS (Mantzouranis et al., 2019).

The results from the two CFA's were in support of our hypothesis. A bifactor model for both the ECS and RCS subscales was retained in the current sample, suggesting the presence of a global factor underpinning social skills abilities as defined by four specific factors (*sociability*, *assertiveness*, *self-disclosure*, *emotion decoding*), also experienced above and beyond global levels. Although this model solution was expected, our factor loadings also suggest that some specific items may not be pertinent or truly related to the factor's construct. For instance, item 5 of the RCS ("I prefer to spend time with a large group of friends rather than a group of two or three people") may not be related to *social competence* per se. Our theoretical understanding of social competence in both online and FtF contexts influences the ability to accurately assess social skills abilities. While evaluating the reliability and validity of each item on the RECS using item response theory is beyond the scope of this paper, it is essential that we understand these constructs as they influence theories like the social-skill-deficit vulnerability hypothesis – a theory that has been used to conceptualize the maintenance of social anxiety (Caplan, 2005; Davis, 2001). It may be beneficial for researchers to further develop and validate a shortened version of the scale to increase the accessibility of its use and eliminate items that do not substantively contribute to defining a latent social skill factor (i.e., whether global or specific).

Furthermore, we found support for our second hypothesis; perceived social skills ability was influenced by communication medium and social anxiety. Our results indicate that specific social skill domains like sociability and assertiveness in FtF contexts are heavily impacted by social anxiety. The magnitude of this influence was not observed for TMC contexts. In TMC, only sociability and assertiveness were affected by social anxiety, and only marginally. These findings

are consistent with previous research that has found that there is generally a greater level of comfort in using TMC relative to FtF among individuals with social anxiety (Kamalou, Shaughnessy & Moscovitch, 2018; Lee & Stapinski, 2012; McKenna & Bargh, 2000; O'Day & Heimberg, 2021). This may be due to the level of perceived self-efficacy in their social skills. When faced with a social interaction, individuals with social anxiety have been shown to have a cognitive bias, holding the belief that they have a social skill deficit (Leary & Kowalski, 1995; Levitan & Nardi, 2009). This perceived social skill deficit results in observable interpersonal consequences, like decreased eye contact, longer pauses when speaking, fewer words spoken, and other anxious behaviours (Alden & Taylor, 2004; Amies, Gelder, & Shaw, 1983; Levitan & Nardi, 2009; Warnock-Parkes, 2020). Although these strategic behaviours are intended to provide a sense of safety (i.e., safety behaviours), the social cost of these deficits can be quite expansive. According to a review by Alden and Taylor (2004), shy and socially anxious individuals are often viewed by their peers as being less likeable and warm, unassertive, and unable to appropriately reciprocate self-disclosures, which decreases the peers' desire for future interaction. As a result, individuals with social anxiety may be perpetuating social isolation and decreased social connectedness; and exacerbating feelings of isolation, especially in in-person interactions.

Interestingly, emotion decoding and self-disclosure were not especially impacted by communication medium or level of social anxiety. The tendency to self-disclose or accurately interpret emotions via non-verbal cues appeared to be low regardless of the medium that individuals with social anxiety communicate through. This finding, although not in support of our hypothesis, may be explained by previous research. Kamalou and colleagues (2018) found that although there is a general preference to use online communication modalities among individuals with social anxiety, the use of safety behaviours is comparable in both contexts (Lee & Stapinski,

2012). Sparrevohn and Rapee (2009) suggest that limiting self-disclosures and emotional expressions may be a strategy used by individuals with social anxiety to protect themselves from possible scrutiny and judgment. Similarly, Stentz and Cougle (2022) also found no difference in emotional disclosure (i.e., discussing emotions) or general disclosure (i.e., discussing dislikes) across in-person and online communication mediums. Encouragingly, this study also found that after two weeks of safety behaviour fading training (i.e., providing instructions on how to decrease the use of safety behaviours), individuals with social anxiety were more willing to self-disclose and express their emotions to peers. In light of the observation that individuals with social anxiety do not exhibit differences in emotion decoding and self-disclosure across in-person and online modalities, clinicians should keep this in mind when providing interventions and not default to online mediums as a means of improvement.

From a clinical standpoint, this study highlights a potential barrier to accessing care. Inherent with social anxiety, the avoidance of social situations where negative evaluation may be present extends to the avoidance of seeking mental health services (Warnock-Parkes et al., 2020). Several studies suggest that clinicians should make treatments for social anxiety more accessible by offering virtual or remote services (Bouchard et al., 2017; Kampmann, Emmelkamp, & Morina, 2016; Warnock-Parkes et al., 2020). Adapting access to care may increase the likelihood that individuals with social anxiety approach, rather than avoid therapy (Warnock-Parkes et al., 2020). Technology-assisted interventions like remote cognitive therapy (Warnock-Parkes et al., 2020) or virtual reality exposure therapy (Bouchard et al., 2017) have been shown to be just as effective as traditional formats (Kampmann, Emmelkamp, & Morina, 2016). Through these virtual interventions, individuals with social anxiety may be more willing to experiment (Kamalou et al., 2019) by challenging negative assumptions about themselves and others, decreasing the use of

safety behaviours and increasing their sense of self-efficacy in their social world (Warnocke-Parkes et al., 2020).

3.4.1 Limitations

There are a few notable limitations to this study. Despite having a large sample size, most participants were recruited through the University of Ottawa's Integrated System for Participation in Research. Second, we had limited success in our ability to enhance the diversity of our sample by including participants from the community. We sought to recruit community participants from an ongoing research study who had received a SAD diagnosis and consented to participate in future research. Unfortunately, there were a limited number of participants who met these criteria, thus limiting the community sample size pool. As a result, we had a disproportionately large university sample, which may limit the generalizability of the results. Future research should attempt to replicate this study with samples collected from more diverse sources. Third, we did not have a "control" sample. The results from this study clearly support an interaction between communication medium and social anxiety level on communication skills within a socially anxious sample. However, the extent to which these results may generalize to a normative sample is not known.

3.4.2 Future Directions

The results from the present study provide evidence supporting the idea that social anxiety has more of an impact on social skills in FtF contexts than TMC ones. Currently, it is unclear *why* specific domains are affected by social anxiety symptom severity and communication medium. Given the narrow scope of this study, we only used the RECS to evaluate participants' social skill abilities. However, using additional measures may have provided some insight into the reasons some social skill domains are more impacted. For instance, evaluating the use of safety behaviours

and communication preference for online versus in-person contexts could have been investigated. Multiple measures like the Subtle Avoidance Frequency Examination (SAFE; Cuming et al., 2009), and the Negative Self-Portrayal Scale (NSPS; Moscovitch & Huyder, 2011), have been widely used in the literature to evaluate these variables. Future research should look into the mechanisms that may be influencing the relationships between social anxiety, communication medium and social skills abilities.

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2.6 Supplementary Materials

2.6.1 CFA Analysis Plan and Data Repository

The confirmatory factor analyses were conducted using *Mplus* 8.6 (Muthén & Muthén, 2017) with a weighted least square mean and variance adjusted (WLSMV) estimation unit variance identification to set the scale of the latent factors. To avoid reliance on the chi-squared test of exact fit, which is overly sensitive to minor misspecifications, we used sample-size independent goodness-of-fit-indices. We used typical interpretation guidelines, which suggest that comparative fit index (CFI) and Tucker-Lewis index (TLI) values should be greater than .90 and .95, supporting adequate and excellent model fit, respectively. Comparable guidelines for the Root Mean Square Error of Approximation (RMSEA) suggest relying on values smaller than .08 and .06 to support adequate and excellent model fit, respectively (Hu & Bentler, 1999; Marsh, Hau, & Grayson, 2005). In addition to these fit indices, we also consider the statistical adequacy of the solution by looking at Global factor (G-factor) and Specific-factor (S-factor) loadings, cross-loadings, uniquenesses, and latent correlations.

For the bifactor-CFA, all items were allowed to load on a global social competence factor (G-factor), and additional shared variance between items from the same dimensions (i.e., sociability, assertiveness, self-disclosure, emotion decoding) was explained through three specific factors (S-factors) as defined in the CFA solution. In line with bifactor assumptions (Morin et al., 2016), all factor correlations were fixed to be 0.

Data are available from the first author's OSF repository (DOI 10.17605/OSF.IO/F2UKW).

2.6.2 Supplementary Tables

Table S3.1

Factor Correlations from the CFA Solutions for the ECS Subscale

	1. Sociability	2. Assertiveness	3. Self-Disclosure	4. Emotion Decoding	5. ECS
1. Sociability					
2. Assertiveness	.000***				
3. Self-Disclosure	.000***	.000***			
4. Emotion Decoding	.000***	.000***	.000***		
5. ECS	.000***	.000***	.000***	.000***	

Note. *** $p \leq .001$

Table S3.2

Standardized Factor loadings bifactor model, ECS subscale of the RECS

Items	General Factor	Sociability	Assertiveness	Self-Disclosure	Emotion Decoding
ECS1	0.321***	0.224***			
ECS2	0.446***			0.541***	
ECS3	0.367***				0.756***
ECS4	0.436***		0.470***		
ECS5	0.547***	0.456***			
ECS6	0.487***			0.699***	
ECS7	0.438***				0.709***
ECS8	0.037		-0.602***		
ECS9	0.521***	0.558***			
ECS10	0.295***			0.126*	
ECS11	0.320***				0.515***
ECS12	0.484**		0.348***		
ECS13	0.546***	0.286***			
ECS14	0.650***			0.295***	
ECS15	0.355***				0.530***
ECS16	0.465***	0.399***			
ECS17	0.259***			0.180	
ECS18	0.181***				0.232***

Note. *$p \leq .05$; *** $p \leq .001$

Table S3.3

Item correlations for the ECS subscale of the RECS

	ECS 1	ECS 2	ECS 3	ECS 4	ECS 5	ECS 6	ECS 7	ECS 8	ECS 9	ECS 10	ECS 11	ECS 12	ECS 13	ECS 14	ECS 15	ECS 16	ECS 17	ECS 18
ECS1																		
ECS2	.197**																	
ECS3	.124**	.161**																
ECS4	.148**	.114**	.126**															
ECS5	.187**	.251**	.155**	.308**														
ECS6	.115**	.547**	.151**	.200**	.295**													
ECS7	.141**	.177**	.652**	.167**	.213**	.161**												
ECS8	-.043	-.019	-.078*	.219**	-.029	.017	-.100**											
ECS9	.261**	.186**	.168**	.300**	.492**	.210**	.223**	.009										
ECS10	.132**	.179**	.141**	.069	.185**	.175**	.140**	-.193**	.192**									
ECS11	.071	.097*	.427**	.115**	.131**	.061	.421**	-.007	.141**	.075*								
ECS12	.145**	.128**	.224**	.330**	.228**	.158**	.238**	.149**	.246**	.002	.253**							
ECS13	.294**	.231**	.170**	.190**	.330**	.214**	.170**	.021	.420**	.141**	.170**	.214**						
ECS14	.142**	.400**	.220**	.210**	.268**	.474**	.293**	.065	.253**	.162**	.147**	.287**	.366**					
ECS15	.033	.148**	.457**	.122**	.119**	.131**	.450**	-.017	.110**	.080*	.384**	.170**	.137**	.286**				
ECS16	.210**	.240**	.085*	.101**	.416**	.306**	.122**	-.003	.390**	.114**	.119**	.158**	.314**	.280**	.160**			
ECS17	.058	.174**	.084*	.103**	.085*	.189**	.079*	-.042	.076*	.199**	.115**	.034	.146**	.194**	.095*	.124**		
ECS18	.002	.051	.171**	.036	.003	.121**	.184**	.020	.076*	-.114**	.194**	.134**	.097*	.169**	.198**	.046	.118**	

