The relationship between the experience of emotion and facial expression recognition ability

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The Relationship Between the Experience of Emotion and Facial Expression Recognition Ability

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Declaration

This thesis contains no material that has been extracted in whole or in part from a thesis that I have submitted towards the award of any other degree or diploma in any other tertiary institution. No other person's work has been used without due acknowledgment in the main text of the thesis. All research procedures reported in the thesis received the approval of the relevant Ethics/Safety Committees (where required).

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Abstract

The ability to recognise facial expressions of emotion is crucial to our ability to function as social beings, informing a number of important social judgements (Willis et al., 2011b). It has been well established that facial expression recognition ability improves over the course of childhood (e.g., Rodger et al., 2015) and decreases in older adulthood (e.g., Ruffman et al., 2008). Some theories suggest that facial expression recognition ability is associated with our experience, and expression of our own emotions (Goldman & Sripada, 2005). Thus, across three studies, this thesis used emotional film clips to examine how subjective emotional experience, facial expressivity (measured using automated facial coding software), emotional concordance (i.e., the relationship between experience and expressivity), and emotion regulation induced in a single task predict performance on a facial expression recognition task. The first study assessed these relationships across two samples of young adults (Experiment 1: $n = 114$; Experiment 2: $n = 116$). Key findings indicated that, in some instances, emotional concordance is a positive predictor of facial expression recognition accuracy, while expressive suppression is a negative predictor. The second study of this thesis examined age-related differences in subjective emotional experience, facial expressivity, emotional concordance, emotion regulation, and facial expression recognition by comparing a sample of older adults (60-85 years; $n = 42$) to a sample of younger adults ($n = 42$). This study was the first to demonstrate that older adults demonstrate significantly lower emotional concordance compared to their younger counterparts. The third study of this thesis involved development of a novel film task to induce and measure discrete emotions in children (6-12 years; $n = 66$), and examined the relationship between subjective emotional experience, facial expressivity, emotional conceptual knowledge, and facial expression recognition ability. This study validated 10 film clips to be used for inducing and measuring discrete emotions in children. Taken together, the findings of this thesis suggest that

emotional concordance may play an important role in facial expression recognition, and that the degree of emotional concordance one experiences declines in older adulthood. Additionally, this thesis contributes significantly by advancing research methods to investigate the development of emotion in childhood, by introducing a novel tool for the induction and measurement of emotion in children.

Chapter 1: Introduction and Thesis Outline

Introduction to Chapter

Facial expressions of emotion are one of the most powerful tools in our emotional toolbelt, as they provide an effective means of communicating our internal state and intentions to others (Darwin, 1978; Hwang & Matsumoto, 2015). The ability to recognise facial expressions is essential for navigating social interactions. Deficits in facial expression recognition can present considerable challenges to social interaction, having a detrimental impact on a number of important social judgements (Willis et al., 2011b), as well as individual's wellbeing and quality of life (Spikman et al., 2013).

As the ability to recognise facial expressions is fundamental to social functioning and wellbeing, a key goal of facial expression recognition research is to identify the mechanisms that underpin facial expression recognition ability. Potential candidates for the underpinnings of facial expression recognition include our propensity to experience and express our emotions. Research has indicated that deficits in facial expression recognition co-occur with deficits in the expression and experience of emotion, specifically our propensity to facially express our emotion (i.e., facial expressivity; Loth et al., 2018; Trevisan et al., 2018) and our subjective experience of emotion (i.e., feelings; Loth et al., 2018). Not only does facial expression recognition appear to be associated with the expression and experience of emotion (Goldman & Sripada, 2005), its acquisition is reported to coincide with development in childhood (Rodger et al., 2015), and its decline coincides with ageing in older adulthood (Ruffman et al., 2008). As such, the expression and experience of emotion may be related to facial expression recognition ability in children and older adults.

Simulationist Model of Facial Expression Recognition

Several theories have been proposed to explain the mechanisms that underpin facial expression recognition. Notably, theories of embodied cognition suggest that our cognitive processes are entrenched in our interaction with the world (Wilson, 2002; Wilson & Foglia, 2011). This approach suggests that many features of cognition are dependent on characteristics of the physical body of a person, such that a person's body plays a significant role in cognitive processing (Wilson & Foglia, 2011). Using this approach to explain facial expression recognition ability, the *simulationist model* of facial expression recognition was proposed by Goldman and Sripada (2005). This model posits that we recognise the facial expressions of others by first simulating the emotion within ourselves. Specifically, facial expression recognition is thought to occur in a three-stage process:

(1) We view an emotional face, inducing the automatic mimicry of the observed expression;
(2) Our mimicry response induces the subjective experience of the observed emotion;
(3) Our subjective experience of the emotion facilitates the accurate recognition of the observed expression.

The *simulationist model* has received a significant amount of empirical support with researchers examining the relationship between the subjective experience of emotion, and facial muscle activity (Feldman et al., 2007; Hussey & Safford, 2009). For example, studies have found that when viewing facial expressions, healthy adults display rapid facial muscle movements that appear to mimic the observed expression (e.g., Dimberg & Thunberg, 1998). Furthermore, studies that have asked participants to generate and hold particular patterns of muscle contraction have found that the process of manipulating one's facial muscles influences the subjective experience of emotion. For example, it has been reported that the voluntary production of a facial expression (e.g., frowning) elicits the subjective experience of the associated emotion (e.g., anger; Levenson et al., 1992; Strack et al., 1988). It has also been reported that holding an object between one's teeth prevents activation of the muscle regions associated with smiling, and impedes the recognition of happiness (Oberman et al., 2007).

Despite the empirical support for a relationship between facial mimicry and facial expression recognition, there is some evidence that challenges mimicry's role in facial expression recognition. For example, older adults demonstrate well reported deficits in facial expression recognition (for a review, see Ruffman et al., 2008), but do not display changes in their propensity to mimic emotion when compared to their younger counterparts (Bailey & Henry, 2009; Slessor et al., 2014). The relationship between facial mimicry and subjective emotional experience has also been challenged with a recent, multi-lab study failing to demonstrate a relationship between mimicry and subjective emotional experience (Wagenmakers et al., 2016). Although there is evidence for a relationship between facial mimicry and both facial expression recognition and subjective emotional experience, these findings challenge these relationships. Recent research has indicated that there may be other aspects of emotional expression and experience that are related to facial expression recognition ability. In particular, participants who self-reported higher emotional expressivity (the extent to which one expresses their emotions) showed greater mimicry responses when viewing facial expressions (Brown, 2015). There is also evidence from research with clinical populations that indicates that there may be a relationship between facial mimicry and facial expressivity. It has been reported that some clinical populations who report deficits in facial mimicry (e.g., individuals with schizophrenia; e.g., Varcin et al., 2010) also exhibit deficits in facial expressivity and facial expression recognition (Dickey et al., 2011). As such, it could be the case that facial expressivity plays an important role in facial expression recognition. This will be addressed in this thesis.

Emotional Concordance

The experience of emotion is constructed by physiological (e.g., heart rate), behavioural (e.g., facial expressions), and experiential components (e.g., subjective emotional experience; Mauss et al., 2005). While it is important to consider how components of emotion (i.e., facial expressivity, subjective emotional experience) uniquely relate to facial expression recognition, it is also important to consider how the relationship between these components may contribute to facial expression recognition. Theories of embodied cognition propose that the occurrence of facial mimicry reflects the simulation of an observed emotion to facilitate the recognition of the emotion (Oberman et al., 2007). That is, when we mimic an observed expression, we read our own expression, which facilitates the interpretation of the observed emotion. In accordance with this notion, it would be expected that our facial expressions produced under emotion inducing circumstances should be positively correlated with our self-reported emotional experience. The extent to which an individual's facial expressions in a particular situation are correlated with their self-reported emotional experience, can be thought of as emotional concordance. There is limited research devoted to emotional concordance, though it has been defined as the relationship between the experiential (i.e., subjective emotional experience), behavioural, and physiological components of emotion (Mauss et al., 2005). It has been reported that individuals who have higher subjective experience of emotion, also have higher facial expressivity (Mauss et al., 2005). For example, those who experience and express greater happiness, would have a higher degree of concordance between these emotion components. While, those who have higher intensity subjective emotional experience of happiness but limited facial expressivity would have a lower degree of concordance.

The importance of considering the role of emotional concordance when examining components of emotion has recently been highlighted. Lougheed et al. (2021) argued that assessing emotional concordance (and discordance) provides a more robust assessment of emotional experience than simply measuring these components in isolation. If we only measure these components in isolation, we are missing key information about the synchronicity between these processes (Lougheed et al., 2021). Given that the *simulationist model* suggests that facial muscle movements induce the experience of emotion, which facilitates the recognition of the emotion, it may be the case that the concordance between our expression and experience of emotion is a good predictor of facial expression recognition. To date, research has not examined how the concordance between facial expressivity and subjective emotional experience may relate to facial expression recognition. This thesis will endeavour to address this gap.

Emotion Regulation

When examining the relationships between the subjective experience of emotion, facial expressivity, and facial expression recognition, it is important to also consider the role that emotion regulation may play. This is particularly important as emotion regulation involves the management of the way we experience and express our emotions (Gross, 2014). Emotion regulation is an important consideration in research on the experience and expression of emotion, as manipulating our experience and expression of emotion may influence the detected relationship between the experience, expression, and recognition of emotion. Furthermore, if there are ties between the subjective experience and facial expressivity of emotion and facial expression recognition, there may also be links with facial expression recognition and emotion regulation.

Two key types of emotion regulation are cognitive reappraisal and expressive suppression. Reappraisal refers to the process by which we construe an emotion-eliciting situation in non-emotional terms. This construal impacts on the trajectory of the entire emotional response by decreasing the experiential, behavioural and physiological responses (Gross, 2002). On the other hand, expressive suppression is a response modulation technique where we inhibit the outward, physical expression of emotion (Gross, 2002). Research has neglected to assess the way in which emotion regulation is associated with facial expression recognition ability. Given that the experience and expression of emotion are associated with facial expression recognition ability, the regulation of these emotional experiences and expressions may have consequences for facial expression recognition ability. This thesis will address this gap by determining if cognitive reappraisal and/or expressive suppression are significant predictors of facial expression recognition ability.

The Development and Decline of Facial Expression Recognition

As outlined earlier, facial expression recognition ability increases over the course of childhood (Rodger et al., 2015) and declines in older adulthood (Ruffman et al., 2008). As discussed above, there may be important links between facial expressivity, subjective emotional experience, emotional concordance, and facial expression recognition ability. Given the links between these processes and the development and decline of facial expression recognition, it is important to consider the developmental/age-related changes in the subjective experience of emotion, facial expressivity, and emotional concordance.

Facial Expression Recognition in Childhood

The ability to accurately recognise facial expressions improves across the course of childhood, with distinct trajectories for different emotion categories (Rodger et al., 2015). Assessment of the pattern of development for the recognition of discrete emotions has demonstrated that happy facial expressions are recognised the earliest with accuracy reaching adult levels of recognition by 5-years of age (Horning et al., 2012; Rodger et al., 2015).

Following happiness, sadness and anger are frequently cited to be most accurately recognised, followed by surprise and disgust (for a review, see Herba & Phillips, 2004; Widen, 2013). There is a scarcity of research that has been devoted to the way in which children subjectively experience and facially express their emotions, and how this may relate to their ability to recognise facial expressions of emotion. This may be explained by a lack of tasks to induce and measure emotional experience in children. Given the scarcity of research on the subjective experience of emotion and facial expressivity in children, there is also a lack of research addressing how these two components relate to each other in childhood (i.e., concordance). This thesis will endeavour to address these gaps in the current literature. Specifically, this thesis develops the first task for the induction of emotion in children in a way that allows for non-invasive analysis of facial expressivity and subjective emotional experience. Additionally, this thesis is the first to address whether emotional concordance is observed in children.

Facial Expression Recognition in Older Adulthood

With regard to the age-related changes in facial expression recognition, it is well-established that older adults (over 60-years) demonstrate deficits in facial expression recognition, relative to younger adults. Specifically, older adults demonstrate significant impairments in the recognition of anger, fear, and sadness compared to their younger counterparts (Ruffman et al., 2008; Hayes et al., 2020). However, older adults demonstrate milder deficits in the recognition of surprise and happiness (Isaacowitz et al., 2007; Ruffman et al., 2008). There are mixed findings for age-related deficits in the recognition of disgust, with Ruffman et al. (2008) indicating that the recognition of disgust remains preserved in older adulthood. However, a more recent meta-analysis indicated that older adults only demonstrate preserved disgust recognition when responding to full intensity stimuli (Hayes et al., 2020). Hayes et al. (2020) report that the dominant finding across the literature, when accounting for stimulus-type, is that older adults demonstrate significant impairment in recognising facial expressions of disgust. Age-related changes are also seen in the subjective experience of emotion, with research suggesting that older adults tend to experience an age-related increase in the experience of positive emotion, and an age-related decrease in the experience of negative emotion (Grühn et al., 2010; Stone et al., 2010). For facial expressivity, however, there is evidence of an age-related increase in positive expression, and an age-related decrease in the expression of negative emotion (Steenhaut et al., 2018; Vieillard & Gilet, 2013). Although research has addressed facial expression recognition, subjective emotional experience, and facial expressivity in older adults, a key limitation of existing literature is the failure to examine these aspects in a single sample, providing further evidence as to the extent to which such age-related changes in facial expression recognition and emotional expression and experience may co-exist. By examining the age-related differences in subjective experience, facial expressivity, and recognition of emotion in a single sample we would gain insight into how these deficits may co-occur. Additionally, research so far has not yet investigated emotional concordance in a sample of older adults. As such, this thesis aims to address these gaps by examining age-related differences in facial expressivity, subjective emotional experience, and emotional concordance in a single cohort of older adults.

The Current Thesis

The aim of this thesis is three-fold. First, this thesis aims to establish the predictors of facial expression recognition by addressing three questions:

(1) Are facial expressivity and subjective emotional experience significant, unique predictors of facial expression recognition ability?

(2) Does emotional concordance predict facial expression recognition ability?

(3) Does emotion regulation predict facial expression recognition ability?

Second, this thesis aims to examine the age-related differences in subjective emotional experience, facial expressivity, emotional concordance, and facial expression recognition in a single sample of older adults. Third, this thesis aims to examine the relationships between the aforementioned emotion processes in children, by first developing a valid and reliable task to induce and measure emotion in children. This thesis presents the results of three empirical studies that seek to address these aims and discusses the contribution of these results to the literature on facial expression recognition.

Thesis Overview

This thesis includes two review chapters, followed by the three empirical studies. The first literature review (Chapter 2) is a review of the literature investigating the *simulationist model* of facial expression recognition. This chapter reviews evidence that facial expression recognition is associated with the subjective experience of emotion and facial mimicry; it also discusses research findings that may point to facial expressivity and emotional concordance as mechanisms involved in facial expression recognition. The second review (Chapter 3) is a review of the commonly used methods for measuring facial expression production. This chapter will provide an overview of various methodological approaches to measuring facial expressions of emotions, reviewing the benefits and limitations of each.