Note. *$p \leq .05$; **$p \leq .01$; *Sociability:* items 1, 5, 9, 13, 16, *Self-Disclosure:* items 2, 6, 10, 14, 17, *Emotion Decoding:* 3, 7, 11, 15, 18, *Assertiveness:* 4, R8, 12, *R*=reverse scored items

Table S3.4

Factor Correlations from the CFA Solutions for the RCS subscale

	1. Sociability	2. Assertiveness	3. Self-Disclosure	4. Emotion Decoding	5. RCS
1. Sociability					
2. Assertiveness	.000***				
3. Self-Disclosure	.000***	.000***			
4. Emotion Decoding	.000***	.000***	.000***		
5. RCS	.000***	.000***	.000***	.000***	

Note. *** $p \leq .001$

Table S3.5

Standardized Factor loadings bifactor model, RCS subscale of the RECS

Items	General Factor	Sociability	Assertiveness	Self-Disclosure	Emotion Decoding
RCS1	0.570***	0.203***			
RCS2	0.038			0.701***	
RCS3	0.190***				0.454***
RCS4	0.433***		0.832***		
RCS5	0.064	0.514***			
RCS6	-0.197***			-0.613***	
RCS7	0.283***				0.752***
RCS8	-0.437***		-0.227**		
RCS9	0.385***	0.407***			
RCS10	0.324***			0.402***	
RCS11	0.393***				0.432***
RCS12	0.649***		0.222**		
RCS13	0.509***	0.507***			
RCS14	0.293***			0.402***	
RCS15	0.325***				0.635***
RCS16	0.579***	0.533***			
RCS17	-0.144***			0.663***	
RCS18	0.372***				0.770***

Note. *$p \leq .05$; **$p \leq .01$; *** $p \leq .001$

Table S3.6

Item correlations for the RCS subscale of the RECS

Variables	RCS 1	RCS 2	RCS 3	RCS 4	RCS 5	RCS 6	RCS 7	RCS 8	RCS 9	RCS 10	RCS 11	RCS 12	RCS 13	RCS 14	RCS 15	RCS 16	RCS 17	RCS 18
RCS1																		
RCS	.134**																	
RCS3	.158**	0.059																
RCS4	.171**	0.002	.080*															
RCS5	.157**	0.026	0.029	.100**														
RCS6	.188**	.402**	-0.016	.092*	.117**													
RCS7	.199**	-0.036	.340**	0.070	-0.009	-0.061												
RCS8	.218**	-0.003	0.023	.310**	-0.008	.143**	.079*											
RCS9	.275**	0.016	0.059	.159**	.338**	.158**	0.038	.210**										
RCS10	.204**	.224**	0.001	.080*	-0.072	.270**	0.048	.146**	.124**									
RCS11	.244**	0.012	.198**	.100**	-0.062	-0.010	.325**	.140**	.122**	.167**								
RCS12	.206**	0.003	.139**	.412**	.090*	.086*	.221**	.270**	.286**	0.072	.225**							
RCS13	.319**	0.063	-0.007	.175**	.164**	.151**	.128**	.165**	.268**	.141**	.137**	.293**						
RCS14	.095*	.199**	0.025	.151**	.081*	.284**	-0.016	0.031	.116**	.351**	0.011	.126**	.188**					
RCS15	.181**	-.078*	.274**	.147**	-0.061	-0.071	.474**	.174**	0.006	0.067	.358**	.211**	.079*	-0.015				
RCS16	.355**	0.060	0.038	.235**	.200**	.122**	.141**	.126**	.303**	.161**	.130**	.349**	.573**	.259**	.127**			
RCS17	0.033	.441**	-0.048	-.113**	-0.009	.322**	-0.013	-.121**	-0.059	.180**	-0.064	-.098**	0.017	.168**	-0.049	-0.014		
RCS18	.233**	0.022	.334**	.124**	0.022	0.030	.604**	.141**	.154**	.089*	.387**	.236**	.108**	0.050	.486**	.138**	-0.041	

Note. *$p \leq .05$; **$p \leq .01$ *Sociability:* items 1, 5, 9, 13, 16, *Self-Disclosure:* items 2, R6, 10, 14, 17, *Emotion Decoding:* items 3, 7, 11, 15, 18, *Assertiveness:* 4, R8, 12, *R*=reverse scored items

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CHAPTER 4: STUDY 3

Investigating the Role of Mood Induction on Emotion Recognition in Social Anxiety

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4.1 Abstract

Individuals with high trait social anxiety experience multiple challenges when interacting with others. Social skills abilities like accurate emotional facial expression recognition are particularly impaired in this population. Ambiguous and angry facial expressions are most often miscategorized and met with uncertainty. Part of this confusion may be attributable to increased state anxiety when approaching social situations. However, little is known about the influencing role of state anxiety on emotional facial expression recognition among those with social anxiety. The present study aimed to evaluate the impact of state anxiety on emotion recognition. Fifty-two undergraduate students with high trait social anxiety participated in a pre-post emotion recognition task. Participants were presented with happy, neutral, and angry facial expressions in random order and asked to categorize the expressed emotion among six basic emotion categories. In between emotion recognition tasks, participants engaged in an affect induction procedure (i.e., mock discussion with a confederate) aimed to increase state anxiety. The results suggest that individuals with high-trait SA were significantly worse at recognizing happy facial expressions post-affect induction. Furthermore, individuals with high-trait SA showed significant difficulty in accurately recognizing neutral facial expressions across pre- and post-conditions. An error rate analysis revealed that neutral and happy facial expressions were most often miscategorized as either surprise, angry, sad, or disgust. This study highlights that positively-valenced expressions are met with increased uncertainty particularly when experiencing elevations in state anxiety.

Investigating the Role of Mood Induction on Emotion Recognition in Social Anxiety

4.2 Introduction

Emotion recognition is a non-verbal behaviour that facilitates social interaction (Plutchik, 2001; Rapee & Heimberg, 1997; van Kleef & Côté, 2021). Feedback from emotional facial expressions can help an observer gauge whether to approach or avoid a social situation (Hudd & Moscovitch, 2020; van Kleef & Côté, 2002). For instance, observing a smile can elicit prosocial behaviours and enhance social connection (Tamir & Hughes, 2018). However, individuals who have deficits in their ability to accurately recognize emotional facial expressions are at risk of missing out on these social benefits and even worse, may misperceive them as more threatening, thus perpetuating avoidance. Hudd and Moscovitch (2020) point out that individuals with high sensitivity to social rejection, like those with high trait social anxiety, have a decreased ability to perceive socially rewarding cues from their environments. These cues, like happy facial expressions, may be perceived by those with social anxiety disorder (SAD) as untrustworthy, contemptuous, or as mocking (Cremers et al., 2015; Gutiérrez-Garcia & Calvo, 2016). A recent meta-analysis by our group confirms that individuals with a primary diagnosis of SAD were significantly worse at recognizing happy and neutral facial expressions compared to healthy controls (Lacombe et al., 2023).

There are multiple reasons why facial expressions might be perceived more negatively among those with SAD. Rapee and Heimberg (1997) note that individuals with SAD allocate a great deal of attentional resources to monitoring for potentially threatening external indicators. In a population that fears negative evaluation from others, indicators like frowns, signs of boredom, or other ambiguous facial expressions can elicit impairing and distressing emotional, somatic, cognitive, and behavioural symptoms of anxiety (Rapee & Heimberg, 1997). These aversive

symptoms subsequently lead to the use of safety behaviours and avoidance, like avoiding eye contact (Richey et al., 2019). The consequences of engaging in gaze avoidance of crucial parts of the face when interacting with others are pronounced. It has not only been shown to decrease emotion recognition accuracy but also to limit the ability to integrate corrective feedback and thus modify maladaptive beliefs (Beaudry et al., 2013; Clark & Wells, 1995; Günther et al., 2021; Yitzhak et al., 2020). This may lead to a negative cycle whereby avoidance of facial cues leads to a poorer ability to interpret them, which in turn leads to greater difficulties in social interaction. This cycle maintains the disorder over time as it reinforces erroneous beliefs, thoughts (e.g., "I will be rejected") and behaviours like hypervigilance and excessive monitoring for threat cues (Rapee & Heimberg, 1997; Warnock-Parkes et al., 2020). As a result, individuals with social anxiety often approach social situations in an already anxious state, which may worsen their emotion recognition abilities.

The Emotions as Social Information (EASI) model of emotion recognition posits that inferential processing of emotional facial expressions is mediated by the affective state of the observer. Authors van Kleef and Côté (2022) theorize that an observer can infer other's emotional expressions based on their *own affective reaction* to the expressor. Therefore, an individual that enters a social interaction in an already anxious state may be biased in interpreting the expressors emotion. A study by Dyer et al. (2021) investigated the impact of state anxiety on emotion recognition. By manipulating carbon dioxide (CO_2) intake concentrations, the authors were able to experimentally increase state anxiety before engaging in a 6-alternative forced-choice emotion recognition task. Their results indicated that high state anxiety significantly worsened emotion recognition abilities. Mood induction paradigms have also been used to temporarily alter affective state. Schmid and Mast (2010) found that negative mood induction through emotionally evocative

video clips enhanced emotion recognition for angry and happy facial expressions among healthy participants. Manierka et al.'s (2021) result also suggested that positive mood induction among a healthy sample decreased accuracy in recognizing happy facial expressions.

As it relates to social anxiety, researchers Kelly-Turner and Radomsky (2020) and others have successfully induced an anxious state in individuals with high trait SA by asking participants to partake in a mock evaluative conversation task with a confederate (Ferguson et al., 2023). In both Kelly-Turner and Radomsky (2020) and Ferguson et al. (2023), the authors asked participants to engage in a time-limited conversation where the confederate asked participants questions about themselves (e.g., "tell me about yourself") before engaging in a task. State anxiety was monitored by asking participants to rate their current level of distress on the Subjective Units of Distress Scale (SUDS) at various points throughout their experiments.

In the current study, we aimed to use a similar mood induction paradigm to evaluate the effect of state anxiety on emotion recognition abilities in a university sample with high trait social anxiety. We conducted a pre-post Facial Emotion Recognition (FER) task; the FER task was separated by a time-limited discussion with a confederate. The conversation task was adapted from Stopa and Clark (1993). Furthermore, we informed participants that their conversation would be video recorded and that the quality of their response would be self-evaluated and evaluated by the confederate. This was done to increase the effectiveness of our mood induction (Joseph et al., 2020). To obtain a complete understanding of emotion recognition abilities, we assessed three FER outcome measures both pre- and post-conversation: accuracy, intensity, and saliency.

Accuracy simply measures whether a participant sees the target emotion (i.e., the emotion the model is trying to portray) in an image as the most intense one, regardless of what other emotions might be mixed in with it. This measure is important because it determines the category

into which a participant would place an emotional expression if forced to choose just one, and allows us to evaluate if they do so correctly. However, it is a limited measure because it ignores the fact that emotional expressions can vary in intensity and can portray mixtures of emotions. For this reason, we also measured the intensity with which each emotional expression was evaluated, as well as saliency, a measure of the degree to which the target emotion was perceived to appear purely on its own, as opposed to mixed with other emotions. Based on previous research, we developed the following hypotheses:

H1: Participants would report a greater subjective anticipatory and post-event anxiety (SUDS) compared to baseline (*manipulation check*).