The empirical studies will be presented in Chapters 4, 5, and 6. Chapter 4 examines the predictors (i.e., facial expressivity, subjective emotional experience, emotional concordance, and emotion regulation) of facial expression recognition at both the valence (e.g., positive, and negative emotion; Experiment 1), and the discrete emotion level (Experiment 2). Chapter 5 presents the first study to (a) assess facial expressivity, subjective emotional experience, emotional concordance, and facial expression recognition in a single sample of older adults, and (b) to compare older adults performance to that of younger adults. This chapter will also examine the correlates of facial expression recognition in older adults. Chapter 6 develops and validates an emotional film task designed for eliciting and measuring emotion in children. In this study, 10 film clips are validated for use for eliciting emotion in children, as well as measuring the extent to which subjective emotional experience, facial expressivity, emotional concordance, emotional conceptual knowledge, and facial expression recognition ability are associated with each other. Each of these three studies were conducted concurrently and are connected by a common theme of addressing the relationships between subjective emotional experience, facial expressivity, emotional concordance, and facial expression recognition.

Finally, this thesis will conclude with a review and discussion of the results in Chapter 7. Chapter 7 will discuss the key findings from the empirical chapters and will also discuss the contribution that the findings from the empirical chapters make to the current literature on facial expression recognition, the limitations of the current studies, and avenues for future research.

Chapter 2: A Narrative Review of Simulation and Facial Expression Recognition

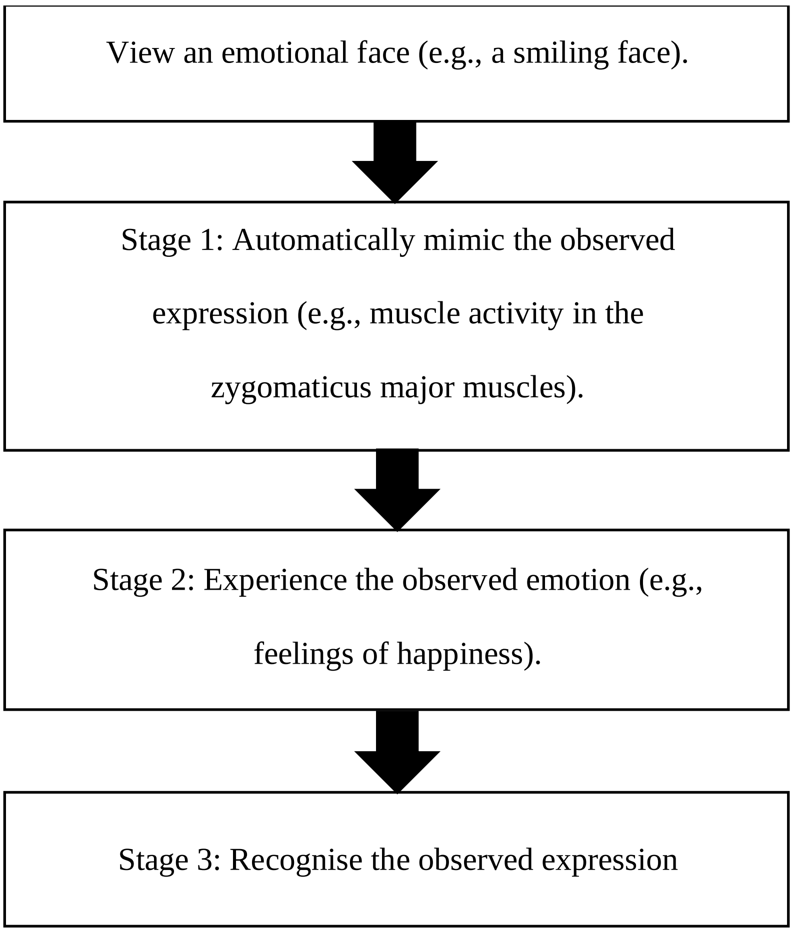
Introduction to Chapter

Facial expressions convey a wealth of information about our emotions and motives to the world around us. By definition, a facial expression refers to the rapid movement of facial muscles that convey a variety of meanings across different contexts (Ekman, 1970; Elliott & Jacobs, 2013). Thus, the ability to recognise the facial expressions of others rapidly and accurately is critical for effective social functioning (Todorov et al., 2008). The recognition of facial expressions of emotion is a skill that is gradually acquired over the course of development (e.g., Rodger et al., 2015) in parallel with other emotion related skills, including the conceptual understanding of emotion (e.g., Bayet & Nelson, 2019; Russell & Widen, 2002; Widen & Russell, 2010). Moreover, it is well-established that facial expression recognition ability declines in older adulthood (for a review, see Ruffman et al., 2008). In addition to an age-related decline in facial expression recognition, older adults also report age-related changes in aspects of emotional experience, including the subjective experience of emotion (e.g., Vieillard & Gilet, 2013) and the production of facial expressions (e.g., Smith et al., 2005; Vieillard & Gilet, 2013). Given that the age-related decline in facial expression recognition coincides with changes in the experience and expression of emotion, it may be the case that our experience of emotion in terms of the subjective experience of emotion and the behavioural expression of emotion (e.g., facial expressivity) may influence our facial expression recognition ability. Prominent models of facial expression recognition have suggested that this may be the case (Goldman & Sripada, 2005)

Theories of embodied cognition suggest that our cognitive processes are entrenched in our interactions with the world (Wilson, 2002; Wilson & Foglia, 2011). Such theories propose that many features of cognition are embodied, as they are reliant on characteristics of a person’s physical body, such that a person’s body plays a significant role in cognitive processing (Wilson & Foglia, 2011). In applying embodied cognition to facial expression recognition ability, the *simulationist model* of facial expression recognition proposed by Goldman and Sripada (2005) suggests that facial expression recognition (i.e., cognition) is associated with bodily reactions (i.e., embodiment). The *simulationist model* posits that we use the mechanism of simulation to recognise the emotion of other people in a three-stage process. That is, when we view an emotional facial expression, we automatically mimic the observed expression, which induces the subjective experience of the observed emotion, facilitating facial expression recognition. This process is depicted in Figure 2.1.

Figure 2.1

Flow Chart Depicting the Three-Stage Process of the Simulationist Model of Facial Expression Recognition



The *simulationist model* has received a significant amount of support from empirical research examining the relationships between the assumed underlying processes including facial mimicry (an automatic process where the observer's face matches the observed facial expression; Hess & Blairy, 2001) and subjective emotional experience (i.e., the feelings associated with an emotion). Such research has established that facial mimicry is associated with the subjective experience of emotion (e.g., Sato et al., 2013; Strack et al., 1988), and that these processes are both associated with facial expression recognition ability (e.g., Neidenthal et al., 2001; Sato et al., 2013). However, there is a lack of strong evidence to indicate that an individual's facial mimicry and the intensity of one's subjective emotional experience are predictors of facial expression recognition ability (Hess & Blairy, 2001). Thus, this chapter will review the evidence for each one of the three underlying processes of the *simulationist model*. Additionally, this chapter will consider facial expressivity (the extent to which an individual facially expresses their emotions) and emotional concordance (the relationship between the subjective emotional experience and facial expressivity) as alternative mechanisms that may predict facial expression recognition ability.

First, this chapter will review the evidence for relationships between facial mimicry and facial expression recognition, subjective emotional experience and facial mimicry, and subjective emotional experience and facial expression recognition. This discussion will draw on evidence from neuropsychological research indicating that the brain regions implicated in the recognition of emotion are also implicated in the expression and experience of emotion. Finally, this chapter will outline future directions for research investigating the predictors of facial expression recognition, laying the foundations of the theoretical approach of this thesis.

Simulation

The *simulationist model* proposed by Goldman and Sripada (2005) posits that we recognise the emotions of others by first simulating the emotion within ourselves. The concept of simulation is not exclusive to Goldman and Sripada (2005), with a review from Adolphs (2002b) proposing simulation as a possible mechanism used for recognising facial expressions.

The concept of simulation has received a considerable amount of attention and support in the literature. A large number of studies adopting facial electromyography (EMG; a technique for assessing subtle facial muscle activity) have demonstrated that when viewing pictures of emotional facial expressions, healthy adults display rapid facial muscle movements that mimic the observed expression (e.g., Dimberg & Thunberg, 1998; Neidenthal et al., 2001). For example, exposure to negatively valenced faces (e.g., angry faces) is associated with increased activity of the corrugator supercilii muscle (i.e., the muscle that knits the eyebrows together to form a frown), while exposure to positively-valenced faces (e.g., happy faces) results in increased activity of the zygomaticus major muscle (i.e., drawing the corners of the mouth upward to form a smile; Dimberg et al., 2000; Hess & Fischer, 2014). Furthermore, this mimicry occurs in response to emotional faces that are presented rapidly, and faces that are presented subliminally, suggesting that this process is automatic and unconscious (Dimberg et al., 2000; Dimberg et al., 2002). Manipulation of this mimicry response has been shown to influence the observer’s ability to judge another’s emotion. Inhibiting muscle responses is associated with decreased performance in facial expression recognition. For instance, holding an object between one’s teeth can prevent mimicry in the zygomaticus major muscle and impair the subsequent recognition of happiness (Oberman et al., 2007). Studies have shown that the experimental (e.g., mechanical blocking, chemical blocking; Rychlowska et al., 2014) and clinical interference (e.g., facial paralysis; Korb et al., 2016) to facial mimicry has been associated with compromised recognition of facial expressions (for a review, see Wood et al., 2016). Together this evidence suggests a link between mimicry and facial expression recognition.

The second stage in the simulation process involves the subjective experience of the observed emotion which is suggested to be prompted by facial mimicry. People commonly report experiencing emotions that are congruent with their facial expressions, reporting that they rarely experience emotions that are incongruent with their facial expressions (e.g., experiencing happiness while frowning; Hatfield et al., 2014). The subjective experience and expression of emotion (e.g., facial expression) are correlated with each other, with some researchers suggesting a causal relationship between the two (Adelmann & Zajonc, 1989; Cacioppo et al., 1992; Rosenberg & Ekman, 1994). Higher intensity subjective emotional experience is associated with greater emotional expression, with some evidence suggesting that the production of emotional facial expressions can lead to changes in the subjective experience of emotion. For example, activation of the zygomaticus major muscle while viewing cartoons leads to a more intense experience of humour (Strack et al., 1988). This would support the notion that mimicry induces the experience of the observed emotion. Despite these findings, a large scale replication attempt failed to replicate the findings of Strack et al. (1988), with inconsistent findings across multiple labs (Wagenmakers et al., 2016). Such inconsistencies, however, may be attributed to the characteristics of the stimuli used in Wagenmakers et al. (2016). A recent meta-analysis provided support for facial feedback effects on subjective emotional experience, indicating that effects were larger in response to some stimuli (i.e., emotional sentences), than others (i.e., pictures; Coles et al., 2019). Collectively, the evidence summarised above provides support for simulation as a mechanism for facial expression recognition ability, highlighting that the type of stimuli moderates the effectiveness of simulation.

A primary criticism of the idea that simulation is a mechanism for facial expression recognition is borne out of evidence indicating that clinical populations with mimicry deficits have intact facial expression recognition ability (e.g., individuals with Moebius syndrome).

Moebius syndrome is a rare, congenital disorder resulting in facial paralysis, and deficits in the production of facial expressions of emotion (Briegel, 2006). Research has indicated that individuals with Moebius syndrome do not differ significantly from controls in facial expression recognition ability (Rives Bogart & Matsumoto, 2010). Furthermore, Rives Bogart and Matsumoto (2010) also reported that facial expression recognition accuracy was not associated with the ability to produce facial expressions. That is, people who experience greater facial paralysis did not perform significantly poorer than those experiencing milder paralysis. Given that facial expression recognition ability remains intact in such clinical populations, it may be the case that facial expression recognition ability is not solely reliant on one of the three stages outlined in this section, rather it is contingent on a combination of these stages. As such, mimicry may contribute to facial expression recognition ability, but may not be necessary to accurately recognise the facial expressions of others.

The literature reviewed thus far has indicated that the experience, expression, and recognition of emotion have links with each other. For example, some populations with impairments in facial expression recognition ability also report a disruption in their own experience and expression of emotion (Feinstein et al., 2011). While numerous studies have provided support for the *simulationist model*, there is still contention that remains. The following sections will examine the validity of the *simulationist model*, discussing conflicting research findings in relation to the implied links between the stages of this model. The first section will evaluate the findings for the role of facial mimicry in facial expression recognition suggesting that this may be a compensatory mechanism in facial expression recognition (Coles et al., 2019). Stage 2 of the *simulationist model* of facial expression recognition will also be evaluated, discussing the research findings for a relationship between facial mimicry and subjective emotional experience. Following this, support for Stage 3 of the *simulationist model* (i.e., subjective emotional experience facilitating facial expression recognition) will be evaluated with the discussion of findings from neuroimaging and lesion studies supporting the relationship between facial expression recognition ability and subjective emotional experience. This review will then turn to discuss the possibility that facial expressivity (the extent to which we express our emotions through our face) and emotional concordance may play important roles in facial expression recognition, suggesting links between our expression, experience and concordance of emotion and facial expression recognition ability.

Relationship Between Facial Mimicry and Facial Expression Recognition

According to the *simulationist model*, increased activity in the muscle regions involved in particular facial expressions should increase an observer's ability to recognise the facial expression (Goldman & Sripada, 2005). This notion is supported by findings suggesting that facial mimicry is associated with our ability to detect changes in the facial expressions of others. When shown videos of emotional facial expressions, participants who were allowed to mimic the observed expression were able to spot the offset of an initial expression earlier than participants who were instructed not to mimic (Neidenthal et al., 2001). Modifying facial muscle movements by actively dampening facial feedback signals through the use of Botox has been shown to impair facial expression recognition (Neal & Chartrand, 2011). Furthermore, the amplification of facial muscle movements through enhanced facial muscle contractions has been shown to improve facial expression recognition (Neal & Chartrand, 2011). In addition to accuracy in facial expression recognition, mimicry is also associated with the speed at which we recognise emotion (Stel & Van Knippenberg, 2008) and our ability to recognise the authenticity of the observed emotion (Korb et al., 2014). It has been suggested that mimicry may result in faster emotion recognition because it involves a shorter route of processing via simulation, compared to longer routes involving matching the visual input with our emotion schemas (Stel & Van Knippenberg, 2008). Additionally, Korb et al.

(2014) reported that muscle activity in the zygomaticus major, orbicularis oculi, and corrugator supercilii muscle regions predicted participants' ability to differentiate authentic smiles from Duchenne smiles. Taken together, these findings suggest that facial mimicry may play an important role in several aspects of processing emotional information from facial expressions (i.e., recognition accuracy, speed of accuracy, and judgements regarding the authenticity of emotional expressions).