H2: Participants would rate their performance during the conversation task more negatively than the confederates using the Behaviour Rating Scale.

H3: Participants would do more poorly in categorizing facial expressions post-conversation than pre-conversation. This would be reflected in lower accuracy.

H4: Participants would interpret emotional expressions less clearly post-conversation than pre-conversation. This would be reflected in lower intensity and saliency values.

4.3 Method

4.3.1 Participants

A power analysis (f = 0.25, α = 0.95, power = 0.95) using G*Power (Faul et al., 2007) for our most stringent analysis suggested a sample size of n = 54. To account for possible technology malfunctions, participant attrition, or discovery of the confederate, we supplemented our sample size by 30%. We recruited a sample of 68 undergraduate students through the University of Ottawa's Integrated System for Participation in Research (receiving one-course credit as compensation). Recruitment occurred between September 15, 2023 and April 2, 2024. Exclusion criteria for this study included having 'face blindness' or prosopagnosia, a history of a severe psychiatric disorder, and uncorrected visual acuity deficits. None of the recruited participants met any of the listed exclusion criteria.

4.3.2 Measures

Sociodemographic Questionnaire. Participants were asked to provide information relating to their demographic characteristics (i.e., age, gender identification, ethnicity identification, employment status, dominant language, and history of a mental health disorder). A summary of the sample characteristics can be found in the Results section.

Liebowitz Social Anxiety Scale – Self-report (LSAS-SR; Liebowitz, 1987). The self-report Liebowitz Social Anxiety Scale is a 24-item self-rated questionnaire that assesses key components of social anxiety (fear, and avoidance) experienced by the participant over the past week. Items on the fear dimension are individually scored on a four-point rating scale ranging from 0 (none) to 3 (severe) (Liebowitz, 1987). Similarly, avoidance is equally rated on a four-point rating scale ranging from 0 (never, 0%) to 3 (usually, 68–100%). Scores that range from 0–29

indicate no/low social anxiety, 30–59 indicate nongeneralized social anxiety, and scores of 60+ indicate generalized social anxiety (Rystinski et al., 2009). The test reported excellent internal consistency for the fear and avoidance subscales (Oakman et al., 2002). The internal consistencies for the fear (ω =0.886, 95% CI = [0.827, 0.992]) and avoidance (ω =0.812, 95% CI = [0.712, 0.866]) subscales in the current sample were likewise excellent.

Depression Anxiety and Stress Scale-21 (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a 21-item self-report that assesses symptoms of depression, anxiety, and stress experienced over the past week. Items on each of the subscales are individually scored on a four-point rating scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). The internal consistencies for all subscales were excellent (Lovibond & Lovibond, 1995). Within our sample, the internal consistencies for depression (ω =0.804, 95% CI = [0.716, 0.870]), anxiety (ω =0.828, 95% CI = [0.701, 0.899]), and stress (ω =0.806, 95% CI = [0.697, 0.874]) were very good. This scale was included as part of a larger project and its outcomes were not analyzed for the purposes of the present study.

Subjective Units of Distress Scales (SUDS; Wolpe, 1958). The SUDS is a measure used to assess participants' subjective level of state distress (Wolpe, 1958). Similar to Ferguson and colleagues (2023), we modified the measure to evaluate participants' state level of anxiety, rather than distress. Participants rated their anxiety on a sliding scale ranging from 0 (no anxiety) to 100 (extremely anxious).

Social Performance Rating Scale (SPRS; Fydrich et al., 1998). We used the five-item SPRS to assess the consistency of the confederates' behaviour across participants. Two research assistants blind to the study aims and hypotheses were asked to rate the confederate's gaze, vocal

quality, length of statements, overt signs of discomfort, and conversation flow during the video-recorded conversation task. Each component was rated on a five-point Likert scale ranging from 1 (very poor) to 5 (very good) (Fydrick et al., 1998). The SPRS has been used in conversation tasks with similar mood induction paradigms (Dannahy & Stopa, 2007; Ferguson et al., 2023). Similar to Ferguson, Ouimet and Gardam (2023), we assessed inter-rater reliability by averaging the SPRS scores and calculating the intraclass correlation coefficient (ICC) to determine inter-rater reliability. Our ICC suggests good reliability (ICC = 0.81, 95% CI = [0.67, 0.89]) (Koo & Li, 2016).

Behaviour Rating Scale (Stopa & Clark, 1993). Given that individuals with social anxiety tend to misperceive their own performance in social interactions, we asked participants to rate how they perceived their performance during the discussion with the confederate (Stopa & Clark, 1993). Participants were asked to rate the 23-item checklist indicating how characteristic their performance was on a series of 16-positive (e.g., friendly, relaxed, warm, confident, assertive) and 7-negative (e.g., nervous, blushing, hands shaking) behaviours (see supplementary materials for appended checklist). The 9-point rating ranged from 0 (not characteristic at all) to 8 (extremely characteristic). Participants were also asked to repeat this checklist, rating the confederate's behaviour.

Credibility Questionnaire. As recommended in Kelly-Turner and Radomsky (2020), we compiled a 'believability' score to evaluate how much participants believed that they were being evaluated, and whether they knew the other participant to be a confederate. Participants were asked to rate this on a sliding scale ranging from 0 (I did not believe I was being evaluated) to 100 (I believed that I was being evaluated). Similarly, participants were asked to indicate 'yes' or 'no' to whether they believed to be interacting with a confederate during the discussion task.

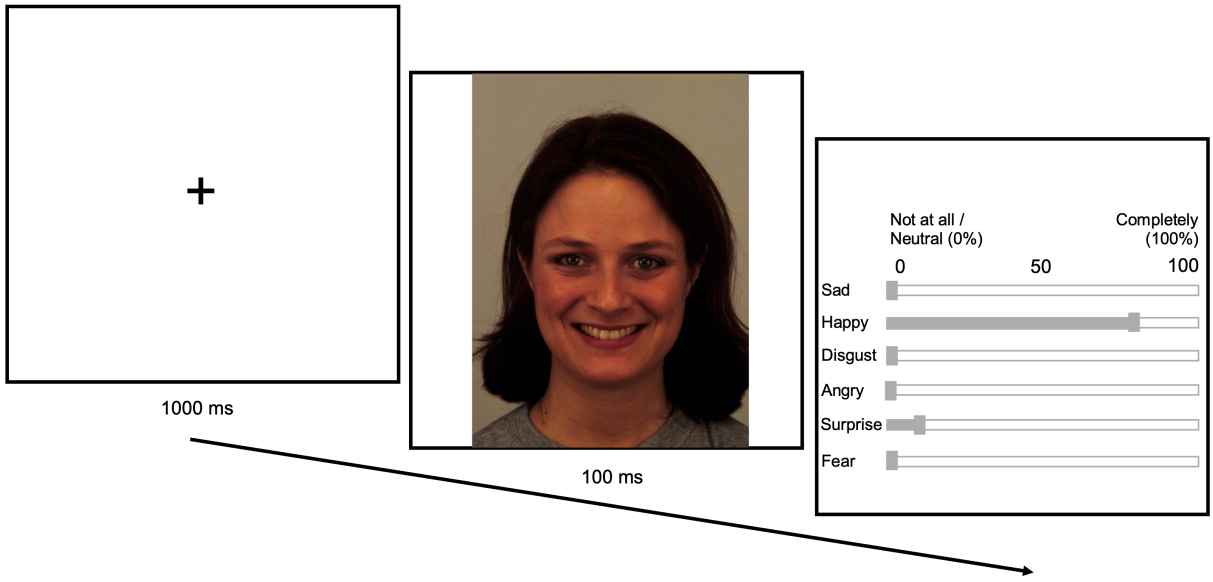
4.3.3 Emotion Rating Task

Participants were presented with 60 images of facial expressions of emotion from the Karolinska Directed Emotional Faces (KDEF) database (Calvo & Lundqvist, 2008). Image set A from the KDEF database was used because it has been previously validated. The stimuli consisted of frontal images of 30 male and 30 female Caucasian individuals. All models were young adults between the ages of 20–30, and had no identifying features (e.g., facial hair, makeup, markings, glasses, or tattoos). The same model was presented three times, once depicting each facial expression (happy, neutral, angry) to minimize any effects that may be due to the individual differences in the model's appearance.

Images of either an angry, happy, or neutral facial expression (20 images from each category) were presented in random order for 100ms each, followed by an intertrial interval with a fixation cross lasting 1000 ms. The three emotional categories were chosen because previous research suggests that individuals with social anxiety tend to miscategorize threatening, happy and neutral expressions (Lacombe et al., 2023). Following the stimulus presentation, participants were presented with six slider scales representing the Ekman emotional facial categories (anger, surprise, fear, sadness, happy, disgust), and asked to rate on a scale of 0 (neutral) to 100 (emotion) what emotion(s) they perceived (Ekman et al., 1987). Participants completed an emotion recognition task pre- and post- the conversation task (see **Figure 4.1**).

Figure 4.1

Sample facial emotion rating trial



4.3.5 Conversation Task

We informed participants that they would be engaging in a 5-minute discussion with another participant (i.e., trained white male confederate) on a particular hypothetical topic. To ensure consistency, a single confederate was used across all participants. The participant and confederate were informed that their discussion would be video recorded, and that they would be evaluating each other's responses to the discussion topic. Discussion topics were adapted from Stopa and Clark (1993) where the confederate was asked to read out loud a hypothetical situation and asked participants "what would you do in this situation?'. These situations included (1) "*You have just started a new job and you have to give a short talk about yourself and about why you wanted the job. Your audience is a group of six people who already work there*"; (2) "*You have gone to the pub with an acquaintance. Your acquaintance sees two old friends whom you do not know and were not expecting to meet. You all sit down together*"; and (3) "*You have bought something at a shop and found a fault. You have to ring the manager to complain and to ask for a*

replacement." Similar to Kelly-Turner and Radomsky (2020), the confederate was trained to initiate the conversation and to appear warm and interested. To reduce order effects, discussion topics were counterbalanced across participants.