Additional evidence for the relationship between facial mimicry and facial expression recognition comes from clinical populations that have impairments in facial mimicry and demonstrate diminished facial expression recognition ability. The remainder of this section will discuss the evidence for mimicry related impairments in several clinical populations that have documented deficits in facial expression recognition. Moreover, this section will discuss evidence of the relationship (and the absence of a relationship) between facial expression recognition and facial mimicry. One of the clinical populations most investigated in this area is Autism Spectrum Disorder (ASD). Individuals with ASD, a population with marked deficits in the ability to process their own emotions and the emotions of others (Loth et al., 2018), display abnormal facial muscle reactions in response to emotional faces (Ogai et al., 2003; Trevisan et al., 2018). When viewing pictures of happy and angry faces, individuals with ASD do not automatically mimic facial expressions, in contrast to controls who do demonstrate automatic facial mimicry (McIntosh et al., 2006). In addition to this, the deficits in facial mimicry observed in ASD are also associated with greater severity of ASD symptoms, suggesting that there may be a link between facial mimicry and social functioning (Yoshimura et al., 2015). The co-occuring deficits in facial mimicry and facial expression recognition in individuals with ASD may be as a result of delayed facial feedback (our facial muscle movements/expressions influence our experience of emotion; Buck, 1980), as opposed to an absence of facial feedback. It has been reported that both blocking and facilitating facial mimicry (automatic and intentional) does not impact the experience of the corresponding emotion in people with ASD, compared to neutrotypical controls (Stel et al., 2008). Indeed, studies have found that across angry, disgusted, fearful, happy, and sad expressions, individuals with ASD displayed a delay in mimicry activity when viewing these expressions in comparison to neurotypical controls (Oberman et al., 2009). Thus, it has been suggested that the deficits in facial mimicry may not be due to a complete absence of mimicry response, but rather a delayed mimicry response.

Another clinical population commonly reported to have co-occuring deficits in facial expression recognition and facial mimicry is individuals with schizophrenia. Schizophrenia is a hetergeneous disorder that is characterised by delusions, hallucinations, disorganised thought, and deficits in social, affective and cognitive functions (American Psychological Association, 2013). Individuals with schizophrenia have repeatedly been identified as possessing deficits in facial expression recognition, displaying greater errors and slower response times compared to typical controls (for a review, see Kohler et al., 2010). Research has demonstrated that when processing facial expressions, individuals with schizophrenia attend to different visual facial information to that of healthy controls. For instance, eye tracking studies have revealed that patients with schizophrenia focus heavily on the mouth, as opposed to the eye region when processing fearful faces, and a combination of the eye and mouth regions for the processing of happy faces (Lee, Gosselin, Wynn, & Green, 2011). This differs from healthy controls, who focus heavily on the eyes when processing fearful faces, and the mouth when processing happy faces (Lee et al., 2011). In addition to the eye-tracking differences between typical controls and individuals with schizophrenia, there is also evidence to suggest abnormalities in facial mimicry in these patients while viewing emotional faces. Facial EMG research examining the occurrence of rapid facial mimicry reactions to angry and happy faces (within 1000ms of stimulus onset), has demonstrated that individuals with schizophrenia failed to produce rapid facial mimicry reactions that were congruent with the observed emotional expression (Varcin et al., 2010). Taken together, these findings indicate that abnormalities in facial mimicry co-exist with impairments in the recognition of facial expressions.

Despite the evidence for deficits in facial mimicry in individuals with schizophrenia, some studies have failed to demonstrate differences in facial mimicry between healthy controls and individuals with schizophrenia. When measuring EMG responses, both individuals with schizophrenia and controls produced congruent muscle activity in response to pictures of positive and negative facial expressions (Kring et al., 1999). That is, individuals with schizophrenia did not produce inappropriate/incongruent mimicry responses compared to controls (Kring et al., 1999). More recently, Chechko et al. (2016) compared facial mimicry responses from stable schizophrenia patients with healthy controls in response to pictures of emotional facial expressions. Results indicated that there were no significant differences between patients with schizophrenia and the controls in the production of spontaneous facial mimicry (Chechko et al., 2016). The disparity in the evidence for deficits in facial mimicry in individuals with schizophrenia may reflect the severity of symptoms. Anhedonia is defined as a reduced capacity to experience pleasant emotions (Kring & Germans, 2000), and is a symptom of schizophrenia (Earnst & Kring, 1997). Given that anhedonia is associated with a reduced experience of positive emotion, it may also be associated with decreased production of facial expressions of positive emotions. As such, it may be that impairments in facial expression recognition in individuals with schizophrenia are associated with the production of facial expressions more broadly, as opposed to mimicry specifically.

Despite the support for the role of facial mimicry in facial expression recognition, much dissension remains in the literature. One area of research that examined the role of facial mimicry in facial expression recognition focuses on age-related differences in these processes. Research into age-related changes to facial mimicry has not provided support for its relationship with facial expression recognition. Older adults do not display changes in their propensity to automatically mimic emotion when compared to their younger counterparts (Bailey & Henry, 2009; Slessor et al., 2014). That is, older adults' facial mimicry responses are neither reduced, nor delayed when compared to their younger counterparts (e.g., Bailey & Henry, 2009; Slessor et al., 2014). This is despite strong evidence that older adults demonstrate significant age-related declines in facial expression recognition ability (see Ruffman et al., 2008 for meta-analysis). Taken together, these results suggest that facial mimicry is a process that is relatively constant across the lifespan when passively viewing emotional facial expressions, despite diminished facial expression recognition ability in older age.

The contradictory evidence for the role of facial mimicry in facial expression recognition gives rise to the idea that it may not necessarily be our propensity to mimic facial expressions that is associated with our ability to recognise them. In a recent review, De Stefani et al. (2019) argued that there are three primary explanations for the controversial findings for facial mimicry. First, blocking facial mimicry when viewing an emotional face may only interfere with recognition, not stop recognition altogether. Second, studies that examine facial mimicry tend to focus on a restricted number of emotions despite muscle regions not necessarily being emotion specific (e.g., corrugator supercilii activation is not unique to the experience of anger). Third, the detection of facial mimicry may be the detection of motor activity that is not a result of facial mimicry, rather the detection of ongoing motor simulation and motion artefacts (De Stefani et al., 2019).

Facial mimicry and its relationship with facial expression recognition has received extensive empirical attention, with a degree of division amongst the findings. It has been well reported that healthy adults exhibit congruent facial muscle activity when viewing emotional facial expressions (Dimberg & Thunberg, 1998; Hess & Blairy, 2001; Neidenthal et al., 2001). However, it has been suggested that facial mimicry may not be necessary for facial expression recognition (Coles et al., 2019). As discussed above, research across a variety of populations (e.g., individuals with Moebius syndrome, individuals with schizophrenia, older adults) provide support for this notion. Rather than facial mimicry being a pivotal mechanism in facial expression recognition ability, Coles et al. (2019) suggest that it is used as a compensatory mechanism in emotional situations that are unclear/ambiguous. Thus, we use our facial mimicry as a tool in identifying facial expressions of emotion in contexts where the expression is difficult to interpret.

Relationship Between Facial Mimicry and Subjective Emotional Experience

The second stage of the *simulationist model* of facial expression recognition is that facial mimicry induces the subjective experience of emotion and is grounded in the facial feedback hypothesis. The facial feedback hypothesis is a theory that suggests that our facial muscle movements/expressions influence our experience of emotion (Buck, 1980). According to the facial feedback hypothesis and the *simulationist model*, our automatic mimicry produced in response to emotional faces induces the subjective experience of the associated emotion in the observer (Goldman & Sripada, 2005). The idea that there is a relationship between the experience of emotion and facial muscle movement is a notion that has also received divided empirical support.

On one hand, the process of manipulating one's own facial expression has been found to influence both the physiological and subjective experience of emotion. Evidence for the relationship between subjective emotional experience and facial mimicry is borne out of research examining emotional contagion (the transfer of emotion between individuals that is triggered by emotional mimicry; Hatfield et al., 1993). One such study measured facial muscle activity while participants viewed dynamic and static facial expressions of positive and negative emotion, and then provided valence ratings of their subjective emotional experience. Facial EMG activity consistently predicted the valence ratings of emotional experience in response to dynamic facial expressions, such that greater facial muscle activity of positive emotion predicted greater experience of positive emotion (Sato et al., 2013). Similar results were reported in response to static facial expressions, though these effect sizes were significantly smaller than dynamic expressions (Sato et al., 2013). Similar to research with emotion contagion, research using facial EMG has also indicated that facial mimicry, the physiological markers of emotional experience, and the subjective experience of emotion are associated with each other. Researchers have demonstrated that the voluntary production of a facial expression (e.g., forming a frown) elicits the physiological markers (e.g., temperature and heart rate), and subjective experience of the associated emotion (e.g., anger; Levenson et al., 1990; Strack et al., 1988). Likewise, studies using facial EMG have indicated that there is a relationship between facial muscle activity and subjective emotional experience, in that the emotional valence of facial muscle activity is congruent with the emotional valence of the emotion being experienced (e.g., Dimberg & Thunberg, 1998; Neidenthal et al., 2001). More recent research has examined this relationship from a discrete emotion (i.e., happiness, anger, and sadness) approach. Both Olszanowski et al. (2020) and Wróbel et al. (2021) measured facial mimicry and self-report subjective emotional experience ratings in response to videos of dynamic facial expressions of happiness, sadness, and anger. It was reported across both studies that participants facial mimicry and subjective emotional experience matched the emotion that was expressed in the video, with most pronounced effects for happiness (Olszanowski et al., 2020; Wróbel et al., 2021). In addition to this, Olszanowski et al. (2020) indicated that facial muscle activity partially explained the relationship between the observed emotion and subjective emotional experience ratings. Such findings highlight the relationship between our own facial muscle movements and our experience of emotion.

Despite the support for the relationship between subjective emotional experience and facial mimicry, this relationship has been contested by several researchers. Hess and Blairy (2001) examined the relationship between facial mimicry and emotional contagion. Even though they reported both facial mimicry and emotional contagion, mediation analyses indicated that these two processes were not related to each other (Hess & Blairy, 2001). Further evidence against a relationship between facial mimicry and subjective emotional experience comes from research with individuals with bilateral facial paralysis. Keillor et al. (2002) examined the role of facial feedback in F.P., a patient with bilateral facial paralysis. When viewing emotionally provocative images, F.P. did not differ significantly from controls in her subjective experience of emotion, despite her inability to produce the matching emotional expression (Keillor et al., 2002). The dissention in the literature regarding the relationship between facial mimicry and subjective emotional experience leaves a gap in the current literature; is there something other than facial mimicry that may play a role in the subjective experience of emotion, and in turn, facial expression recognition?

So far, this section has focussed on evidence for an association between facial muscle movements and subjective emotional experience that comes from studies that have amplified or inhibited facial muscle movements. For example, people have reported significantly higher levels of negative mood when lowering their eyebrows, higher levels of surprise when raising their eyebrows, and elevated experience of disgust when wrinkling their nose (Larsen et al., 1992; Lewis, 2012; Strack et al., 1988). It should be noted, however that these findings were not specific to facial mimicry. Rather, in these studies participants were instructed to manipulate their facial expressions in the absence of images of emotional facial expressions. Thus, these facial muscle movements may be more reflective of facial expressivity, as opposed to facial mimicry, as they were produced in the absence of a stimuli that elicited mimicry. There is evidence from some research with clinical populations that exhibit paired abnormalities in facial expressivity and the experience of emotion. As mentioned previously, individuals with ASD are a population with marked deficits in the ability to process their own emotions, and the emotions of others (Loth et al., 2018). Children with ASD demonstrate differences in the frequency and intensity of experience of some emotions, when compared to typically developing children. For example, children with ASD tend to experience lower intensity amusement (Samson, 2013), but greater frequency and intensity of anger (Ho et al., 2012; Quek et al., 2012) and anxiety (Samson et al., 2015). It has also been reported that individuals with ASD produce facial expressions with less frequency, and for shorter durations compared to neurotypical counterparts (see Trevisan et al., 2018 for a meta-analysis). It is important to note that in addition to the abnormalities in the experience and expression of emotion in ASD, it has been well established that individuals with ASD demonstrate impairments in facial expression recognition ability (see Lozier et al., 2014, for a meta-analysis). As such, it may be the case that the impairments in facial expression recognition are associated with the reported abnormalities in facial expressivity and subjective emotional experience. Given that the above evidence provides support for the notion that one's expression of emotion (as opposed to mimicry) is associated with their experience of emotion, and perhaps the recognition of emotion in a clinical population, it is important to consider this relationship in neurotypical individuals. This is a concept that will be explored throughout this thesis.

Relationship Between Subjective Emotional Experience and Facial Expression Recognition

The third stage of the *simulationist model* of facial expression recognition outlines that our subjective experience of emotion facilitates facial expression recognition accuracy. Although there is a scarcity of research assessing subjective emotional experience and facial expression recognition directly, there is some evidence to suggest that when viewing videos of dynamic facial expressions and rating emotional experience, participants ratings of emotional experience were predictive of their ability to recognise the emotional expression (Sato et al., 2013); participants who had higher ratings of emotional experience were more accurate in recognising emotional expressions. Much of the support for a relationship between subjective emotional experience and facial expression recognition is borne out of two areas. First, neuroimaging and lesions studies focussing on the amygdala, orbitofrontal cortex (OFC), and the insula provide evidence that these brain regions are involved in the experience and recognition of emotion. Second, work on clinical populations, such as patients with schizophrenia and ASD, support the notion that subjective emotional experience and facial expression recognition are associated with each other. This section will first review evidence from lesion and neuroimaging studies, and then review findings from research with clinical populations.

The amygdala (located in the medial temporal lobe) is a key structure implicated in both the recognition and experience of emotion (Schirmer & Adolphs, 2017). Assessment of the experience of emotion amongst patients with bilateral amygdala damage has indicated that these patients experience blunted negative emotion in a manner that parallels the deficits in the perception of negative emotion (Tranel et al., 2006). SM is a patient with bilateral amygdala lesions, who has been involved in a number of studies examining the role of the amygdala in the processing of emotion. In addition to deficits in the recognition of fearful facial expressions, SM also displays abnormalities in the experience of fear (Feinstein et al., 2011). That is, when exposed to fear-inducing stimuli, SM reported near floor level experience of fear. However, when compared to healthy controls, patients with amygdala damage report no significant differences in the frequency that they experience emotions in their everyday lives (Anderson & Phelps, 2002). That is, despite differences in the intensity of the emotional experience, patients with amygdala damage still report experiencing the emotion. As such, it may be the case that the amygdala is recruited in the experience of emotion but the way in which amygdala patients experience fear is different to healthy controls.

An additional brain region implicated in the recognition and experience of emotion is the orbitofrontal cortex (OFC). Located in the ventral portion of the prefrontal cortex, the OFC has anatomical connections to the amygdala, with activation associated with tasks requiring the recognition of emotions (e.g., Adolphs, 2002a; Minagawa-Kawai et al., 2009; Willis et al., 2015). Research conducted with patients with OFC damage has highlighted the role of the OFC in the recognition of facial expressions and the experience of emotion. Despite often performing comparably to healthy controls on standard neuropsychological tests, patients with OFC damage often exhibit profound deficits in social and emotional functioning, demonstrating distinct difficulties in recognising facial expressions (Willis et al., 2014). Patients with both unilateral and bilateral OFC damage exhibit poor performance on both facial and vocal emotion recognition tasks (Hornak et al., 1996). Interestingly, altered emotional experience in OFC patients is significantly correlated with the degree of impairment in emotion recognition (Hornak et al., 1996). The occurrence of paired impairments in emotional experience and recognition amongst OFC patients supports the notion that the experience of emotion is associated with facial expression recognition ability.