4.3.6 Procedure

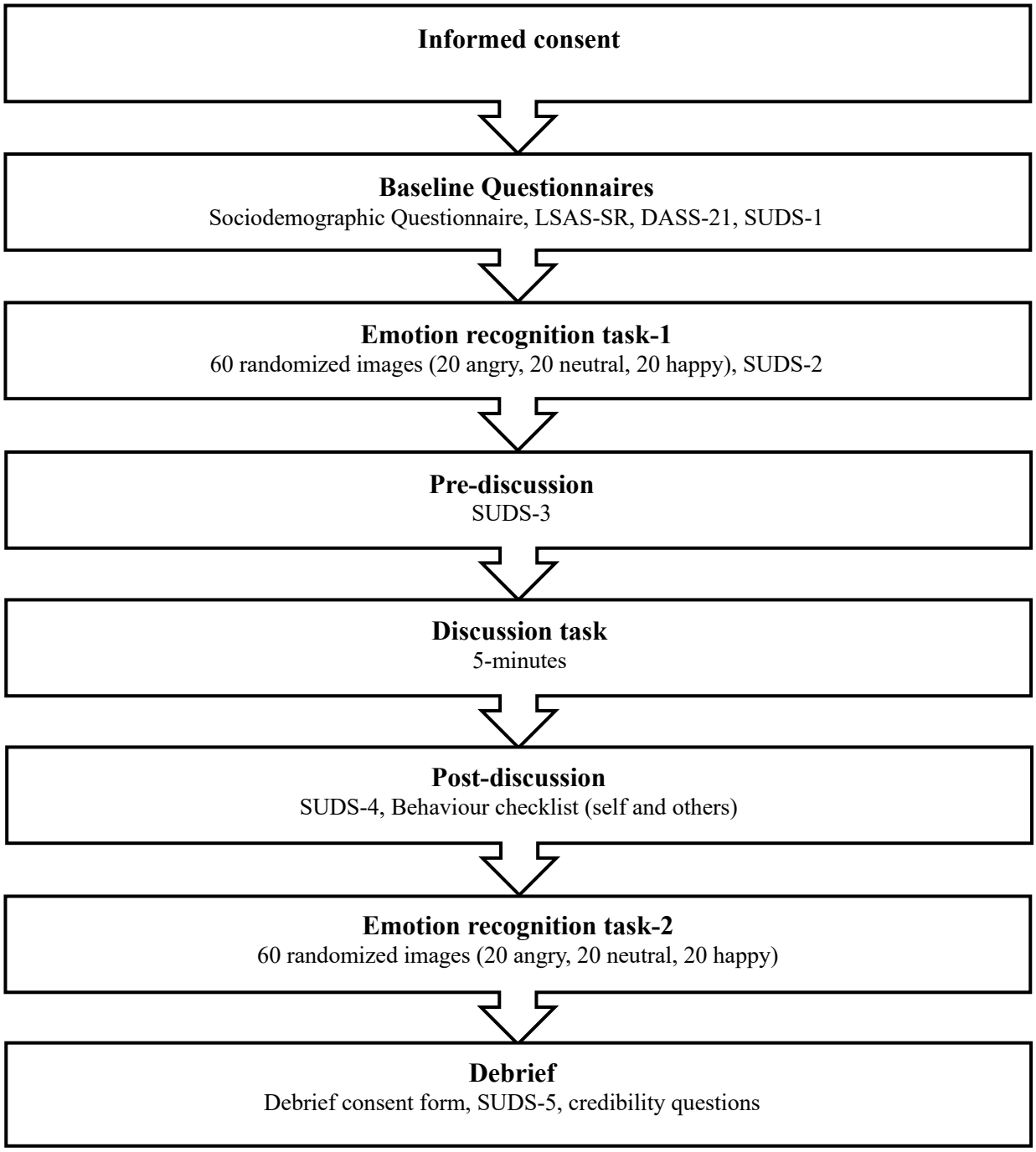
This study was completed in-person and approved by the University of Ottawa's Research Ethics Board (H-02-23-8878). Prior to obtaining written consent, participants were informed that they would be conducting two emotion recognition tasks and participating in a peer discussion with another participant, which would be video recorded. Participants then completed a Sociodemographic Questionnaire, a baseline SUDS and a baseline questionnaire package (LSAS-SR, DASS) before completing a second SUDS and beginning the first Facial Emotion Recognition (FER) task. Once the participants completed the first FER task, the researcher informed them that they would begin the peer discussion shortly. At this time, participants completed a third SUDS to evaluate anticipatory state anxiety. Once the confederate and participant were joined in the same room, the researcher presented them with the discussion topic and reminded both that they would be video recorded and would need to evaluate the quality of theirs and the other's responses to the question. Once the 5-minute discussion was completed, the participant returned to their computer and were asked to complete a fourth SUDS and the behaviour checklist, followed by the final FER task.

Following the task completion, the researcher thoroughly debriefed the participant and consent was re-obtained given that mild deception had been used. Finally, participants were asked to complete a final SUDS and a 2-item credibility questionnaire to assess the believability of the deception. Specifically, participants were asked how much they believed that they were being

evaluated during the discussion and whether they knew the other participant was indeed a confederate. See **Figure 4.2** for a detailed diagram of the study procedure.

Figure 4.2

Procedural flow chart [6]



4.4 Results

4.4.1 Statistical Analyses

The data of seven participants was not included in our analyses because they reported knowing that they were conversing with a confederate. Similarly, list-wise deletion was used to remove the data of an eighth participant who had more than 5% of their data missing. An additional eight participants were removed from the analyses, as their LSAS-SR scores fell below the clinical cut-off score. As a result, the data from 52 participants was used in all of the listed analyses. The distribution of scores in histograms, QQ plots, and residual plots were visually inspected and revealed no apparent deviations from normality. Skewness and kurtosis were further evaluated to assess for deviations from normality. Ceiling effects were observed for the saliency and accuracy of happy facial expressions, which was reflected in a negatively skewed distribution. No spurious univariate or multivariate outliers were identified in the sample. The demographic sample characteristics can be found in **Table 4.1**.

Table 4.1

Participant demographic characteristics

Variable		%	*M*	*SD*	Range
LSAS-SR score			58.92	19.7	31–110
Age			19.98	4.19	16–40
Gender					
	Cisgender woman	65.0			
	Cisgender man	15.0			
	Female	13.3			
	Gender fluid	1.7			
	Male	3.3			
	Transgender	1.7			
Ethnicity					
	Arab	6.7			
	Arab/African	1.7			
	Asian (East, South, Southeast, Central, Other)	20.0			
	Black – African	10.0			
	Black – Caribbean	5.0			
	Black – North American	0.1			
	First Nations	1.7			
	Latin American	1.7			
	Middle Eastern	3.3			
	Mixed Heritage	1.7			
	White – European	18.3			
	White – North American	23.3			
	Other (nothing applies to me)	6.7			
Occupation					
	Full-time student	95.0			
	Part-time student	5.0			
Received mental health diagnosis by a health professional					
	Yes	18.3			
	No	80.0			
	I prefer not to say	1.7			

N = 52

Note. LSAS-SR = Liebowitz Social Anxiety Disorder Scale Self Report

Accuracy, intensity, and saliency scores were assessed through a series of nine repeated measures ANCOVAs, with trait social anxiety scores measured via the LSAS–SR being used as a covariate. Similarly, SUDS and behavioural rating scores were assessed through a series of repeated measures ANOVAs. Greenhouse-Geisser corrections for violations of sphericity were used with the appropriate degrees of freedom. Post hoc tests were adjusted using a Bonferroni correction. For each ANOVA model and post hoc test, an alpha level of 0.05 was used. Effect sizes (i.e., partial eta-squared) are reported where appropriate. All analyses were conducted with SPSS Version 29 and JASP Version 0.18. Results of the ANOVAs are given in the sections below.

4.4.2 Emotion Recognition

The overarching aim of this study was to evaluate whether state social anxiety would influence emotion recognition performance (accuracy, intensity, saliency) across happy, neutral and angry emotional facial expressions while accounting for trait social anxiety. Intensity and saliency were not evaluated for the neutral emotion given that we theoretically could not assess how intense or salient the absence of an emotion is. The unadjusted and adjusted means listed in **Table 4.2** indicate that the covariate trait social anxiety had little to no influence on our outcome measures. Our main results were analyzed via a series of nine repeated measures one factor with 2 level (pre- vs. post-conversation) ANCOVAs. We conducted an ANCOVA for each emotional facial expression (happy, neutral, angry) across all three outcome measures (accuracy, intensity, saliency), using trait social anxiety scores are the covariate. Our results suggest that participants were significantly worse at recognizing happy facial expressions post-mood induction ($F(1, 50) = 4.367$, $p = .042$, $\eta_p^2 = .080$). No significant differences were observed between pre-post performance for the neutral or angry emotion categories (see **Table 4.3**). Similarly, no significant

interactions were observed between the trait social anxiety covariate and any of the outcome measures across all emotion categories.

Table 4.2

Unadjusted and covariate adjusted descriptive statistics for pre- post-emotion recognition task

	Unadjusted		Adjusted	
	$M(SD)_{pre}$	$M(SD)_{post}$	$M(SD)_{pre}$	$M(SD)_{post}$
Accuracy				
Happy	0.911(0.073)	0.905(0.096)	0.911(0.072)	0.905(0.094)
Neutral	0.223(0.242)	0.264(0.247)	0.223(0.245)	0.264(0.245)
Angry	0.653(0.161)	0.668(0.174)	0.654(0.159)	0.668(0.173)
Intensity				
Happy	76.501(14.206)	71.951(15.738)	76.501(14.206)	71.951(15.706)
Angry	54.771(12.756)	54.318(14.779)	54.771(12.850)	54.318(14.920)
Saliency				
Happy	0.848(0.109)	0.831(0.135)	0.848(0.108)	0.831(0.137)
Angry	0.576(0.154)	0.600(0.161)	0.576(0.159)	0.600(0.159)

$N = 52$

Table 4.3

Main effect estimates for pre-post emotion recognition task

	$F(1, 58)$	p	η_p^2
Accuracy			
Happy	4.367	.042	.080
Neutral	1.269	.265	.025
Angry	0.852	.360	.017
Intensity			
Happy	0.873	.355	.017
Angry	0.127	.724	.003
Saliency			
Happy	2.446	.124	.047
Angry	0.966	.330	.019

$N = 52$

Although not a primary aim of the study, the results do highlight that participants were significantly worse at recognizing neutral and angry facial expressions compared to happy facial expressions in both pre- and post-conversation conditions ($F(1.512, 155.685) = 409.974$, $p < .001$, $\eta_p^2 = .799$). A distribution of the types of errors made for both pre- and post- happy, angry, and neutral expressions can be found in **Figure 4.3**. Similarly, Participants rated angry expressions significantly less intensely ($F(1, 103) = 187.279$, $p < .001$, $\eta_p^2 = .645$) and saliently ($F(1, 103) = 416.283$, $p < .001$, $\eta_p^2 = .802$) as compared to happy facial expressions across all conditions (see **Table 4.4**).

Figure 4.3

Proportion of errors for each emotional facial expressions category indicating types of errors made by participants