A third brain region that is involved in the experience and recognition of some emotions is the insula, which is located underneath the fronto-parietal and temporal opercula (Guenot et al., 2004; Phillips et al., 1997; Wright et al., 2004). Research adopting functional magnetic resonance imaging (fMRI) has identified that the insula plays a key role in the recognition and the experience of disgust. For example, Wicker et al. (2003) used fMRI to record insula activity in response to participants inhaling odorants designed to produce disgust responses. Wicker et al. (2003) also recorded insula activity while showing participants clips of dynamic facial expressions. Results indicated that the insula was activated when viewing disgusted facial expressions, as well as when experiencing disgust. Similarly, it has been shown that insula responses to disgust inducing pictures are predicted by the intensity of participants' disgust and arousal ratings (Wright et al., 2004). Together these studies suggest that greater insula activity is associated with greater intensity of the experience of disgust.

The findings that the amygdala, OFC, and insula are implicated in both the recognition and the experience of emotion provides support for the third stage of the *simulationist model*. As explained above, evidence for a relationship between facial expression recognition and the subjective experience of emotion has been provided by research involving clinical populations, including individuals with schizophrenia, and ASD. It has been established that individuals with schizophrenia demonstrate significant deficits in facial expression recognition ability compared to healthy controls (Trémeau, 2006). In addition to this, individuals with schizophrenia also report differences in their experience of emotion. In studies that provoke and measure emotional experience, individuals with schizophrenia report similar experiences of positive emotion, but higher experiences of negative emotion compared to typical controls (for a review, see Trémeau, 2006). Individuals with ASD are another population who display deficits in facial expression recognition and the subjective experience of emotion. As discussed in the previous section, children with ASD report differences in the frequency and intensity of experience of some emotions, including amusement (Samson, 2013), anger (Ho et al., 2012; Quek et al., 2012), and anxiety (Samson et al., 2015). It has also been reported that individuals with ASD demonstrate impairments in facial expression recognition ability compared to typical controls (see Lozier et al., 2014, for a meta-analysis). The co-occurrence of abnormalities in facial expression recognition and subjective emotional experience in individuals with ASD and schizophrenia provides support for the notion that these two processes are related.

Facial Expressivity and Facial Expression Recognition

The previous sections have outlined the *simulationist model* of facial expression recognition and provided discussion of the support for each of the stages. As discussed in previous sections of this review, evidence from mimicry studies have suggested that the mimicry of the emotion of others is associated with our ability to recognise and interpret the facial expressions of others (e.g., Baumeister et al., 2016). Additionally, some research has also indicated that the extent to which we subjectively experience emotion is associated with our facial expression recognition ability (Sato et al., 2013). There is also evidence suggesting that the mimicry of the facial expressions of others may be associated with the subjective experience of one's own emotions (Sato et al., 2013).

Despite the evidence for relationships between facial mimicry and subjective emotional experience, and facial mimicry and facial expression recognition, these relationships have also been disputed by some research findings. As discussed in earlier sections, a key criticism for the *simulationist model* is borne out of research indicating that clinical populations with mimicry deficits have intact facial expression recognition ability. For example, individuals with Moebius syndrome do not differ significantly from controls in facial expression recognition ability (Rives Bogart & Matsumoto, 2010). Hess and Blairy (2001) also disputed the relationship between facial mimicry and subjective emotional experience, reporting that mediation analyses revealed that facial mimicry and the experience of emotion were not associated with each other. Further support for this has come from research indicating that patients with bilateral facial paralysis do not report significant differences in the experience of emotion compared to controls, despite the inability to facially mimic expressions (Keillor et al., 2002). Taken together, these findings dispute the role of facial mimicry in facial expression recognition.

Alongside the *simulationist model,* Goldman and Sripada (2005) explained the findings disputing the role of facial mimicry in the model by suggesting that simulation can occur via the 'as if' loop. The 'as if' loop is a pathway that bypasses facial mimicry, suggesting that when facial expression is seen, we imagine what it would feel like to make that expression, in turn provoking the experience of that emotion within ourselves (Goldman & Sripada, 2005). As such, the experience of the observed emotion facilitates the accurate recognition of the facial expression (Goldman & Sripada, 2005). If imagining ourselves producing the observed emotion facilitates the experience, and the subsequent recognition of the observed emotion, it may be the case that our facial expressions produced under emotion inducing conditions may relate to our ability to recognise the emotion of others. Thus, it would be expected that higher levels of facial expressivity are associated with more accurate facial expression recognition. It is yet to be determined, however, the extent to which facial expressivity predicts our capacity to recognise the emotions of others.

There is a scarcity of research devoted to examining the relationships between facial expressivity, subjective emotional experience, and facial expression recognition. However, research has indicated that when we block our own facial expressions of emotion (e.g., via expressive suppression), our facial expression recognition ability is impacted. When participants suppressed their own facial expressions, they demonstrated decreased perception of facial expressions of emotion (Schneider et al., 2013). Evidence for a relationship between facial expressivity and subjective emotional experience has come from correlational research that has demonstrated that there is a positive association between an individual's facial expressivity and their subjective emotional experience of emotions. For example, higher levels of facial expressivity for a particular emotion are associated with a more intense subjective experience of emotion (Adelmann & Zajonc, 1989). Furthermore, Ekman et al. (1980) indicated that individuals who are more facially expressive tend to report greater emotional experience of the corresponding emotion when watching emotionally provoking film clips. Given the association between facial expressivity and subjective emotional experience, and the association between subjective emotional experience and facial expression recognition, it may be the case that facial expressivity is associated with one's ability to recognise the emotions of others.

Emotional Concordance and Facial Expression Recognition

Although the *simulationist model* has received a great deal of support, an additional argument is that the relationship between the experience, expression and recognition of emotion may not follow a step-like trajectory as is suggested by the *simulationist model*. Instead of a step-like trajectory, it may be the case that the contribution of facial expressivity and subjective emotional experience to facial expression recognition are enmeshed; it may be that a person's level of emotional concordance is what facilitates our ability to recognise facial expressions of emotion. Emotional concordance is a functional definition of emotion, referring to the synchronisation of the physiological, cognitive and behavioural components of emotion (Hollenstein & Lanteigne, 2014). Although there are multiple components to emotion, there is evidence to suggest a degree of concordance between them. This concordance has been demonstrated with experiential (e.g., feelings), behavioural (e.g., facial expressions), and physiological responses (e.g., heart rate) monitored second-by-second during an emotional film task; participants' experiential and behavioural responses were correlated with each other, with the physiological responses (i.e., cardiovascular activity, skin conductance, and somatic activation) producing a moderate correlation with experience and behaviour (Mauss et al., 2005).

Further evidence of a relationship between facial expression recognition and emotional concordance is provided by studies involving clinical populations. For example, individuals with ASD have been shown to exhibit blunted facial expressivity (e.g., Stagg et al., 2014; Trevisan et al., 2018). Given that we see paired abnormalities in facial expression recognition, subjective emotional experience, and facial expressivity in some clinical populations, if the *simulationist model* is correct, it would be expected that people with higher concordance between their subjective emotional experience and facial expressions will also be more accurate in recognising facial expressions of emotion. The relationships between facial expressivity, subjective emotional experience, facial expression recognition and emotional concordance are yet to be examined in a single study.

Conclusion

The *simulationist model* of facial expression recognition proposes that we recognise the emotions of others by first simulating the emotion within ourselves. That is, when we observe an emotional face, we automatically mimic this expression, which induces the subjective experience of the observed emotion, facilitating the recognition of the facial expression (Goldman & Sripada, 2005). The components that comprise the *simulationist model* of facial expression recognition have been the topic of extensive research. Research has provided support for each stage of this model, demonstrating links between facial mimicry in response to facial expressions (Neal & Chartrand, 2011; Neidenthal et al., 2001), facial mimicry and subjective emotional experience (Olszanowski et al., 2020; Wróbel et al., 2021), and subjective emotional experience and facial expression recognition (Sato et al., 2013). However, there remains some dissention in the literature regarding the links between facial mimicry, subjective emotional experience, and facial expression recognition (Hess & Blairy, 2001; Rives Bogart & Matsumoto, 2010). The literature reviewed above has highlighted inconsistencies in the current literature, elucidating important theoretical questions regarding the processes involved in facial expression recognition.

The first question of interest concerns the role of facial expressivity in the recognition of facial expressions. According to the ‘as if’ loop, an observer recognises the observed emotion by imagining what it would feel like to produce that facial expression, which provokes the experience of that emotion, facilitating the recognition of that emotion (Goldman & Sripada, 2005). As such, it may be the case that our facial expressions produced under emotion inducing conditions (i.e., facial expressivity) may predict our recognition of the emotions of others. If this is the case, is facial expressivity associated with facial expression recognition ability? A second question of interest concerns the concordance between facial expressivity and subjective emotional experience. If we recognise the emotion of others by aligning our experience of emotion with the facial expressions that we would produce when experiencing the observed emotion, do those who have a greater alignment between the experience and expression of emotion have superior facial expression recognition ability? In line with the ‘as if’ loop, it may be the case that the emotional concordance between facial expressivity and subjective emotional experience plays an important role in facial expression recognition abilities. As such, this thesis will address these questions by assessing facial expression recognition ability, facial expressivity, subjective emotional experience, and emotional concordance across a number of different samples.

Chapter 3: Methods for Measuring Facial Expressions

Introduction to Chapter

The face and its ability to express emotions are imperative to social communication, allowing us to exchange information with other individuals in the world around us (Chen & Chung, 2004). Thus, it is essential to measure facial expressions in research in an appropriate, and effective way. Based on the conditions under which they occur, our facial expressions in response to emotional stimuli (e.g., images of facial expressions, emotional film clips) can be classified into two categories; (1) Facial expressivity; and (2) Facial mimicry. Facial expressivity refers to the extent to which we express our emotions through our face. Thus, it is a tool for conveying affective information to our peers in social communication (Gracanin et al., 2007; Stagg et al., 2014). Facial mimicry is instead defined as the automatic, reflex-like response in our facial muscles when viewing emotional facial expressions of others (e.g., Hess & Fischer, 2014). Given that facial expressivity and facial mimicry both involve the movement of facial muscles, these processes are typically measured in the same way. To date, facial expressivity and facial mimicry have been assessed through the use of (a) facial electromyography (EMG; e.g., Dimberg & Thunberg, 1998), (b) human coding systems (namely the Facial Action Coding System; Ekman & Friesen, 1978), and (c) automated systems of facial expression coding (i.e., a computer classification system that uses algorithms to code facial expressions of emotion; Dente et al., 2017).

This chapter will review each of the current approaches to the measurement of facial expressions. In order to appropriately measure facial expressions of emotion, a measure must possess the ability to perform two tasks: (1) measure facial motion, and (2) provide an indication of emotional expression (Tian et al., 2005). Each of the approaches to measuring facial expressions come with both advantages and disadvantages, and the selection of any one of these methods results in compromise. However, when selecting a measure, it is important to consider the precision and reliability of the measure, measuring emotional expression in a natural context, financial/time restraints, ability to measure all discrete emotional expressions, and the ability for this measure to be used across different circumstances and with different populations (e.g., children and adults). Given the overarching aim of this thesis includes the assessment of emotional experience and expression in children, adults, and older adults, it is important to adopt a measure of facial expressions that is easily applied to these differing age-ranges, and that accounts for the considerations outlined above.

Methods for Measuring Facial Expressions

Facial Electromyography (EMG)

Facial EMG is a method for measuring facial muscle movements that requires the placement of electrodes on the surface of the skin above facial muscles and can be used to measure both conscious and unconscious movements. Facial EMG measures the subtle electrical activity of facial muscles arising from the contraction/relaxation of specific muscles. In order to allow for identification of specific facial expressions, researchers place electrodes on muscle groups associated with specific expressions (Cacioppo et al., 2007). For example, measuring the muscle activity of the corrugator supercilii muscle is used to identify negatively valenced facial expressions, such as anger. On the other hand, placing electrodes on the zygomaticus major muscle is used to identify positively valenced expressions such as happiness. There are three stages to the general procedure for recording facial EMG; (1) electrode selection and placement on the face; (2) EMG recording; and (3) signal conditioning (i.e., reducing the influence of noise collected during the recording process; Fridlund & Cacioppo, 1986). There are several benefits associated with the use of facial EMG for measuring facial expressions, including its sensitivity to unobservable muscle movements, and the objectivity that comes with these recordings. This section will discuss these benefits and the potential limitations that are also associated with facial EMG.

Facial EMG is sensitive to any muscle movement, detecting even the weakest facial responses (Van Boxtel, 2010). As such, EMG records muscle activity, even when it is very subtle and not perceivable to the naked eye. For example, when exposing participants to masked happy and angry faces outside their awareness, EMG responses revealed distinct facial muscle reactions that were consistent with the stimulus faces (Dimberg et al., 2000). Thus, using facial EMG compared to other methods (e.g., human coders) allows researchers to measure subtle facial expressions that would otherwise be unnoticed. A second benefit in adopting facial EMG to measure facial expressions is that it allows researchers to make objective inferences about the type and intensity of the emotion that is displayed (Chen & Chung, 2004). For example, when viewing happy facial expressions there is an increase in muscle activity in the zygomaticus major muscle region, and a decrease in the corrugator supercilii region, implicating the zygomaticus major muscle region in positive mood states, and the corrugator supercilii in negative mood states (Hess & Fischer, 2014). As specific muscle activity is differentially associated with different expressions, researchers can make objective inferences about the type of emotion that is being displayed. However, it should be noted that these EMG responses are typically recorded in response to images of emotional facial expressions as an indicator of facial mimicry (e.g., Hess & Fischer, 2014; Mauersberger et al., 2015) and are not typically measured as an indicator of facial expressivity (e.g., the facial expression produced when a person is experiencing sadness).

Though some of the benefits of using facial EMG include the objectivity and sensitivity of detecting facial muscle movement that is not readily perceptible otherwise, there are several drawbacks to adopting this methodology. First, and perhaps most notably, facial EMG is quite intrusive. Before placing the electrodes on the surface of the skin, the skin must be prepared and cleaned and a conductive gel applied (Chen & Chung, 2004). The placement of electrodes on the surface of the skin may impact on the comfort of the participant (Van Boxtel, 2010). This is problematic for two reasons: (1) participants may produce facial expressions associated with discomfort that are unrelated to the experimental manipulation (Read, 2017; Tassinary & Cacioppo, 2000), and (2) the placement of electrodes on the face creates an unnatural situation for the experience/expression of emotion and may impact on the natural expression of emotion.

Although facial EMG can be used to discriminate between emotional valence, it is difficult to discriminate between discrete emotions without the employment of multiple channels, requiring the placement of several electrodes on the participants face. However, even with the use of multiple channels, there is a degree of ambiguity when using facial EMG as activity in particular muscle regions can be present for multiple emotions. The experience of emotion often consists of a mixture of discrete emotions that can change rapidly (Van Boxtel, 2010). In the expression of discrete emotions, there is a degree of overlap in the muscle regions that are activated; the same facial muscles can be implicated in the expression of different emotions (Read, 2017). As such, a researcher may aim to measure anger, however muscle activity may be indicative of sadness, as both of these emotions involve activation of corrugator supercilii muscles (Sun et al., 2015). Thus facial EMG lacks the specificity needed to discriminate each emotional expression, unless the researcher uses a number of channels to record activity (Van Boxtel, 2010). Furthermore, the human face produces a range of activity, some of which is not associated with the expression of emotion (e.g., expressions of fatigue, effort, or movements produced by speaking; Cacioppo et al., 2007; Van Boxtel, 2010). As such, researchers have to monitor all facial movements of the participants to identify movements that are not associated with an emotion, in addition to recording facial EMG.