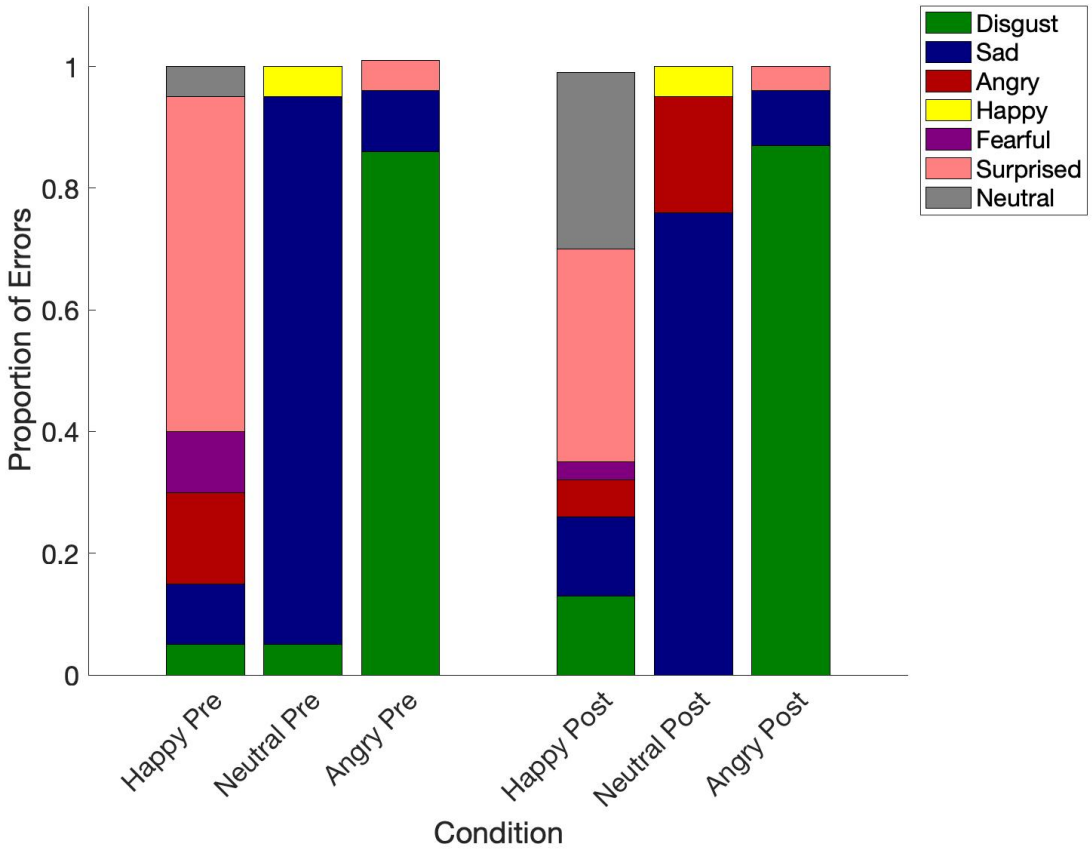


Table 4.4

Main effect estimates for emotion recognition task collapsed across timepoints

	$M(SD)_{happy}$	$M(SD)_{angry}$	$M(SD)_{neutral}$	F	df	p	η_p^2
Accuracy	0.910(0.085)	0.661(0.167)	0.244(0.244)	409.974	1.512, 155.685	< .001	.799
Intensity	74.266(15.093)	54.545(13.739)	-	187.279	1, 103	< .001	.645
Saliency	0.840(0.123)	0.588(0.158)	-	416.283	1, 103	< .001	.802

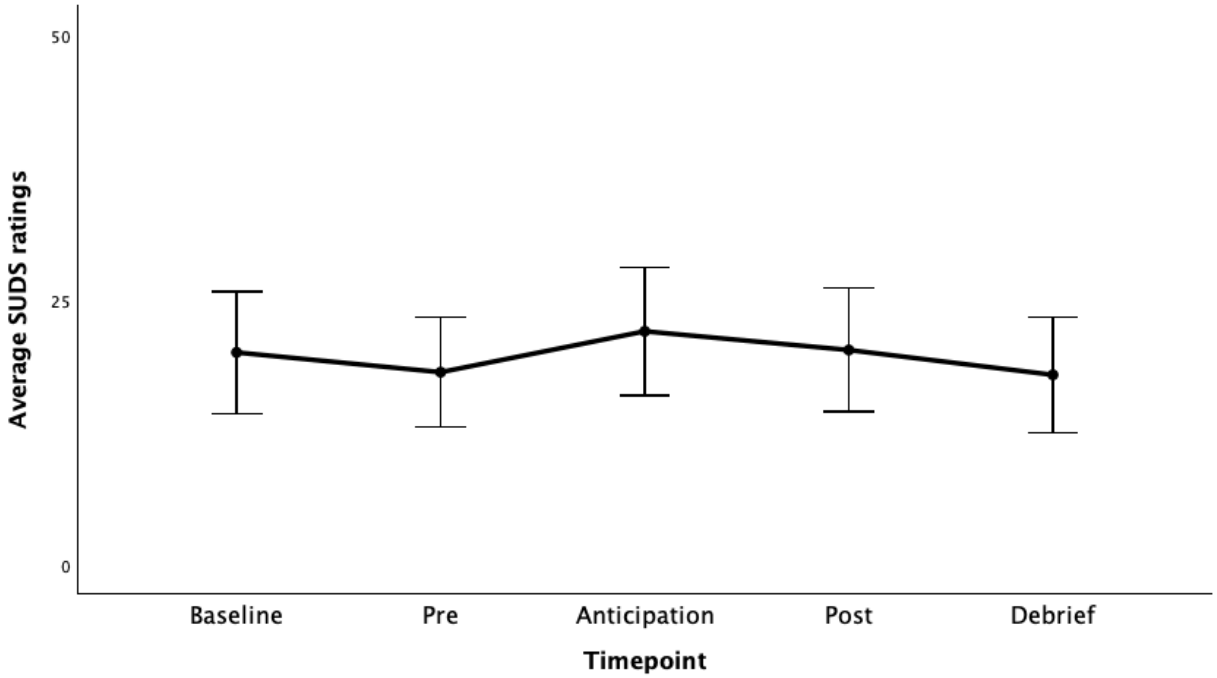
$N = 52$

4.4.2 Manipulation Check

Using the SUDS, we evaluated participant's subjective level of state anxiety at five points: baseline, pre-emotion recognition task, in anticipation of the discussion with a confederate, post-discussion, and at debriefing. Results of a 1-way repeated measures ANOVA suggest that our manipulation did not significantly increase state anxiety at any of these time points ($F(2.4, 122.403) = 1.336$, $p = .267$, $\eta_p^2 = .026$). These results suggest that our manipulation was ineffective at increasing state anxiety (see **Figure 4.4**).

Figure 4.4

Subjective Units of Distress Scale (SUDS) ratings across study time points



Note. Mean ratings are encompassed by 95% confidence intervals.

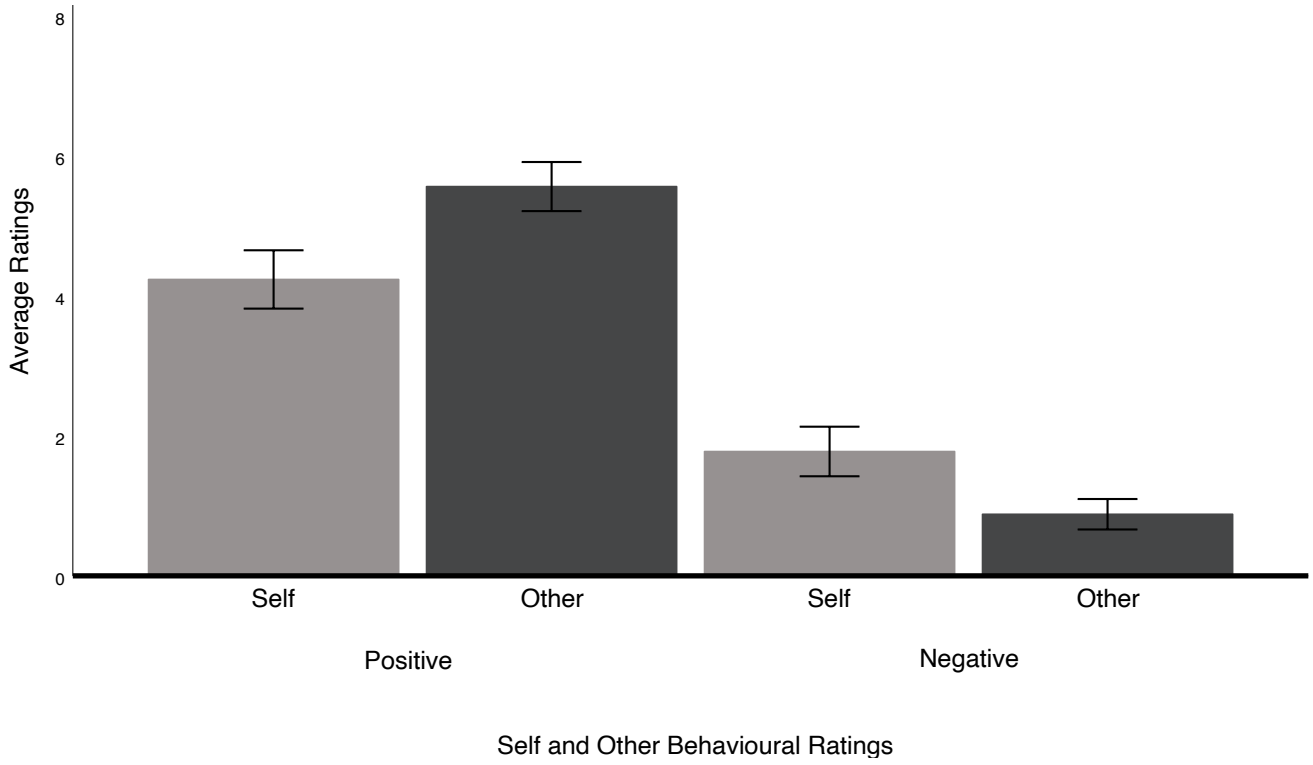
4.4.3 Behavioural Ratings

Participants were asked to self-assess their perceived performance and the perceived performance of the confederate immediately following the discussion. The results indicate a

significant difference across self and other-rated performance for both positive and negative behavioural statements ($F(1.739, 88.695) = 157.887$, $p < .001$, $\eta_p^2 = .756$). Post-hoc analyses revealed that participants rated themselves as displaying significantly greater negative characteristics ($p < .001$) and significantly fewer positive characteristics ($p < .001$) compared to the confederate (see **Figure 4.5**).

Figure 4.5

Post-conversation self and other behavioural ratings



Note. Mean ratings are encompassed by 95% confidence intervals.

4.4.4 Video Ratings

Averaged across both raters, the overall quality of the videos was judged as good to very good. On the SPRS, the raters determined that the confederate maintained very good eye contact ($M = 4.71$, $SD = 0.52$), good vocal quality ($M = 4.47$, $SD = 0.86$), spoke at an appropriate length

without monopolizing the conversation (M = 4.49, SD = 0.86), demonstrated good gesturing and displayed minimal discomfort (M = 4.44, SD = 0.67), and consistently maintained good conversational flow with the participants (M = 4.49, SD = 0.80).

4.4.5 Credibility Check

After being debriefed at the end of the study, participants were asked how much they believed their responses to the questions were being evaluated by the confederate on a scale of 0–100 (0 = I did not believe it at all, 100 = I completely believed it). Our results indicated that believability was quite high (M = 76.846, SD = 25.080).

4.5 Discussion

The goal of this study was to evaluate whether emotional facial expression recognition abilities would be affected by state anxiety in a group of individuals with high-trait social anxiety. We aimed to achieve this by asking participants to engage in a pre-post emotion recognition task, which was separated by a mock socially evaluative discussion with a confederate. Given previous research, we hypothesized that our manipulation would be effective in temporarily increasing state anxiety. We anticipated that participants would report greater subjective anticipatory anxiety compared to baseline. Our results suggest that our manipulation was largely ineffective at significantly increasing state anxiety.

There are at least two reasons why we may have been unsuccessful in manipulating state anxiety. First, our confederate was trained to initiate the conversation and to appear warm and interested. According to emotional contagion theory, peoples' affective states and emotional reactions can be spread to others (Hatfield et al., 1994; van Kleef & Côté, 2022). Our confederate's warm and interested style, which was displayed via facial expressions, tone of voice and body posture may have been "contagious," therefore impacting the emotional state of the participant. In

Kelly-Turner and Radomsky (2020), the authors instructed their confederate to initially appear warm and interested, and then switch to appearing cold and disinterested. Following a similar approach may have been beneficial in inducing state anxiety. However, given the short duration of the discussion, it was not feasible within our protocol to have the confederate switch to a cold and disinterested interpersonal style. A second possibility is the duration of the conversation. Previous studies investigating the role of state anxiety on various tasks within a socially anxious sample had participants engage in a 10-minute conversation task (Ferguson et al., 2023; Ferguson & Ouimet, 2023; Thompson & Rapee, 2002). In a study evaluating how long mood induction procedures last, Gillies and Dozois (2021) note that 7-minute mood induction procedures are an optimal duration, often inducing a negative state lasting between 4–8 minutes. Therefore, having a shorter than recommended mood induction duration may have produced an especially short-lived altered state of anxiety.