Human Coding

Human coding is a method of coding facial expressions of emotion that requires a researcher to observe and code facial action into emotion categories. This review will devote specific attention the Facial Action Coding System (FACS) developed by Ekman and Friesen (1978), as it has been widely used in research. The FACS system is used across a range of different fields, with particular applications in research and computer science settings (Paul Ekman Group, 2020). The FACS manual describes the criteria for observing and coding facial muscle movements (i.e., action units), and describes how they appear in combinations to form emotional expressions (Paul Ekman Group, 2020). The FACS method allows human coders to systematically analyse the emotion of facial expressions based on 46 observable action units (Ekman & Friesen, 1976). To be proficient in the FACS method, training takes approximately 50-100 hours to complete (Paul Ekman Group, 2020). There are several benefits that are associated with using the FACS method, including that it is an unobtrusive and reliable way to quantify facial activity. This section will address the benefits and limitations that are associated with using the FACS method to measure facial expressions.

First, and perhaps most notably, the human coding methods provide an unobtrusive method of quantifying facial expressions. By providing objective criteria for facial expressions that allow researchers to classify facial muscle movements into discrete emotions (Read, 2017; Stöckli et al., 2018), FACS allows researchers to make inferences about facial expressions without the use of intrusive methods (i.e., facial EMG). As such, the FACS method of coding facial expressions provides an immediate and unobtrusive assessment of facial expressions of emotion. This is beneficial to the measurement of facial expressivity, as it allows for the measurement of naturally occurring facial muscle activity (Ekman, 1997; Sayette et al., 2001). That is, this method does not cause discomfort, or impact on the natural quality of facial muscle activity as other, more intrusive methods do (i.e., facial EMG).

In addition to the unobtrusive nature of FACS, another key benefit of this method is its reliability for both induced and spontaneous expressions. The FACS method of coding facial expressions has become one of the most influential methods of describing facial expressions, providing immediate, and reliable analyses of facial activity (Ekman, 1997; Sayette et al., 2001). Research adopting FACS in measuring facial expressions has involved the use of posed expressions, where the participant is required to voluntarily contract specific muscles to produce prototypical expressions of emotion, and the assessment of naturally occurring emotional expressions (Ekman et al., 1983; Sayette et al., 2001). In an assessment of the reliability of FACS for spontaneous facial expressions, the reliability of the detection of occurrence, intensity, and timing of FACS action units was tested between FACS-certified coders across three different emotion induction techniques (exposure to pleasant/unpleasant odours, deprivation from nicotine and giving a speech; Sayette et al., 2001). Results revealed that there was good to excellent reliability across all three factors between both FACS-certified coders for measuring spontaneous facial expressions of emotion (Sayette et al., 2001).

Although the FACS method is reliable and unobtrusive, there are several drawbacks including limitations associated with labour and sensitivity. First, human coding systems require labour-intensive training and implementation. As previously noted, the FACS method requires human coders to undergo training that lasts between 50 and 100 hours, followed by a FACS proficiency test (Paul Ekman Group, 2020). Furthermore, FACS requires frame by frame analyses on videos of facial expressions that is also very time-consuming (Paul Ekman Group, 2020). A further limitation is that, although reliable, human coding may not be sensitive enough to detect weak to moderate affective responses. That is, the experience of emotion is expressed with facial actions that may vary in a wide range of intensities, and therefore may be unobservable to the human eye (e.g., micro expressions or suppressed facial expressions; Van Boxtel, 2010). Human coding may not be sensitive enough to detect these subtle emotional expressions, where physiological measures (e.g., facial EMG) could detect such changes. Although the FACS method was designed to detect subtle changes in facial features, given that it is a system that is based on a human observer, it is inevitable that this method will miss the identification of facial expressions below the threshold of human perception (Tian et al., 2005).

When compared to facial EMG, human coding offers an unobtrusive alternative that is easily applied to several different populations (e.g., children, older adults) with minimal disruption to the natural expression of emotion. However, given the discussed shortcomings in the application of human coding (i.e., the length of time for training and to apply the method for analysis), a more appropriate method for measuring facial expressions may be computer-based facial expression coding, which measures, and classifies facial expressions automatically, and requires minimal, or no training.

Automated Systems of Facial Expression Coding

The use of automated computer coding in the assessment of facial expressions has gained popularity in recent years. Automated computer coding is a video classification system that uses machine learning algorithms to train the computer to detect muscle activity and indicate the likelihood that a target emotion is being expressed. This method is automatic in the detection of facial expressions from videos of human faces, and provides an unobtrusive alternative to methods such as facial EMG (Kulke et al., 2020). The use of automated systems of facial expression coding have also provided a popular alternative to FACS, offering a faster, more cost effective and less intrusive method compared to human raters (iMotions, 2016; Meiselman, 2016). There are a variety of computer automated coding systems that exist, including EmoVu (Eyevis, 2013), Face Reader (Technology, 2007), and iMotions Emotient module (www.imotions.com). For computer-based classification systems to be verified in detecting and processing facial expressions, such systems must demonstrate two things: (1) reliability in detecting emotion and (2) comparability to more traditional methods of facial expression analysis (e.g., facial EMG; Kulke et al., 2020). This section will discuss the utility and shortcomings of automated computer coding methods of expression analysis in alignment with these two criteria, devoting specific attention to iMotions Emotient module.

The efficacy of iMotions Emotient (formerly FACET) module has been widely supported by its use in several psychology studies, and by reviews comparing automated coding to human coding. In a recent and detailed review, Dupré et al. (2020) concluded that FACET outperforms human judges in classifying emotions on standardised sets of emotional facial expressions. An additional review demonstrated the success of automated coding systems across multiple databases of dynamic, prototypical facial expressions (Krumhuber et al., 2020). A recent empirical study required participants to either conceal or naturally express their emotions while watching emotionally provoking film clips (Clark & Jasra, 2020). Results indicated that there was no significant difference in the average time in detection of either concealed or unconcealed emotional expressions for overall emotions (Clark & Jasra, 2020). Such findings aid in validating both the accuracy and speed of automated coding systems.

There are several advantages in employing automated computer coding to identify emotional facial expressions. One advantage of automated coding, that parallels human coding, is that it allows for facial expressions to be expressed in a natural way (Dente et al., 2017). That is, because automated coding methods do not require the placement of electrodes on specific areas of the face, this method for assessing facial expressions is effective in maintaining the naturalistic quality of the research setting. Recent validation research has provided substantial support for Emotient in facial expression analysis. Participants were required to display happy, angry, and neutral facial expressions while video and EMG responses were recorded (Kulke et al., 2020). Results demonstrated that happy and angry facial expressions were reliably detected by both methods, whereas the software was more accurate in identifying neutral expressions compared to EMG (Kulke et al., 2020). When examining the accuracy of Emotient in recognising facial expressions (e.g., happy, angry, disgusted, afraid and sad expressions), the recognition of happiness and disgust remained high and consistent when the expression was low in intensity (Dente et al., 2017). Accuracy of recognition of sadness, anger, fear and surprise, however, demonstrated a modest decline in recognition when facial expressions were less pronounced (Dente et al., 2017). In addition to discrete emotions, it has also been found that Emotient is superior in detecting neutral expressions compared to facial EMG, which more often identified neutral expressions as negative (Kulke et al., 2020). The high degree of correlation between Emotient and facial EMG suggests that automated coding is a valid method of assessing facial expressions, with the additional benefit of being less laborious and unobtrusive compared to facial EMG.

In addition to the high degree of association between more traditional methods of facial expression assessment (i.e., facial EMG), the use of Emotient reduces the potential for error in coding of expressions. As is the case with automated coding methods, Emotient detects changes in key facial structures (i.e., eyebrows, eyes, and lips) and uses this information to generate evidence values that reflect the likelihood of that a target emotion is being expressed (Stöckli et al., 2018). The benefit of this approach is that it classifies emotion based on statistical procedures and psychological theories (Stöckli et al., 2018). In order to code facial muscle movements, Emotient uses per-frame evidence scores that represent the probability of an expert human coder recognising the observed expression as the target category (iMotions, 2016). The values that are created by Emotient are expressed on a decimal, logarithmic scale that can be interpreted in a way similar to a z-score (iMotions, 2016; Krumhuber et al., 2020);

negative values indicate that an expression is likely not present, and positive values indicate the likely presence of an expression. This method is compared to procedures such as FACS, that require a level of judgement from the observer. A final strength that computer coding has when compared to FACS is that it allows for the measure of graded emotional responses. When using Emotient, facial expressions are simultaneously coded alongside the presentation of stimuli, allowing the researcher to obtain an indication of when/how facial expressions change (Farnsworth, 2019). These measurements can be paired with other physiological indicators of emotional arousal (i.e., galvanic skin response) to provide a robust understanding of the type of emotions, intensity, and causes of an emotional experience (Farnsworth, 2019).

Despite the number of benefits that are associated with the use of computer coding, there are also drawbacks of this approach. A notable limitation of computer coding is that machine analysis has difficulty adapting to changes in viewing angle and overall visibility of the face (Dente et al., 2017). Given that the expression of emotion is often dynamic in nature, this could be problematic for analysing the expressions of emotion that are associated with extreme movements or turning of the face. Furthermore, the identification of combinations of emotion is not within the ability of computer-coding systems (Stöckli et al., 2018). Thus, because the experience of emotion often consists of a mixture of discrete emotions, computer-based coding may not be able to robustly assess facial expressions that are not prototypical.

Summary

Despite notable utility and shortcomings across each of the three methods for assessing facial expressions, all methods remain useful in different contexts. The use of facial EMG may be more appropriate for the assessment of facial mimicry, as it is associated with the measurement of predetermined muscle regions but may interfere with the natural facial expression of emotion. The use of human-coding systems (i.e., FACS) is appropriate for situations with the production of both prototypical and spontaneous facial expressions of emotion. However, this method is labour and resource-intensive, and requires a substantial amount of training to achieve proficiency. An additional limitation of this method is that it may not be sensitive enough to detect unobservable, micro expressions that are often associated with facial mimicry and facial expressivity. Finally, the use of computer-coding systems (e.g., Emotient) are appropriate for the measurement of facial muscle activity, given that they are able to detect emotions presented at lower intensities. The use of computer-coding systems is beneficial in the assessment of facial expressivity, as it does not require the placement of electrodes on the surface of the skin, enhancing the naturalistic quality of the research setting. However, this method has shortcomings associated with its sensitivity to changes in viewing angle or obscuring of the face. Thus, the method of assessment for facial expressivity is dependent on the research aims. Computer-coding allows for a number of practical applications, and is not labour-intensive, thus this method seems the most appropriate for assessing the expression of emotion during emotional experience. Given the primary objective of this thesis is to assess emotional expression, experience and recognition across different age groups, the benefits of using computer-based coding outweigh the shortcomings for the current research. Compared to facial EMG, computer coding of emotion allows for emotions to be expressed (and experienced) in a naturalistic way, allowing for the unobstructed measurement of facial expressivity. This is particularly important for the measurement of facial expressivity in children. Furthermore, the use of computer coding is most appropriate for the scope of this thesis as, compared to human-coding systems, it allows for automatic detection and coding of facial muscle movements, leading to time-effective data collection and analysis.

Chapter 4: The Predictors of Facial Expression Recognition: Does the Way We Experience Emotion Predict Facial Expression Recognition Ability?

Abstract

The ability to recognise facial expressions is one of the most powerful tools in our social tool belt, providing the basis for a number of important social judgments. Simulationist theories of facial expression recognition suggest that our experience and expression of emotion are tightly linked with our ability to recognise emotion in others. There is also evidence to suggest that there is a degree of synchronisation between our expression and experience of emotion (i.e., emotional concordance). However, there is a lack of direct evidence for the relationship between emotional concordance and facial expression recognition ability. Across two studies, this chapter aims to examine the relationships between facial expressivity, subjective emotional experience, emotional concordance, emotion regulation and facial expression recognition ability at an overall, valance (i.e., positive and negative), and discrete emotion level. Specifically, both Experiment 1 and Experiment 2 aimed to examine if emotion regulation, facial expressivity, subjective emotional experience, and emotional concordance are significant predictors of facial expression recognition ability. Additionally, both experiments aimed to determine if emotional concordance predicted facial expression recognition ability above and beyond the expression, experience, and regulation of emotion. Both experiments used emotional film tasks to induce and measure facial expressivity (using automated facial coding software) and subjective emotional experience in samples of 114, and 116 younger adults respectively. In addition to the emotional film tasks, participants also completed an emotion regulation questionnaire, indicating the extent to which they regulated their emotions during the film task. Results from Experiment 1 indicated that emotional concordance is a significant, positive predictor of facial expression recognition ability at the overall level. Additionally, results from Experiment 2 revealed that expressive suppression is a significant, negative predictor of facial expression recognition ability at an overall level.

Taken together, these findings suggest that emotional concordance and expressive suppression may play an important role in facial expression recognition ability.

Introduction

Facial expression recognition ability plays a pivotal role in the success of our social interactions. The importance of accurate facial expression recognition ability is highlighted by fact that the facial expressions of others inform a number of important social judgements (Willis et al., 2011a). Given the importance of facial expression recognition ability to effective social communication, impairments in facial expression recognition can have a negative impact on social interaction and well-being (Spikman et al., 2013). A number of theories regarding the mechanisms that underpin facial expression recognition ability have been put forward, with prominent theories suggesting that experience of our own emotions guides our ability to recognise the facial expressions of others (e.g., Goldman & Sripada, 2005; Wilson, 2002). The experience of emotion is composed of physiological (e.g., heart rate), behavioural (e.g., facial expressions), and experiential components (e.g., subjective emotional experience; Mauss et al., 2005). While there are multiple components to emotion, there is evidence to suggest a degree of correspondence between them (Mauss et al., 2005). Emotional concordance refers to the synchronisation of the physiological, experiential, and behavioural components of emotion (Hollenstein & Lanteigne, 2014). *Simulationist models* suggest that facial expression recognition ability is underpinned by our experience of emotion, using the concordance between our own facial expressions and subjective emotional experience to guide facial expression recognition. There is a lack of direct evidence for the relationship between facial expression recognition ability and emotional concordance. However, some evidence exists from research with populations with deficits in facial expression recognition, who also report deficits in other areas of emotion processing and experience. For example, older adults demonstrate declines in facial expression recognition accuracy, and have also been reported to experience emotions with a diminished intensity, when compared to their younger counterparts (Gross et al., 1997). As such, it is essential to consider each component of emotional experience (e.g., behavioural, experiential) individually, but also understand the relationships between them to obtain a robust understanding of the mechanisms that underpin facial expression recognition abilities.