Given that our manipulation was ineffective, we were unable to truly test our hypotheses regarding the impact of state anxiety on emotion recognition abilities. Nevertheless, we did observe that individuals with high-trait SA were significantly worse at accurately recognizing happy facial expressions following slight elevations in state anxiety. Here, individuals with SA may be making inferences about others' emotional expressions that are based on their own anxious state (van Kleef & Côté, 2022), leading to incorrect interpretations about the expressor's emotional facial expressions. In the post-mood induction condition, happy facial expressions were most often miscategorized as neutral or negative. Yoon and Zinbarg (2007) similarly found that individuals with high trait SA had a tendency to interpret happy facial expressions as disgusted, mocking, or derisive. Similarly, Gutierrez-Garcia and Calvo (2016) found that individuals with SAD mistrust the genuineness of happy facial expressions. Unsurprisingly, we did not observe any additional

significant differences in accuracy, intensity, or saliency between our pre- and post-conversation conditions. Similar to previous research, Mullins and Duke (2004) note that in contexts with low situational anxiety, individuals with social anxiety perform just as well in pre-post emotion recognition tasks compared to situations that induce high arousal.

Despite being unable to test our primary hypothesis, we did observe significantly different emotion recognition abilities across conditions. Consistent with other findings, our sample with high trait social anxiety had significantly greater difficulty accurately recognizing neutral facial expressions (Lacombe et al., 2023). Neutral facial expressions were also most often confused with other expressions. A frequency analysis of the incorrectly categorized neutral expressions indicated that neutral expressions were most often confused with sadness. This aligns with cognitive models of SAD, which suggest that individuals with social anxiety demonstrate a negative interpretative bias towards ambiguous facial expressions (Brozovich et al., 2014). Similarly, angry facial expressions were also frequently confused with other negative emotional facial expressions, like disgust. According to Aan Het Rot and colleagues (2022), individuals with high social anxiety likely confuse anger with disgust (and vice versa) because they both elicit similar interpersonal responses. Emotional facial expressions of anger or disgust can both suggest negative evaluation or conflict and therefore result in avoidance (Aan Het Rot et al., 2022).

Finally, we did find support for our hypothesis regarding self-evaluations and other evaluations on the behaviour checklist. Participants rated their own performance during the mock discussion as having *more negative* and *less positive* characteristics compared to the confederate. This is consistent with findings that individuals with social anxiety hold biased perceptions about their own performance in social situations, which likely exacerbates anxiety (Stopa & Clark, 1993). However, contrary to Stopa and Clark (1993), participants within our sample rated their

own performance as having more positive relative to negative characteristics overall. This result contradicts their hypothesis that individuals with social anxiety tend to underestimate their social abilities. Although our sample had clinically elevated levels of social anxiety on the LSAS-SR, we may have been unable to observe a similar finding due to sampling a non-clinical group of individuals.

4.5.1 Conclusion

There are a few notable limitations in this study, including the duration of the manipulation and no comparable control group. As previously stated, our manipulation was ineffective at significantly increasing state anxiety. Future studies should aim to replicate this study with a greater discussion time, which would allow sufficient time to have the confederate switch to a more disinterested and cold interpersonal style. Following such a protocol may lead to better success in activating fears of negative evaluation, and therefore increasing state anxiety. Another noteworthy limitation is the absence of a "control" group. The aim of this study was to evaluate the impact of state anxiety on emotion recognition abilities within a sample of individuals with high-trait social anxiety in a pre-post design. Although we were able to observe clear emotion recognition differences between happy, angry, and neutral facial expressions overall, it is unclear whether these responses would differ from a group with low trait social anxiety.

With respect to diversity considerations, all participants were recruited through the University of Ottawa's Integrated System for Participation in Research. Having a university sample may limit the generalizability of the results. Future research should attempt to replicate this study with samples collected from more diverse sources, including a clinical sample. As a final note, the SUDS is a single-item inventory and the only measure used in this study to evaluate state anxiety. Incorporating additional measures, like the widely used 40-item State-Trait Anxiety

Inventory may have provided additional insight into understanding the constructs of state and trait anxiety (Spielberger et al., 1983). Future research should replicate this study implementing the suggested changes listed.

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CHAPTER 5: GENERAL DISCUSSION

5.1 Summary of Goals and Results

The overarching goal of this thesis was to broadly evaluate the relationship between emotion expression recognition (EER) abilities and social anxiety (SA), as well as factors that interacted with this effect. More specifically, the objectives were threefold. First, through a systematic review and meta-analysis, this thesis explored the impact of social anxiety disorder (SAD) on EER abilities, and the moderating role of stimulus duration and mental health comorbidity on this relationship. Our results revealed that individuals with SAD are significantly worse at recognizing emotional facial expressions compared to healthy controls. Highlighted in these results are that individuals with SAD have prominent difficulties identifying expressions that are not overtly negative, such as neutral facial expressions, with particularly robust effect sizes in reaction time. Mental health comorbidities were also observed to have influenced accuracy and reaction time measures for happy facial expressions among those with SAD. Stimulus duration was shown to have no impact on EER abilities, suggesting that performance in EER may be impaired regardless of the length of time of time spent processing the stimuli.

Second, this thesis investigated the impact of communication modality on perceived social skill abilities, such as emotion decoding. Our results indicated that specific social skill abilities are strongly influenced by context and SA severity. We found that individuals with higher trait social anxiety (paradoxically) perceive themselves to have stronger emotion decoding abilities, particularly in face-to-face contexts, relative to other social skills such as sociability, self-disclosure, and assertiveness.

The final study aimed to assess the influence of experimentally induced state anxiety on EER capabilities in a sample with high trait social anxiety. Although the mood induction procedure was ineffective at significantly elevating state anxiety, our results nevertheless indicated that minimal elevations in state anxiety significantly worsened the ability to recognize happy facial expressions. Our results further supported the findings from Study 1, demonstrating that individuals with SA had prominent difficulties identifying neutral facial expressions. Taken together, the results strongly suggest that individuals with SA demonstrate specific difficulties accurately recognizing ambiguous and happy emotional facial expressions.

5.2 Synthesis of Findings

A common finding that emerged across studies was that of a pronounced difficulty in accurately recognizing neutral facial expressions. In Study 1, we found robust significant differences in reaction time. The SAD group had prolonged reaction times in accurately recognizing neutral facial expressions compared to healthy controls, perhaps suggesting a hesitancy and uncertainty in how to appropriately categorize such an expression. The confusion may arise because neutral facial expressions are not truly neutral and contain traces of other facial expressions. Compared to an angry expression, which is overtly negative, a neutral facial expression may be appraised in many ways. A study by Yoon and Zinbarg (2007) found that individuals with high trait SA associate neutral emotion facial expressions with negative cues. Neutral expressions were processed quickly and easily when primed by an angry or disgusted facial expression. In contrast, positively valenced cues had no significant impact on the processing speed of neutral expressions. Our findings add to this by highlighting that even with their prolonged reaction times, individuals with SA are still significantly worse at recognizing neutral facial expressions. This is likely due to a negative interpretative bias (Brozovich et al., 2014).

Several studies have shown that individuals with high levels of SA default to viewing neutral expressions as negative and aversive (Cooney et al., 2006; Gutierrez-Garcia & Calvo, 2016; Yoon & Zinbarg, 2007). In fact, Cooney et al. (2006) found that neutral facial expressions were not only rated by individuals with SAD as negatively valenced but that they elicited similar amygdala activation levels to explicitly threatening facial expressions. Our results from Study 3 similarly support that neutral expressions were often miscategorized as either surprised, angry, sad, or disgusted.

In addition to neutral expressions, happy facial expressions also appeared to elicit some confusion. In Study 1, we found that individuals with SAD alone (i.e., without mental health comorbidities) had significantly slower reaction times when categorizing happy facial expressions relative to healthy controls. Similar to neutral expressions, an increased decision-making time that is unique to SAD may be due to a difficulty identifying socially rewarding or prosocial cues like smiles (Hudd & Moscovitch, 2020; Hudd & Moscovitch, 2023). Either a difficulty identifying positively valenced stimuli or a tendency to discount them (Yoon & Zinbarg, 2007) may be occurring in these individuals. In either case it may be due to cognitive and attentional biases that are activated by emotion dysregulation. Specifically, individuals with SA may be making inferences about others' emotional expressions that are based on their own anxious state (van Kleef & Côté, 2022). Increased anxiety when approaching a happy facial expression may be leading to incorrect interpretations about the expressor's emotional facial expressions. In study 3, we observed that happy facial expressions were most often miscategorized as neutral or negative, particularly when experiencing elevated state anxiety. Yoon and Zinbarg (2007) similarly found that individuals with high trait SA had a tendency to interpret happy facial expressions as disgusted,

mocking, or derisive. As such, it is not surprising that Gutierrez-Garcia and Calvo (2016) found that individuals with SAD mistrust the genuineness of happy facial expressions.

The findings presented in this thesis provide support for Rapee and Heimberg's (1997) model of social anxiety, which focuses on the perception of having an inherently critical audience. Our results suggest that individuals with SA show specific impairments in their ability to accurately recognize neutral and happy facial expressions, which research suggests may be due to a negative attentional bias (Bar-Haim et al., 2007). The existing body of literature exploring the relationship between social anxiety and EER has largely focused on the interpretation of negatively valenced emotional facial expressions, such as anger. The findings from this thesis add to Rapee and Heimberg's (1997) model highlighting that individual's with SA scan for potential signs of negative evaluation across a multitude of emotional expressions. Specifically, our findings would suggest that it is not overtly negative cues that are particularly challenging to process, but rather neutral and positively valenced emotional facial expressions. This challenge, characterized through increased latencies, may be associated to increased emotion dysregulation. Mathai and colleagues (2021) found that individuals with SAD are quicker to disengage from happy and neutral expressions in an effort to regulate anxiety, therefore resulting in increased response latencies. In our studies, we found that neutral and happy facial expressions are not only being processed for greater durations, but that despite the increased decision-making time, these emotional facial expressions are most susceptible to being miscategorized. These incorrect interpretations may in turn reinforce certain erroneously held beliefs in individuals with SAD.

Taking greater amounts of time to respond to non-verbal cues present in social exchanges is likely to lead to poorer performance in social interactions (Sutterby & Bedwell, 2012). The prolonged latencies that individuals with SAD show in interpreting facial expressions can therefore

have real world implications in that social interactions may be impaired or disrupted. For instance, greater conversational pauses in social interactions may project an impression of distance or disinterest to other people (Alden & Taylor, 2004; Rapee and Heimberg, 1997). The unintended effects of this serve as a self-fulfilling prophecy whereby others may interpret the behaviours of those with SAD as being less friendly (Curtis & Miller, 1986; McManus et al., 2008). This negative feedback then reinforces the belief that they are socially inept and lack social skills (Ashbaugh et al., 2005; Hofmann, 2007; McManus et al., 2008). Thus, a cognitive bias is maintained as a result of their own perceptual difficulties, and further, by the beliefs about their perceptual abilities.