Prominent models of emotion recognition propose that facial expressions are recognised by imitating the perceived facial expression, and then subjectively experiencing the feelings associated with the emotion (Goldman & Sripada, 2005). One such theory is the *simulationist model* of facial expression recognition (Goldman & Sripada, 2005), which suggests that when we view an emotional facial expression, we automatically mimic this expression, inducing the subjective feelings associated with the emotion through facial feedback, which in turn facilitates the accurate recognition of the observed emotion. Within the theory of facial feedback, it is suggested that a person's own facial muscle movements or facial expressions can influence their own emotional experience (Buck, 1980). Thus, for the *simulationist model* and facial feedback hypothesis to be supported, there must be evidence of two things. First, we generate facial expressions of emotion upon viewing the facial expressions of others, and second, our own mimicked expressions inform our judgements of the observed expression.

Support for the *simulationist model* and facial feedback hypothesis has come from studies employing facial electromyography (EMG), a technique that is used to measure rapid and subtle changes in facial muscle activity (e.g., Neidenthal et al., 2001). A number of studies have demonstrated that when viewing pictures of emotional facial expressions, healthy adults display rapid facial muscle movements that mimic the observed expression (i.e., facial mimicry; e.g., Dimberg & Thunberg, 1998; Neidenthal et al., 2001). For example, exposure to negatively-valenced faces (e.g., angry faces) is associated with increased activity in the corrugator supercilii muscle (i.e., the muscle that knits the eyebrows together to form a frown; Dimberg et al., 2000; Hess & Fischer, 2014). Similarly, exposure to positively-valenced faces (e.g., happy faces) is associated with increased activity in the zygomaticus-major muscle region (i.e., the muscle that draws corners of the mouth upward to form a smile; Dimberg et al., 2000; Hess & Fischer, 2014). Support for the notion that there is relationship between facial mimicry and facial expression recognition has come from research with clinical populations reporting paired deficits in these processes. For example, individuals with schizophrenia exhibit paired abnormalities in the mimicry and recognition of emotion, demonstrating atypical facial mimicry in response to pictures of facial expressions and decreased facial expression recognition ability compared to typical controls (e.g., Bediou et al., 2007; Torregrossa et al., 2019; Varcin et al., 2010).

Links have also been found between facial muscle movements and the experience of emotion, with activation of certain muscle regions associated with an increase in subjective emotional experience. Strack et al. (1988) instructed participants to hold a pen tightly between their lips (activating the zygomaticus major muscle region) while viewing cartoons and providing humour ratings. Subsequent humour ratings demonstrated that participants experienced a more intense humour response when viewing the cartoon while activation of the zygomaticus major muscle was mechanically induced. Such findings suggest that there is a link between the facial muscle activity and the subjective experience of emotion. Despite these findings, much dissension remains in the literature with regard to the facial feedback hypothesis. A recent, large scale replication attempt failed to replicate the findings of (Strack et al., 1988), with inconsistent findings across multiple labs (Wagenmakers et al., 2016). However, a recent meta-analysis has provided basic evidence for the facial feedback hypothesis, suggesting that effects tend to be small and are moderated by presence of a stimulus (e.g., presence/absence of emotionally provocative stimuli), type of stimulus (e.g., cartoons/emotion provoking images) and emotional outcome (e.g., ratings of emotional experience; Coles et al., 2019). Although the findings from Strack et al. (1988) have failed to be replicated, this does not invalidate the more general facial feedback hypothesis, as evidence for the hypothesis is present but is dependent on contextual conditions.

Fundamental support for the *simulationist model* of facial expression recognition has come from studies employing neuroimaging techniques, such as functional magnetic resonance imaging (fMRI), to examine neural activation during emotional experience and when viewing emotional expressions. Data from such studies have shown that the same neural regions are activated in both the experience of emotion, and when observing the corresponding emotion in another person (e.g., Haslinger et al., 2008; Wicker et al., 2003). The amygdala has been shown to play an integral role in the processing of both positively and negatively valenced emotions, and has been particularly implicated in the experience, and recognition of negative emotions (e.g., fear; Baxter & Murray, 2002; Whalen, 2007). Moreover, in lesion studies, patients with bilateral amygdala lesions have been found to demonstrate impairments in the ability to recognise negative emotions, such as anger and fear (Adolphs et al., 1994; Morris et al., 1996). The activation of the amygdala has also been found to be influenced by the activation of facial muscles. Data from fMRI research has demonstrated that Botulinum Toxin (Botox) injections to the forehead (i.e., effectively de-nerving the corrugator supercilii muscle) lead to attenuated activity of the amygdala when voluntarily producing an angry facial expression (Haslinger et al., 2008). Additionally, when required to complete a complex emotion recognition task, participants who received Botox injections demonstrated significant impairments in emotion recognition compared to a control group (Neal & Chartrand, 2011) and reduced perception of emotional intensity when viewing facial expressions (Baumeister et al., 2016). Findings such as these provide links between facial muscle activity, facial expression recognition, and the activity of key neural structures implicated in both facial expression recognition and the experience of emotion.

Studies demonstrating that both amplifying and inhibiting facial muscle movements can influence the experience of emotion have provided support for the notion that facial feedback can influence subjective emotional experience. For example, people have reported significantly higher levels of negative mood when lowering their eyebrows, higher levels of surprise when raising their eyebrows, and elevated experience of disgust when wrinkling their nose (e.g., Larsen et al., 1992; Lewis, 2012; Strack et al., 1988). A recent meta-analysis conducted by Coles et al. (2019) summarised the circumstances that lead to stronger facial feedback effects, namely: (1) type of emotional outcome: affective judgements (i.e., funniness of a cartoon) were affected to a greater degree by facial feedback than emotional experience (i.e., self-reported amusement); (2) presence of emotional stimuli: facial feedback is more effective at initiating emotional experience (i.e., the experience of emotion in non-emotional situations) than modulating it (i.e., enhancing emotion in response to an emotional stimulus); (3) type of stimuli: the effects of facial feedback are more pronounced when presented with emotional sentences than with emotional pictures. Such findings may indicate that facial feedback is used as a compensatory mechanism when stimuli are emotionally ambiguous, or difficult to interpret. This notion is supported by findings that individuals with Botox injections demonstrate reduced perception of emotional intensity when viewing facial expressions when the expressions are slightly emotional stimuli, as opposed to neutral, or very emotional stimuli (Baumeister et al., 2016).

Evidence from mimicry studies has suggested that the extent to which we mimic the emotions of others is associated with our ability to recognise the facial expressions of others (e.g., Baumeister et al., 2016; Strack et al., 1988). Theories of embodied cognition postulate that the occurrence of mimicry reflects the internal simulation of a perceived emotion in order to facilitate its recognition (Oberman et al., 2007). That is, when we mimic an emotion, we read our own expression which facilitates the interpretation of the observed emotion. In accordance with the notion that our ability to recognise our own facial expressions is associated with our ability to recognise the emotions of others, it would be expected that facial expressions produced under emotion inducing circumstances should correlate with our self-report emotional experiences, that is, there should be emotional concordance. Evidence from correlational research has demonstrated that there is a positive association between an individual's facial expressivity (i.e., the extent to which an individual facially expresses their emotion) and their subjective experience of emotions. Adelmann and Zajonc (1989) reported that higher levels of facial expressivity for a particular emotion are associated with a more intense subjective emotional experience of the corresponding emotion. Indeed, Ekman et al. (1980) showed that when watching emotionally-provoking film clips, those who were more facially expressive tended to report a higher intensity of their subjective emotional experience of the corresponding emotion. This concordance has been demonstrated with experiential (e.g., feelings), behavioural (e.g., facial expressions), and physiological responses (e.g., heart rate) monitored second-by-second during an emotional film task; participants' experiential and behavioural responses were highly correlated with each other, with the physiological responses (i.e., cardiovascular activity, skin conductance, and somatic activation) producing a moderate correlation with subjective emotional experience and behaviour (Mauss et al., 2005).

Additional support for the idea that facial expressivity is related to the subjective experience of emotion and facial expression recognition is provided by studies involving clinical populations. For example, individuals with Autism Spectrum Disorder (ASD), a population with marked deficits in the ability to process their own emotions and recognise emotions in others (e.g., Loth et al., 2018), have been shown to exhibit decreased levels of facial expressivity (e.g., Dawson et al., 1990; Hobson & Lee, 1998; Trevisan et al., 2018). Given that we see paired abnormalities in facial expression recognition, subjective emotional experience, and facial expressivity in some clinical populations, if the *simulationist model* and facial feedback hypothesis are correct, it would be expected that people with higher concordance between their subjective emotional experience and facial expressivity will also be more accurate in recognising facial expressions of emotion.

The notion that higher levels of emotional concordance is associated with superior facial expression recognition ability has been supported with recent research investigating emotional concordance in children with ASD, and sex differences in emotional concordance. When placed under fear inducing conditions, children with ASD demonstrate a degree of discordance between their physiological experience of emotion (i.e., heart rate) and their outward expressions of their emotional experience (i.e., facial expressivity; Zantinge et al., 2019). That is, when presented with fear inducing stimuli, there was no significant relationship between physiological and behavioural emotional responses for children with ASD, in contrast to their neurotypical counterparts who showed a relationship between physiological and behavioural emotional responses (Zantinge et al., 2019). Given that it is well established that individuals with ASD also demonstrate impairments in facial expression recognition (e.g., Lozier et al., 2014), it may be that a discordance between the physiological and behavioural emotional responses are what underpin these impairments. In addition to individuals with ASD, it has been reported that there are sex differences in emotional concordance. A recent study on sex differences in emotional concordance has indicated that females display higher levels of concordance between emotional responses (i.e., ratings of emotional experience, physiological indictors of emotional experience, and facial expressivity) when compared to their male counterparts (Rattel et al., 2020). When viewing emotion inducing film clips, females demonstrated greater concordance between all response pairings (e.g., experiential, autonomic, respiratory, and behavioural responses) than males. One possible explanation for higher emotional concordance in females, is that females tend to possess greater bodily awareness than males, and this increased awareness can explain greater concordance between emotional responses in women (Brody & Hall, 2008; Sze et al., 2010). The finding that females demonstrate greater emotional concordance aligns with results of a meta-analysis indicating that females also demonstrate superior facial expression recognition abilities when compared to males (McClure, 2000). When taken together, these findings on ASD and sex differences in emotional concordance and facial expression recognition lend support to the notion that our degree of emotional concordance may be associated with our ability to recognise the facial expressions of others. However, research is yet to assess the relationship between emotional concordance and facial expression recognition in a single study.

Although extensive research has been carried out on facial expression recognition, there are no studies addressing the relationship between facial expressivity, subjective emotional experience and facial expression recognition. Furthermore, there is a scarcity of research devoted to addressing the emotional concordance between facial expressivity and subjective experience of emotion, and its role in explaining facial expression recognition ability. This is an important question to address, as understanding the relationship between these processes may assist in better understanding what underpins deficits in facial expression recognition in clinical populations (e.g., individuals with ASD, or schizophrenia). Thus, one aim of the current study is to assess the contribution of the emotional concordance between facial expressivity and subjective emotional experience to our degree of facial expression recognition ability.

Emotions are helpful tools for navigating our internal world, as well as interpersonal relationships. Despite the usefulness of emotion in facilitating our social interactions, emotions can be problematic when they do not match a given situation (Gross, 2014). It is often the case in such situations that we manage our emotions, shaping which emotions we experience, when we experience them, and the way in which we experience and express them through emotion regulation (Gross, 2014). Emotion regulation can be both conscious (i.e., changing a conversation topic that may be upsetting), or unconscious (i.e., diverting your attention away from unpleasant stimuli; Boden & Baumeister, 1997; Gross, 2002), and refers to the process by which we manage our emotions, and the way that we express and experience them (Gross, 2002). Two key methods of emotion regulation are cognitive reappraisal and expressive suppression. The use of reappraisal and suppression are important to consider when assessing the relationship between the expression, experience and recognition of emotion, as regulating emotional experiences may influence the detected relationship between the experience, expression and recognition of emotion. Reappraisal refers to the process by which we construe an emotion-eliciting situation in non-emotional terms. This construal impacts on the trajectory of the entire emotional response by decreasing the experiential, behavioural and physiological responses (Gross, 2002). Expressive suppression, on the other hand, is a response modulation technique where we inhibit the outward expression of emotion (Gross, 2002). This technique is associated with a decrease in expressive behaviour, but does not decrease emotional experience (Gross, 2002). In comparison to cognitive reappraisal, expressive suppression has been reported to have a negative impact on physical health; suppression is associated with increased activation in the cardiovascular and electrodermal systems, which could have ties to hypertension and atherosclerosis (Mauss & Gross, 2004). The use of emotion regulation techniques is not exclusive to the management of negative emotion, with reappraisal and suppression being associated with the regulation of both positive and negative emotion (Parrott, 1993). Although a wealth of research has been devoted to assessing facial expression recognition, research has neglected to assess the way in which emotion regulation is associated with facial expression recognition ability. Given that emotion regulation is associated with changes in the expression and the experience of emotion, and that the expression and experience of emotion is associated with the ability to recognise facial expressions, it may be the case that emotion regulation is related to facial expression recognition ability.

Overview of the Current Study

The current study aimed to investigate the relationship between the expression, experience and recognition of emotion. Across two experiments, an emotional film task was employed to induce and measure the subjective experience of emotion and facial expressivity. In Experiment 1, facial expressivity, subjective emotional experience, emotional concordance, emotion regulation, and facial expression recognition was assessed at the overall and valence (i.e., positive and negative) specific levels. Experiment 2 assessed these same components of emotion and facial expression recognition at an emotion specific level. In Experiment 1, we used a film task developed by Koval et al. (2016), which comprised film clips that were selected based on their ability to evoke moderate intensity positive and negative emotions (Koval et al., 2013). Thus, emotion was measured at the valence level for this experiment, as it was not expected that the stimuli in this task would elicit significant levels of discrete emotion. As Experiment 2 aimed to examine facial expression recognition and other related components of emotion at a discrete emotion level, an adapted version of this film task was used in Experiment 2, with film clips specifically selected to elicit discrete emotions of interest. In both experiments, participants watched emotional film clips and provided emotional self-report ratings post clip. While watching the film clips, iMotions' Emotient module was used to record and automatically code participant facial expressions, concurrently examining subjective emotional experience and facial expressivity. The use of the Emotient module to record and analyse the production of facial expressions in the current study allowed for participants' expression of emotion to occur in a natural way. Recent validation research has provided substantial support for the Emotient module in facial expression analysis in the successful detection of happy, angry, disgusted, sad, fearful and surprised facial expressions (Dente et al., 2017; Kulke et al., 2020). The data obtained from the subjective emotional experience ratings and facial expressivity were also used to compute participants' level of emotional concordance. To determine the degree to which these processes relate to facial expression recognition, participants also completed a facial expression recognition task. In order to assess the relationship between emotion regulation and the experience, expression and recognition of emotion, participants completed a questionnaire after completing the film task which asked participants to indicate the extent to which they were actively regulating (i.e., suppressing and reappraising) their experience and expression of both positive and negative emotions.

Experiment 1 aimed to examine the relationship between facial expressivity, subjective emotional expression, emotional concordance, emotion regulation (i.e., suppression and reappraisal) and facial expression recognition at both the overall (i.e., all emotions), and emotional valence level (i.e., positive and negative). Experiment 2 aimed to extend on the findings from Experiment 1 by examining the relationship between facial expressivity, subjective emotional experience, emotional concordance, and facial expression recognition at the discrete emotion level (i.e., happy, sad, angry, disgusted, and afraid). For Experiment 2, emotion regulation was examined at the valence level (i.e., regulation of positive and negative emotions).

For Experiment 1, it was anticipated that, at the overall level and emotional valence levels, there would be significant, positive relationships between facial expression recognition, facial expressivity, subjective emotional experience, and emotional concordance. Specifically, it was anticipated that participants with greater facial expression recognition ability would also experience higher intensity subjective emotional experience, higher facial expressivity, and greater emotional concordance between facial expressivity and subjective experience of emotion. Furthermore, it was hypothesised that facial expressivity and subjective emotional experience of emotion (i.e., overall), as well as positive and negative emotional valence emotional valence would be significant, unique predictors of facial expression recognition of the correspondence emotion (i.e., overall, positive/negative valence). It was also anticipated that emotional concordance would account for an additional proportion of variance in facial expression recognition ability, above and beyond that accounted for by facial expressivity and subjective emotional experience. Finally, given that emotion regulation (i.e., expressive suppression and cognitive reappraisal) is associated with the inhibition of the expression and experience of emotion (Gross, 2002), it was predicted that emotion regulation would be negatively associated with subjective emotional experience, facial expressivity and facial expression recognition. That is, expressive suppression and cognitive reappraisal would be associated with decreased emotional expression and experience, and decreased accuracy in emotion recognition.

Experiment 1 Method

Participants

The sample consisted of 114 participants, aged between 18 and 59 years (*M* = 24.32, *SD* = 8.86, 74.3% female), who were recruited from the Australian Catholic University undergraduate psychology student population and the general community. Out of the 114 participants that took part in the research, one participant failed to complete the facial expression labelling task, and the post film questionnaire, thus no data for facial expression recognition, reappraisal and suppression was recorded. Given this participant was missing data for a number of key variables, they were excluded from the final sample. The final sample for the current experiment consisted of 113 participants. Exclusion criteria for the current study included a reported history of head injury, developmental, psychiatric, or neurological illness. No participants were excluded on this basis. All participants reported normal or corrected-to-normal visual acuity. As reimbursement for participation, students received course credit, and community members received an AUD$20 gift voucher.

Sample Size Justification

Two power analyses were conducted using the pwr package in R version 1.3.1073. The first analysis was to determine the sample size necessary for observing a moderate correlation ($r \geq .30$) with 80% power and $\alpha = .05$. Results indicated that 84 participants would be necessary to achieve these parameters. The second analysis was to determine the sample size needed for the full model to account for at least 20% of variability, with 80% power and $\alpha = .05$. It was determined that at least 56 participants were required for these criteria. To be conservative, we recruited 114 participants, giving us 80% power to find a correlation of $r \geq .30$, and a model of $r^2 \geq .20$.

Measures

Film Task

In order to assess facial expressivity and subjective emotional experience, participants completed the emotional film task developed by Koval et al. (2016). The task was comprised of 10 film clips (ranging from 25 seconds to 2 minutes and 27 seconds in length) selected from a validated database of emotion-eliciting film excerpts (Schaefer, Nils, Sanchez, & Philippot, 2010) and presented in a fixed sequence. The film task comprised four positive (There is Something About Mary[1], When a Man Loves a Woman, Benny and Joon, Trainspotting[3]), four negative (Trainspotting[1], Schindler's List[3], The Dentist, Indiana Jones and the Last Crusade), and two neutral (Blue[2], Blue[3]) film clips. Following each film clip, participants provided ratings of their subjective experience of 10 emotions (i.e., amused, angry, anxious, content, disgusted, fearful, happy, relaxed, sad, and surprised) on a scale from 0 (*not at all*) to 6 (*very much*). The ratings of subjective emotional experience were completed in a pre-determined randomised order following each film clip, with an inter-trial interval of 200ms between each emotion rating. Following the initial post-film ratings, there was a 20-second break where a neutral stimulus (a ball of yarn) was displayed on the screen. Participants then re-rated their subjective experience of the same ten emotions. In order to ensure that the experienced-emotion dynamics were consistent for each participant, clips were presented in a fixed order. Participants were provided with an unlimited time-frame to provide ratings of their emotional experience, deviating from the original methodology outlined in Koval et al. (2016), this was in order to avoid missing data. For a full description of the original methodology and film stimuli see Koval et al. (2016).

Before the commencement of the task, participants were shown a neutral clip not included in the 10 test clips and were given the opportunity to practice rating their subjective emotional experience. Following the practice clip, participants provided baseline ratings of their current subjective emotional experience of the 10 emotions. The task was programmed using experimental software (iMotions Survey Module; www.imotions.com) and presented on a 15-inch Lenovo ThinkPad computer (screen size 1920 by 1080 pixels) at a viewing distance of approximately 60cm.

Facial Expressivity

Facial expressivity was measured during the film clip task using the iMotions Emotient Module software (www.imotions.com). This software automatically codes facial muscle movements according to ten discrete emotions, providing a measure of facial expressivity. Raw evidence scores that are produced by the Emotient module indicate the likelihood that the observed expression matches the target expression. Higher positive numbers indicate a higher likelihood of the target expression, while larger negative numbers indicate a lower likelihood. In the current study, we were interested in only five basic emotions (i.e., happy, anger, fear, sadness and disgust) as these emotions mapped onto the emotion categories in the facial expression recognition task. These basic emotions were used to compute valence categories of facial expressivity, consisting of positive emotion (i.e., happy), and negative emotion (i.e., the average of anger, fear, sadness, and disgust).

Emotion Regulation Questionnaire

Following the film task, participants completed an adapted version of the Emotion Regulation Questionnaire (Gross & John, 2003) to measure state emotion regulation. The Emotion Regulation Questionnaire was found to have acceptable reliability in measuring state emotion regulation (12 items; $\alpha = .70$). The questionnaire required participants to provide an indication of the extent to which they regulated and managed their experience and expression of both positive and negative emotions throughout the film task (e.g., "When I experienced negative emotions during the film-clips, I changed what I was thinking about"), and their external expressions of emotion (e.g.., "While watching the film-clips, I was careful not to express my negative emotions"). These were rated on a scale ranging from 1 (*Strongly Disagree)* to 7 (*Strongly agree*).

Facial Expression Recognition

The emotion-labelling task developed by (Palermo et al., 2013) was used to assess facial expression recognition ability amongst participants. This task was chosen as it is a highly valid and reliable measure for facial expression recognition and is sensitive to individual differences amongst a typical population (Palermo et al., 2013). This task consists of 144 target faces, 24 for each of six emotions: happy, sad, anger, disgust, fear and surprised. The stimuli used in this task consisted of full-colour pictures of people of European descent displaying facial expressions, sourced from the Karolinska Directed Emotional Faces database (Lundqvist, Flykt, & Öhman, 1998). In the original task, faces were presented one at a time for 1000ms, however this study presented faces for 400ms using SuperLab 5 (Cedrus Corp.) to increase the sensitivity of the task. Participants were required to indicate by mouse click which emotion label (presented on the screen together with the faces) matched the facial expression; for a full description of stimuli and methodology see (Palermo et al., 2013).

Procedure

At the beginning of the session, participants provided written informed consent before providing demographic information. To increase the likelihood of natural facial expressivity responses, participants were not informed that their facial expressions were being recorded. Instead, participants were asked to sit as still as possible and avoid touching/obscuring their face for the duration of the film task as the software was recording their face for the purpose of eye tracking. Participants were given basic instructions on how to respond (i.e., using the mouse) to the questionnaires, and were given with the opportunity to ask any questions.

At the end of the film task, participants were asked to complete the emotion regulation questionnaire. The emotion recognition task was presented after completion of the emotion regulation questionnaire. After all of the tasks were completed, participants were debriefed and advised their facial expressivity was being recorded. A debrief consent form was provided to participants, where they indicated that they understood that their facial expressions were being recorded and analysed and were given the opportunity to withdraw consent. No participants withdrew consent following the completion of the session.

Data Processing

Facial Expression Recognition

Overall facial expression recognition ability was calculated by summing accuracy scores across happy, angry, sad, disgusted, and fearful faces. Although surprise was included in the task, this emotion was not included in computing valence specific facial expression recognition ability in the analyses as it is not an exclusively positive or negative emotion (Noordewier & Breugelmans, 2013). Therefore, the maximum score for overall facial expression recognition was 120. Negative facial expression recognition ability was calculated by summing accuracy scores for angry, sad, disgusted and fearful facial expressions, with a maximum score of 96. Thus, positive facial expression recognition corresponds to accuracy scores in response to happy facial expressions, with a maximum obtainable score of 24. In order to aid interpretation of facial expression recognition accuracy, the percentage of correct responses for each emotion level was calculated.

Facial Expressivity

In order to assess facial expressivity across each film task, facial expressivity was exported from the Emotient module and aggregated based on the mean for each emotion, for each clip. The mean was the chosen method of analysis in order to account for potential anomalies in facial expressivity data (i.e., yawning, coughing, sneezing). In order to produce a measure of overall facial expressivity, average facial expressivity of each positive (i.e., happy) and negative emotion (i.e., anger, disgust, fear, and sadness) in response to each film clip was extracted from the Emotient module. Valence-specific facial expressivity was calculated by averaging (a) facial expressivity of positive emotions (i.e., happiness) in response to the four positively valenced films, and (b) facial expressivity of negative emotions (i.e., anger, sadness, disgust, and fear) in response to the four negatively valenced clips. In order to obtain a measure of overall facial expressivity, the average positive facial expressivity to positive clips, and negative expressivity to negative clips was computed.

In order to measure the change in participants' facial expressivity during the film task, the average positive facial expressivity and the average negative facial expressivity during neutral film clips was subtracted from the corresponding facial expressivity during the target film clips (e.g., positive facial expressivity during the neutral film clips was subtracted from the positive facial expressivity recorded during positively valenced film clips). For overall facial expressivity, the average of positive and negative expressivity to neutral clips was computed, and subtracted from overall facial expressivity (i.e., average of positive and negative facial expressivity). The neutral film clips were used as a baseline as they allowed us to determine the extent to which participants express emotion in the absence of emotion provoking stimuli. These baseline corrected facial expressivity variables were used for all analyses.

Subjective Emotional Experience

In order to obtain a measure of subjective emotional experience for each participant, the subjective rating of each emotion for each film clip was extracted. In this instance, we were only interested in the ratings given immediately after viewing the clip[1]. Valence-specific subjective emotional experience was calculated by averaging (a) subjective emotional experience of positive emotions (i.e., happiness and amusement) in response to positively valenced clips, and (b) subjective emotional experience of negative emotions (i.e., anger, sadness, disgust, and fear) in response to negatively valenced clips. These emotion ratings were used to calculate valence specific emotional experience as they map on to the expressions that are included in the facial expression recognition task. For the purpose of conducting manipulation checks, we also calculated (a) subjective emotional experience of positive emotions (i.e., happiness and amusement) in response to negatively valenced clips, and (b) subjective emotional experience of negative emotions (anger, sadness, disgust, and fear) in response to positively valenced clips. In order to measure the change in participants'

[1] To honour the original method developed by Koval, Sütterlin and Kuppens (2016) the second round of ratings were kept in the procedure. However, the research question did not focus on the second ratings, thus they were omitted from analyses.

subjective emotional experience during the film task, the baseline emotion rating provided at the beginning of the film task was subtracted from the average of subjective emotional experience ratings during the film task (e.g., the baseline rating of happiness was subtracted from the average experience of happiness during positively valenced film clips).

To compute baseline-corrected subjective experience of positive emotion, the average baseline corrected subjective emotional experience of amusement and happy was calculated. In addition to this, in order to assess subjective emotional experience for negatively valenced emotion, the average of the baseline corrected subjective emotional experience of anger, fear, sadness, and disgust was calculated. Finally, in order to assess subjective emotional experience at the overall level, the average of baseline corrected positive emotion and baseline corrected negative emotion was calculated. The baseline corrected subjective emotional experience variables were used for all analyses.

Emotional Concordance

In order to generate a measure of general emotional concordance between subjective emotional experience and facial expressivity for each participant, the average intensity of facial expressivity for happiness, anger, disgust, fear, and sadness for each film clip (regardless of film clip valence) was obtained. Additionally, the subjective emotional experience ratings obtained immediately after each film clip were also extracted for these same emotions (regardless of the valence induced by the clip). Given that emotional concordance was not computed in response to a specific clip (i.e., positive emotional concordance to positive clips), the raw subjective emotional experience and facial expressivity ratings were used, as opposed to the corrected variables. The raw variables were used for this calculation as we were not interested in the change in intensity of emotional concordance (e.g., change from baseline), rather the way in which the experience and expression of emotion relate to each other. A measure of emotional concordance for each emotion was obtained by estimating the bivariate correlation of facial expressivity and subjective emotional experience for each emotion across film clips, separately for each participant. In order to assess emotional concordance at the valence-specific level, a measure of emotional concordance was obtained by estimating the bivariate correlation between facial expressivity and subjective emotional experience for positively valenced emotions and negatively valenced emotions across all film clips. For example, in order to calculate negative emotional concordance, correlations between facial expressivity and subjective emotional experience were estimated for anger, sadness, disgust, and fear for each film clip, and then averaged across emotions. For the measures of emotional concordance, scores range from +1 to -1, and are interpreted in the same manner as a correlation.

Emotion Regulation

The scores for expressive suppression and reappraisal were extracted from the emotion regulation questionnaire. To assess suppression and reappraisal at the overall level, the average suppression and reappraisal was computed. To obtain a measure of suppression and reappraisal at the valence-specific level, the average suppression and reappraisal of positive emotion and negative emotion was computed separately. Higher scores for reappraisal and suppression indicated greater use of emotion regulation.

Statistical Analyses

To determine whether the film-clips were effective at eliciting the target emotional valence, a 2 (film: positive and negative) x 2 (emotion rating: positive and negative) repeated measures ANOVA was conducted on subjective emotional experience ratings. Significant interactions were investigated using Bonferroni-corrected simple main effects analyses. Shapiro-Wilk analyses revealed normality violations across facial expression recognition, positive and negative suppression and reappraisal, positive emotional concordance, positive subjective emotional experience, and facial expressivity, W (110) ≤ .969, p ≤ .011. However, normality was assumed due to the adequate sample size (n > 30; Field, 2009).

In order to establish whether facial expression recognition ability varied depending on the emotional expression, a one-way repeated measures ANOVA was conducted with emotion as a factor with five levels (anger, disgust, fear, happiness, sadness).

To determine the nature of the relationship between subjective emotional experience, facial expressivity, emotional concordance, reappraisal, suppression, and facial expression recognition a series of Spearman’s bivariate correlations and hierarchical multiple regressions were conducted. Spearman’s rho was conducted due to violations to normality, in an attempt to minimise the effects of extreme scores. In Step 1 of each regression, suppression and reappraisal of emotion were added, followed by subjective emotional experience and facial expressivity in Step 2. To determine if emotional concordance explains additional variance in facial expression recognition, it was added in Step 3. Assessment of plots of standardised residuals revealed that linearity had been met for all regressions. The assumption of independence of residuals was met for all regressions, as assessed by a Durbin-Watson statistic of ≥ 1.69. Homoscedasticity was present in all regressions, as assessed by a visual inspection of a scatterplot of standardised predicted values. There was no evidence of multicollinearity for any of the regressions, as assessed by tolerance values ≥.65, and VIF values ≤1.55. There was no studentised deleted residuals greater than ±2.5 standard deviations. Leverage values revealed that, for negative, there was 1 case where the leverage value exceeded .162. This case was only marginally higher than the cut-off, thus it was included in the final analyses as cases with large leverage values do not necessarily influence the model (Field, 2009). For all regression, values for Cook’s distance were below 1 (≤.142).