Paradoxically, the results from Study 2 indicated that individuals with high trait SA *perceive* themselves to be relatively good at reading others' non-verbal emotional cues. Particularly in in-person contexts, individuals with SA identified emotion decoding to be their best social skill relative to other ones like sociability, self-disclosure, and assertiveness. This was especially interesting given that perceived in-person (as opposed to online) social skills were found to be highly negatively impacted by SA severity. However, in the absence of normative data, it is not possible to ascertain whether individuals with SA comparatively perceived themselves to generally have better social skills than the population in general. It is nevertheless noteworthy that relative to other skills evaluated, emotion decoding is not an area where they perceive themselves to be particularly impaired. One possible explanation for this is that individuals with SA do not conceptualize emotion decoding to be an important marker of successful social interactions. Emotion decoding in fact may not be a social skill metric that is used to indicate social functioning. Research has suggested that individuals with SA have a common fear of blushing, stuttering, sweating, or sounding "stupid" in social settings (Ashbaugh et al., 2005; Moscovitch et al., 2013; Rapee & Heimberg, 1997; Stopa & Clark 1993), all of which contribute to social avoidance

(Brozovich & Rapee, 2010). Nowhere is accurate emotion decoding indicated as a gauge used by those with SA for determining their social performance. A second possibility is that there is a genuine disconnect between subjective and objective emotion decoding abilities. Individuals with SA may be perceiving themselves to be more perceptive and attuned to others emotional mental states than what we are observing through objective measures of performance. However, this hypothesis is only speculative at this time, with limited research evaluating confidence ratings among those with SA in their emotion recognition abilities. To our knowledge, only one related study by Folz and colleagues (2023) found that individuals with high trait SA had low confidence in their emotion recognition abilities regardless of actual performance on EER tasks. However, this was conducted in a non-clinical sample and the results were generally inconsistent with the literature more broadly. Thus, exploring the relationship between subjective and objective performance in EER tasks is a potentially fruitful avenue for future research. Investigating this relationship would give us better insight into the cognitive biases held by those with SA.

5.3 Future Directions and Treatment Implications

The work presented in this thesis highlights the presence of emotion recognition deficits in people with SA. These deficits occur in specific emotion categories, and some of them are exacerbated by mental health comorbidities and small elevations in state anxiety. The results further suggest that EER performance is incongruent with perceived EER abilities, particularly when interacting in face-to-face contexts. Together, these results indicate that EER is influenced by increases in emotional distress and currently held cognitive biases. As such, treatments should be focused on decreasing emotional distress when interacting in face-to-face contexts, and on modifying cognitive biases.

Emotional states marked by high distress influence whether one approaches or avoids a situation, how attention is allocated, how information is appraised, and how one responds to a given situation. When experiencing states of emotional distress, individuals with SA may draw catastrophic conclusions (e.g., viewing ambiguous faces as threatening). As such, employing emotion regulation strategies may allow those with SA to reframe the meaning of stimuli that generate such an emotional reaction. Several therapies such as Dialectical Behaviour Therapy (DBT) and experiential therapies have been shown to effectively enhance emotion regulation across a broad range of psychopathologies (Iwakabe et al., 2023). A key ingredient that is common among these interventions is the practice of enhancing awareness through mindfulness (McMain et al., 2001). Mindfulness-based strategies have been shown to effectively and reliably decrease state anxiety and improve emotional reactivity to negative aversive stimuli (Jazaieri et al., 2015). Doll and colleagues (2016) found that participants viewed aversive stimuli less negatively after engaging in a two-week, 20-minutes daily, mindfulness training program. To date, the impact of these strategies on emotion recognition abilities in a sample with SA has not been explored. However, emotion regulation can reduce fear, avoidance of negative stimuli, and improve meaning making (Doll et al., 2016; Jazaieri et al., 2015), all of which may improve the ability to accurately recognize emotions.

A second important treatment consideration is centered around cognitive and attentional biases. Cognitive Bias Modification (CBM) training techniques have been used to restructure a range of biases, including attention, interpretation, and memory of various cues (Adams et al., 2013). For instance, CMB training has been shown to reduced attentional biases to threatening stimuli and reduce social anxiety symptom severity (Amir et al., 2009). In the context on emotion recognition, Penton-Voak and colleagues' (2020) found that CBM procedures significantly

reduced negative emotion recognition biases at a 6-week follow up in a group of adults with high depressive symptoms. A similar study by Rawdon et al. (2018) found that adolescents with high-trait anxiety who received emotion recognition training through CBM were more likely to categorize ambiguous faces as happy as opposed to disgusted at the two-week follow-up. However, across both studies, neither found any impact of CBM on ameliorating symptoms of depression or anxiety. This is not entirely surprising given that most treatments for depression, social anxiety, or anxiety more broadly are delivered over the course of 12-16 weeks (Beck, 2021; Hope et al., 2019; Zinbarg et al., 2006). As such, it is unclear at this point in time what clinical utility CBM procedures may yield when provided for greater durations of time. Future research is needed to better understand whether EER training would benefit those with SAD and high-trait SA at decreasing attentional biases to neutral and happy facial expressions.

5.4 Conclusion

Social anxiety disorder (SAD) is characterized by prominent fears of negative evaluation, which often occur when encountering social situations, or when faced with the prospect of entering social situations (APA, 2022; DSM-5-TR). Cognitive models of SAD suggest that attentional biases to threat cues, like emotional facial expressions, play a critical role in maintaining the disorder stable over time (Rapee & Heimberg, 1997; Wong & Rapee, 2013). Attentional biases towards specific facial expressions, characterized by a combined hypervigilance-avoidance behavioural eye-movement pattern (Gomes e Claudino et al., 2019), have been associated with poor emotion recognition performance. Avoiding crucial regions of the face, such as the eyes, when interacting with others leads to emotion misidentification and categorization errors (Beaudry et al., 2014; Yitzhak et al., 2022). Through the studies presented

in this thesis, we were able to demonstrate that individuals with SAD and those with high levels of trait anxiety exhibit emotional facial expression recognition deficits.

Our efforts to explore the relationship between these two variables was bolstered by the use of multiple research approaches (i.e., systematic review and meta-analysis, self-report, and experimental), and through the examination of other possible influencing variables (i.e., comorbidity, stimulus duration, communication medium, social anxiety symptom severity, and state anxiety). Despite the identified limitations in each of the conducted studies, this thesis adds to the literature by providing evidence which suggests prominent within-group and between-group emotion expression recognition differences, and notable distinctions in perceived social skill abilities (which include perceived emotion decoding capabilities).

In addition to these efforts, this thesis identified feasible avenues for future work. Further analysis of the role that comorbidity plays in the relationship between EER and SAD is needed. Subsequent systematic reviews and meta-analyses with a wider research scope and larger sample sizes would allow us to conduct in-depth analyses and generate new hypotheses about what commonalities exist between disorders that may be contributing to an EER deficit. Additionally, conducting repeated measures in-vivo emotion recognition experiments that are conducted both in-person and through online platforms would further our understanding of whether perceived emotion decoding deficits correlate to observable ones. Lastly, replicating study 3 using an improved mood-induction methodology, which includes increased conversation times, a cold and disinterested interpersonal style, or conducting the conversation in a group format with multiple confederates, would likely yield to a more successful manipulation. Together, studies exploring these directions would add to the findings of the present work, granting us a better understanding of social anxiety and of approaches for alleviating its negative impacts.

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APPENDICES:

APPENDIX A: Liebowitz Social Anxiety Scale – Self-report

Liebowitz Social Anxiety Scale (LSAS-SR)

Name: _____ **Date:** _____

This measure assesses the way that social phobia plays a role in your life across a variety of situations. Read each situation carefully and answer two questions about it; the first question asks how anxious or fearful you feel in the situation; the second question asks how often you avoid it. If you come across a situation that you ordinarily do not experience, we ask that you imagine "what if you were faced with that situation", and then rate the degree to which you would fear this hypothetical situation and how often you would tend to avoid it (using the 0 to 3 scales below). Please base your

Fear or anxiety	None	Mild	Moderate	Severe
	0	**1**	**2**	**3**
Avoidance	never (0%)	occasionally (1-33%)	often (33-67%)	usually (67-100%)

	Anxiety	**Avoidance**
1. Telephoning in public (p)		
2. participating in small groups (p)		
3. Eating in public places (p)		
4. Drinking with others in public places (p)		
5. Talking to people in authority (s)		
6. Acting, performing or giving a talk in front of an audience (p)		
7. Going to a party (s)		
8. Working while being observed (p)		
9. Writing while being observed (p)		
10. Calling someone you don't know very well (s)		
11. Talking with people you don't know very well (s)		
12. Meeting strangers (s)		
13. Urinating in a public bathroom (p)		
14. Entering a room when others are already seated (p)		
15. Being the centre of attention (s)		

16. Speaking up at a meeting (p)		
17. Taking a test (p)		
18. Expressing a disagreement or disapproval to people you don't know very well (s)		
19. Looking at people you don't very well in the eyes (s)		
20. Giving a report to a group (p)		
21. Trying to pick up someone (p)		
22. Returning goods to a store (s)		
23. Giving a party (s)		
24. Resisting a high pressure salesperson (s)		
Total performance (p) subscore		
Total social interaction (s) subscore		
Total score		

APPENDIX B: Real and Electronic Communication Skills Questionnaire

RCS

All these statements are about what you do in real life only and **NOT** what you do when you are on the Internet!

Use the grid to indicate how much you agree or disagree with each of the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I really enjoy getting to know new people.	☐	☐	☐	☐	☐
2. Sometimes, I cry in front of others.	☐	☐	☐	☐	☐
3. When I think someone is happy, I'm rarely wrong.	☐	☐	☐	☐	☐
4. When I disagree with someone respected, I say so.	☐	☐	☐	☐	☐
5. I prefer to spend time with a large group of friends rather than a group of two or three people.	☐	☐	☐	☐	☐
6. I rarely share my emotions.	☐	☐	☐	☐	☐
7. When someone is sad, I see it immediately, even if he tries to hide it.	☐	☐	☐	☐	☐
8. When I am with my friends, I do not express my opinions if they are different from those of others.	☐	☐	☐	☐	☐
9. People say that I have a lot of friends.	☐	☐	☐	☐	☐
10. I often tell a close friend about things that secretly frighten or distress me.	☐	☐	☐	☐	☐
11. When I talk to someone, I also pay attention to their body language.	☐	☐	☐	☐	☐
12. In general, my friends consider me as someone who knows how to assert himself.	☐	☐	☐	☐	☐
13. When I have just met a person, I often ask or suggest activities (e.g., going for a coffee, talking about a specific topic).	☐	☐	☐	☐	☐
14. I often tell a close acquaintance about things about myself that I am ashamed of.	☐	☐	☐	☐	☐
15. When someone is angry, I can see that easily.	☐	☐	☐	☐	☐
16. I often suggest doing new things to people I have just met and who I find interesting and appealing.	☐	☐	☐	☐	☐
17. Sometimes, I have trouble hiding my emotions, even if I try.	☐	☐	☐	☐	☐
18. I am good at identifying other people's emotions.	☐	☐	☐	☐	☐

ECS

All these statements are about what you do when you are connected to the Internet (from a desktop computer, from a smartphone, etc.)

Use the grid to indicate how much you agree or disagree with each of the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. When I am online, I prefer to talk publicly with many people at a time, rather than staying with a few people.	☐	☐	☐	☐	☐
2. When I chat on the Internet with a close acquaintance, I can easily tell them things I'm ashamed of.	☐	☐	☐	☐	☐
3. When a person is sad online, I immediately realize it, even if he tries to hide it.	☐	☐	☐	☐	☐
4. On the Internet, if I don't agree with someone, I say so without any problems.	☐	☐	☐	☐	☐
5. On the Internet, I often invite people to do certain activities (e.g., games, participate in a discussion group, Facebook tests, etc.).	☐	☐	☐	☐	☐
6. Through the Internet, I can easily tell a friend about things that make me anxious or frighten me in secret.	☐	☐	☐	☐	☐
7. When I am online, I can easily identify the emotions of the other Internet users.	☐	☐	☐	☐	☐
8. When I chat online with friends, I don't give my opinion if it is different from other people's.	☐	☐	☐	☐	☐
9. On the Internet, when I meet people I find interesting, I suggest them to do other online activities (e.g., exchanging photos or participating in competitions).	☐	☐	☐	☐	☐
10. It's hard for me to hide my emotions when I'm online.	☐	☐	☐	☐	☐
11. On the Internet, when I think someone is happy, I'm often right.	☐	☐	☐	☐	☐
12. The people I talk to online consider me as someone who knows how to assert himself.	☐	☐	☐	☐	☐
13. I really like to increase my circle of friends on the Internet.	☐	☐	☐	☐	☐
14. I can easily express my emotions when I chat online.	☐	☐	☐	☐	☐
15. When someone is angry on the Internet, I can easily see that.	☐	☐	☐	☐	☐
16. On the Internet, I often propose to several people I know to meet together in a private system (e.g., in a group chat).	☐	☐	☐	☐	☐
17. When I communicate online, I tend to write very long texts.	☐	☐	☐	☐	☐
18. When I talk with someone online, I also pay attention to the emoticons they use.	☐	☐	☐	☐	☐

APPENDIX C: Depression, Anxiety, Stress Scale (DASS-21)

DASS21

Name: Date:

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week**. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree or a good part of time
3 Applied to me very much or most of the time

1 (s)	I found it hard to wind down	0	1	2	3
2 (a)	I was aware of dryness of my mouth	0	1	2	3
3 (d)	I couldn't seem to experience any positive feeling at all	0	1	2	3
4 (a)	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5 (d)	I found it difficult to work up the initiative to do things	0	1	2	3
6 (s)	I tended to over-react to situations	0	1	2	3
7 (a)	I experienced trembling (e.g. in the hands)	0	1	2	3
8 (s)	I felt that I was using a lot of nervous energy	0	1	2	3
9 (a)	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10 (d)	I felt that I had nothing to look forward to	0	1	2	3
11 (s)	I found myself getting agitated	0	1	2	3
12 (s)	I found it difficult to relax	0	1	2	3
13 (d)	I felt down-hearted and blue	0	1	2	3
14 (s)	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15 (a)	I felt I was close to panic	0	1	2	3
16 (d)	I was unable to become enthusiastic about anything	0	1	2	3
17 (d)	I felt I wasn't worth much as a person	0	1	2	3
18 (s)	I felt that I was rather touchy	0	1	2	3
19 (a)	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20 (a)	I felt scared without any good reason	0	1	2	3
21 (d)	I felt that life was meaningless	0	1	2	3

APPENDIX D: Social Performance Rating Scale (SPRS)

Social Performance Rating Scale
SPRS

Items

A.1. GAZE

(1) Very Poor: Participant completely avoids looking at the partner or stares continually.

(2) Poor: Participant avoids eye contact (or stares) for majority of time. Disruptive to performance.

(3) Fair: Participant frequently avoids eye contact (or stares). Gaze pattern is mildly disruptive to performance.

(4) Good: Participant occasionally avoids eye contact or tends to look too much (stares) while partner is speaking or during shifts of conversation.

(5) Very Good: Participant keeps eye contact during the conversation, does not stare; shifts focus during pauses and conversation.

A.2. VOCAL QUALITY

(1) Very Poor: (a) Participant speaks in a flat, monotonous voice; or (b) speaks at a low volume or mumbles; or (c) speaks overly loudly, or has intrusive tone (harsh or unpleasant voice quality).

(2) Poor: (a) Participant demonstrates no warmth, enthusiasm, or interest in verbal expression; or (b) volume somewhat low and speech somewhat unclear; or (c) speaks a little bit too loudly, or tone is somewhat intrusive or sarcastic.

(3) Fair: (a) Participant shows some warmth in verbal expression but at most times sounds unenthusiastic or uninterested; and (b) speaks in appropriate volume (given partner's volume); has clear voice quality; and (c) does not have an intrusive or sarcastic tone.

(4) Good: (a) Participant shows moderate warmth but inconsistent enthusiasm or interest. Could also be too 'gushy' (seems fake or forced); and (b) and (c) are as in Fair.

(5) Very Good: Participant is warm and enthusiastic in verbal expression without sounding condescending or gushy.

A.3. LENGTH

(1) Very Poor: Monosyllabic ('hmmm', 'yeah', 'OK') speech turns; or responses so long that partner must interrupt or cannot utter reply.

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Social Performance Rating Scale
SPRS

Items

A.3. LENGTH (continued)

(2) Poor: Participant makes mostly short statements with very long pauses; or speaks in long phrases that monopolize the conversation.

(3) Fair: Participant mostly speaks one sentence at a time with occasional long pauses between sentences; or s/he tends to talk excessively (or tangentially) most of the time but allows some responses from the partner.

(4) Good: Participant mostly speaks in statements of one or two sentences without any major pauses, but there are other occasions where speech is short or excessive or tangential.

(5) Very Good: At most times, participant's utterances are two or more sentences long. Participant acknowledges partner's remarks without taking over and monopolizing the conversation.

A.4. DISCOMFORT

(1) Very High: Complete rigidity of arms, legs or whole body. Constant leg movements or fidgeting with hands, hair or clothing. Extremely stiff face or constant facial tics. Frequent nervous throat clearing, swallowing, or stuttering. Frequent inappropriate giggling or laughing. Look of extreme discomfort and desire to flee situation shown by 2 or more breaks in role. Participant does not pay attention to the role-play tasks most of the time.

(2) High: Rigidity or fidgeting for majority of time. Difficulty sitting still is somewhat disruptive to conversation. Stiff face or frequent facial tics. Some nervous throat clearing or swallowing. Some inappropriate giggling or laughing. Participant shows signs of discomfort by frequently looking around. There is no more than 1 break in the role-play.

(3) Moderate: No rigidity. Slight movement of legs, fidgeting, throat clearing, or swallowing. Participant shows only brief periods of discomfort. Focuses on the role-play tasks most of the time. There are no interruptions in the role-play.

(4) Low: No rigidity, nervous throat clearing, or swallowing. Minimal fidgeting that is not disruptive to performance. No notable signs of discomfort. Remains focused on the role-play tasks throughout the role-play. At times may appear relaxed and at ease (smiling or gesturing).

(5) Very Low: Relaxed body posture and natural body movement. Participant laughs and smiles at appropriate times. S/he shows effective gesturing (to be distinguished from fidgeting). Participant focuses on the task all the time, does not appear at all uncomfortable, but at ease in situation.

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Social Performance Rating Scale
SPRS

Items

A.5. CONVERSATION FLOW

(1) Very Poor: Participant makes few attempts to initiate the conversation. Even when prompted by the partner, participant cannot maintain the conversation. Participant uses almost no open-ended questions, or is intrusive in questions and shows no empathy. Participant does not attend to information provided by partner.

(2) Poor: Participant tries to initiate the conversation but is only successful about half the time. The conversation does not flow smoothly, but is more like an interview than a conversation (participant does not follow up on topics and does not provide free information about him/herself). Participant sometime forgets factual information provided by the partner (repeats questions).

(3) Fair: For the most part, the participant is able to maintain the conversation with little help from the partner, although the conversation is still somewhat awkward and stalls at times. Participant asks some open-ended questions. Participant provides little free information and may forget the partner's comments.

(4) Good: Participant is able to maintain the conversation with little to no help from the partner. The conversation flows smoothly (given partner's responses), the participant discloses something about self, and then asks partner a related question (e.g., open-ended questions). Shows interest in partner, and follows up appropriately on partner's remarks. No obvious deficits.

(5) Very Good: Participant easily maintains the conversation and responds smoothly to pauses in the conversation, often by following up on previous information provided by the partner or providing free information about the self on a related topic. Participant introduces new topics fluidly and frequently uses open-ended questions. Participant shows genuine interest in the partner and follows up on the partner's remarks with warmth or enthusiasm.

APPENDIX E: Behaviour Checklist

Behaviour Checklist – Self

Please rate how you believe ***you*** performed in the discussion. That is, please rate your own social skills performance. This scale ranges from 0-8.

A score of **0** indicates that the behaviour was **"not at all characteristic"** of you.

A score of **8** indicates that the behaviour was **"extremely characteristic"** of you.

	0	1	2	3	4	5	6	7	8
Friendly									
Confident									
Relaxed									
Assertive									
Attractive									
Liked									
Warm									
Answered questions easily									
Humorous									
Self-assured									
Understood what the other said									
Fluent									
Asked interesting questions									
Pleasant									
Socially skilled									
Competent									
Nervous									
Blushing									
Hands shaking									
Embarrassed									
Left long gaps in the conversation									
Awkward									
Uncomfortable									

Behaviour Checklist – Other

Please rate how you believe ***the other participant*** performed in the discussion. That is, please rate the social skills performance of the other participant. This scale ranges from 0-8.

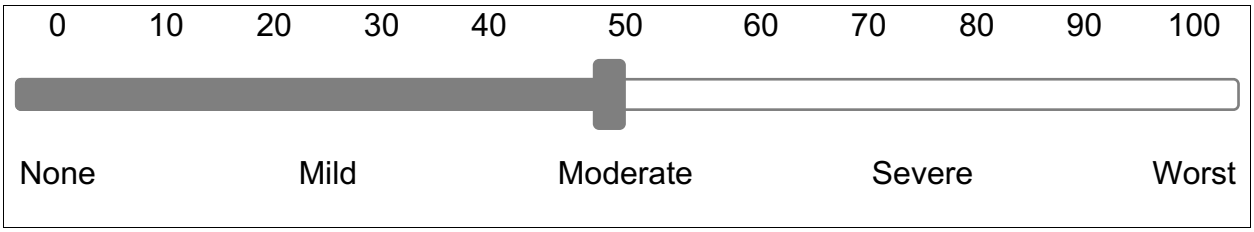
A score of **0** indicates that the behaviour was **"not at all characteristic"** of you.

A score of **8** indicates that the behaviour was **"extremely characteristic"** of you.

	0	1	2	3	4	5	6	7	8
Friendly									
Confident									
Relaxed									
Assertive									
Attractive									
Liked									
Warm									
Answered questions easily									
Humorous									
Self-assured									
Understood what the other said									
Fluent									
Asked interesting questions									
Pleasant									
Socially skilled									
Competent									
Nervous									
Blushing									
Hands shaking									
Embarrassed									
Left long gaps in the conversation									
Awkward									
Uncomfortable									

Appendix F: Subjective Units of Distress Scale (SUDS)

Please rate your current level of distress or discomfort:



APPENDIX G: Resource List

Resource list | Listes des ressources

Crisis Call Centres		
Ottawa Distress Centre (www.dcottawa.on.ca)	613-238-3311	24-hr general crisis intervention.

Mental Health & Social Services Resources		
Centre for Psychological Services (University of Ottawa)	613-562-5289	Offers individual therapy for adolescents and adults, couple therapy and child and family services.
University of Ottawa Student Academic Success Counselling Services (www.sass.uottawa.ca/personal)	613-562-5800	Offers personal counselling regarding topics such as depression, anxiety, stress, self-esteem, relationships, and sexual harassment to students registered at the University of Ottawa