Experiment 1 Results

Missing Data

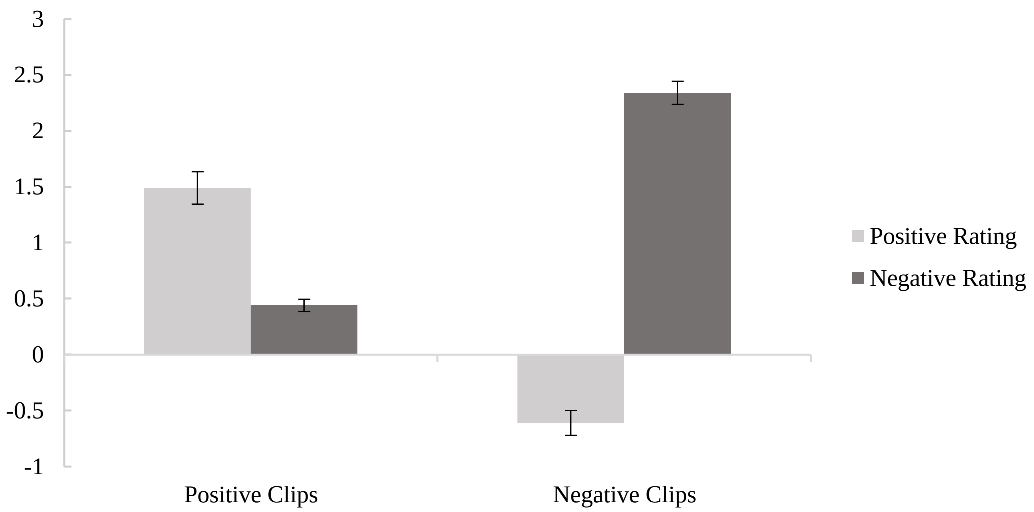
As emotional concordance is calculated by estimating bivariate correlations between subjective emotional experience and facial expressivity, concordance could not be computed for some participants as there was no variability in emotional experience ratings in some instances. Thus, for emotional concordance, there were eight cases where overall and/or negative emotional concordance could not be computed. Thus, the sample size for overall and negative concordance ratings was 105). For the hierarchical multiple regressions, missing data were excluded on a listwise basis.

Manipulation Check

Figure 4.1 displays means for positive valence and negative valence emotion ratings, split by target valence. The 2 × 2 repeated measures ANOVA indicated there was no significant main effect of film, F (1, 112) = 3.15, p = .079, $\eta_p{}^2$ = .03. There was a significant main effect of emotion rating, F (1, 112) = 49.88, p < .001, $\eta_p{}^2$ = .31, that was moderated by a significant Film × Emotion Rating interaction, F (1, 112) = 472.08, p < .001, $\eta_p{}^2$ = .81. As demonstrated in Figure 4.1, Bonferroni-corrected simple main effects analysis revealed the film clip manipulation had the expected effect of emotion ratings. Specifically, positive ratings were significantly higher in response to positive clips than negative clips, t (112) = 6.45, p < .001, d = .91. Furthermore, negative ratings were significantly higher in response to negative clips, compared to positive clips, t (112) = 18.16, p < .001, d = 2.59.

Figure 4.1

Means and Standard Deviations for Subjective Emotional Experience Scores for Positive and Negative Film Clips.

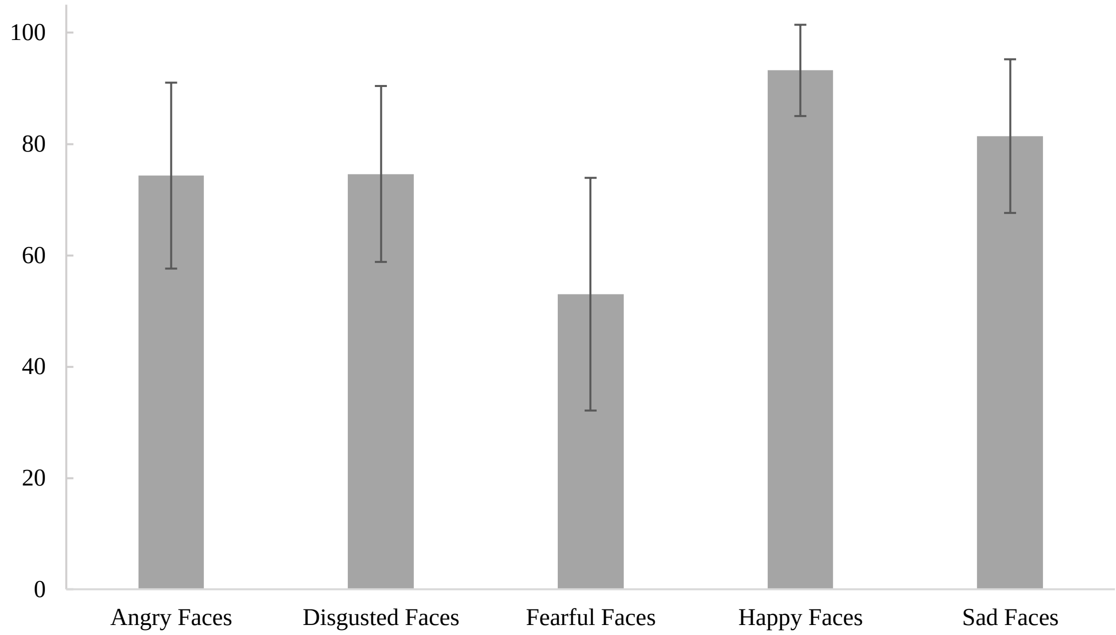


Facial Expression Recognition

The descriptive statistics for facial expression recognition for each emotion are summarised in Figure 4.2. Results from the repeated measures ANOVA indicated that there was a significant effect of emotion on facial expression recognition accuracy, F (3.48, 390.25) = 127.64, $p < .001$, $\eta_p{}^2 = .53$. Bonferroni-corrected simple main effects analysis revealed that happy facial expressions were recognised significantly more accurately than all other emotions, t (112) ≥ 8.24, *p*s < .001, $d \geq 1.04$. Sad faces were significantly identified more accurately than all other negative emotions, t (112) ≥ 3.76, *p*s < .01, $d \geq 0.46$. Recognition of fearful faces was significantly less accurate than all other emotions, t (112) ≥ 10.74, *p*s < .001, $d \geq 1.13$. There was no significant difference between recognition of disgusted facial expressions and angry facial expressions t (112) = 0.16, $p = 1.00$, $d = 0.02$.

Figure 4.2

Means and Standard Deviations for Facial Expression Recognition Percentage Accuracy Scores for Each Emotion Category



Descriptive Statistics and Correlations

Overall

Means and standard deviations for overall facial expression recognition, emotional concordance, facial expressivity, subjective emotional experience, suppression and reappraisal are summarised in Table 4.1. To establish whether there was evidence of emotional concordance, a one-sample t-test was conducted to ensure that emotional concordance scores were significantly different from 0. Overall emotional concordance was significantly different from 0, t (104) = 11.02, p < .001.

In order to determine whether overall facial expressivity, overall subjective emotional experience, overall emotional concordance, and overall suppression and reappraisal were related to facial expression recognition ability, bivariate correlations were first conducted. The results of these correlations are summarised in Table 4.1. Overall facial expression recognition performance was significantly and positively correlated with overall facial expressivity, and overall emotional concordance. In addition to this, there was a significant, negative correlation between overall facial expression recognition and suppression. There were significant, negative correlations between overall emotional concordance and reappraisal, and facial expressivity and suppression. Overall facial expression recognition performance was not significantly correlated with overall subjective emotional experience or reappraisal.

Table 4.1

Means, Standard Deviations and Correlations Between Overall Facial Expression Recognition, Overall Emotional Concordance, Overall Facial Expressivity, Overall Subjective Emotional Experience, Overall Suppression, and Overall Reappraisal

Variables	*M*	*SD*	1.	2.	3.	4.	5.	6.
1. Overall Facial Expression Recognition	75.3	9.6	-	.32**	.24**	.17	-.21*	-.10
2. Overall Concordance	.2	.2		-	.43**	.11	-.11	-.24*
3. Overall Facial Expressivity	0.5	0.5			-	.03	-.25**	-.11
4. Overall Subjective Emotional Experience	1.9	1.0				-	-.06	-.03
5. Overall Suppression	3.0	1.2					-	.19*
6. Overall Reappraisal	3.0	1.0						-

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

Positive Valence

Descriptive statistics for positive facial expression recognition, positive emotional concordance, positive facial expressivity, positive subjective emotional experience, and the suppression and reappraisal of positive emotion are displayed in Table 4.2. To determine whether emotional concordance for positively-valenced emotions was significantly different from 0, a one-sample t-test was conducted. Results indicated that positive emotional concordance was significantly different from 0, t (112) = 11.13, $p < .001$.

In order to establish whether positive facial expressivity, subjective emotional experience and emotional concordance were associated with the recognition of positively-valenced faces, bivariate correlations were computed. The results of these correlations are summarised in Table 4.2. There was a significant, negative correlation between positive facial expression recognition, and the reappraisal of positive emotion. In addition to this, there was also a significant, negative correlation between the suppression of positive emotions, and positive emotional experience and emotional concordance. Reappraisal of positive emotions was significantly, and negatively correlated with positive facial expressivity.

Table 4.2

Means, Standard Deviations and Correlations Between Positive Facial Expression Recognition, Positive Emotional Concordance, Positive Neutral Corrected Facial Expressivity, Positive Baseline Corrected Subjective Emotional Experience, Positive Suppression, and Positive Reappraisal

Variables	*M*	*SD*	1.	2.	3.	4.	5.	6.
1. Positive Facial Expression Recognition	93.2	8.2	-	-.16	-.06	.03	-.09	-.24*
2. Positive Concordance	.4	.4		-	.51**	.29**	-.25**	-.18
3. Positive Facial Expressivity	0.8	1.0			-	.20*	-.14	-.30**
4. Positive Subjective Emotional Experience	1.5	1.5				-	-.26**	-.01
5. Positive Suppression	2.8	1.2					-	.28**
6. Positive Reappraisal	3.0	1.4						-

Note: *$p < .05$, **$p < .01$

Negative Valence

Descriptive statistics for negative facial expression recognition, negative emotional concordance, negative facial expressivity, negative subjective emotional experience, and suppression and reappraisal of negative emotion are presented in Table 4.3. Compared to positively valenced emotion, participants were less accurate in facial expression recognition of negatively valenced emotions, and exhibited less facial expressivity of negative emotions. Conversely, participants indicated greater subjective experience and regulation (i.e., suppression and reappraisal) of negative emotions compared to positive emotion. To establish whether emotional concordance of negative emotion was significantly different from 0, a one samples t-test was conducted. Negative emotional concordance was significantly different from 0, t (104) = 7.94, $p < .001$.

To establish whether negative facial expressivity, subjective emotional experience and emotional concordance were related to the recognition of negatively-valenced faces, bivariate correlations were conducted. Unlike positively valenced emotions, results indicate that negative facial expression recognition ability was positively and significantly correlated with negative emotional concordance, negative facial expressivity, and negative subjective emotional experience. The results of these correlations are summarised in Table 4.3.

Table 4.3

Means, Standard Deviations and Correlations Between Negative Facial Expression Recognition, Negative Emotional Concordance, Negative Facial Expressivity, Negative Subjective Emotional Experience, Negative Suppression, and Negative Reappraisal

Variables	*M*	*SD*	1.	2.	3.	4.	5.	6.
1. Negative Facial Expression Recognition	70.8	11.5	-	.24*	.27**	.20*	-.07	-.08
2. Negative Concordance	.2	.2		-	.44**	.11	-.17	-.02
3. Negative Facial Expressivity	0.2	0.2			-	.12	-.07	-.13
4. Negative Subjective Emotional Experience	2.3	1.1				-	.02	.05
5. Negative Suppression	3.3	1.1					-	.11
6. Negative Reappraisal	3.1	1.3						-

Note: *$p < .05$, **$p < .01$

Hierarchical Multiple Regressions

To determine the predictors of facial expression recognition ability at an overall, positive, and negative valence level, three hierarchical multiple regressions were conducted.

The full hierarchical regression predicting *overall facial expression* recognition from all variables was significant, F (5, 103) = 3.99, p = .002, accounting for 16.9% of variance in overall facial expression recognition. Overall emotional reappraisal and suppression did not significantly contribute to the model in Step 1, F (2, 103) = 2.16, p = .119, accounting for 4.1% of variance in overall facial expression recognition. The addition of overall subjective emotional experience and facial expressivity significantly contributed to the model in Step 2, F_{change} (2, 99) = 4.21, p = .018, accounting for an additional 7.5% of variance in overall facial expression recognition. The addition of overall emotional concordance in Step 3 explained an additional 5.3% of variance in overall facial expression recognition, significantly improving the model, F_{change} (1, 98) = 6.20, p = .014. Regression coefficients for this model are presented in Table 4.4.

For *positive facial expression* recognition, the full hierarchical regression was non-significant, F (5, 106) = 1.34, p =.255, only accounting for 5.9% of variance in positive facial expression recognition. Step 1, Step 2 and Step 3 did not contribute significantly to the regression. Coefficients for this regression are summarised in Table 4.4.

The full hierarchical regression predicting *negative facial expression* recognition was significant, F(5, 98) = 2.60, p = .030, accounting for 11.7% of variance in negative facial expression recognition. Negative reappraisal and suppression did not contribute significantly to the model in Step 1, F(2, 101) = 0.77, p = .467, only accounting for 1.5% of variance in negative facial expression recognition. The addition of negative subjective emotional experience and negative facial expressivity significantly contributed to the model in Step 2, F_{change}(2, 99) = 4.90, p = .009, accounting for an additional 8.9% of variance in negative facial expression recognition. Despite this, negative facial expressivity was a significant, positive predictor of facial expression recognition in Step 2, t (103) = 2.56, p = .012. Negative emotional concordance did not significantly improve the model in Step 3, F_{change} (1, 98) = 1.50, p = .224, accounting for only an additional 1.3% of variance in negative facial expression recognition. Despite the significance of the full regression model, none of the variables were significant, unique predictors of facial expression recognition in the full model. Regression coefficients for this model are summarised in Table 4.4.

Table 4.4

Summary of Hierarchical Multiple Regression Analyses for Variables Predicting Overall, Positive, and Negative Facial Expression Recognition

		Overall				Positive				Negative			
		B	SE B	β	Sr^2	B	SE B	β	Sr^2	B	SE B	β	Sr^2
Step 1													
	Constant	82.15	3.55			96.13	2.32			75.69	4.05		
	Reappraisal	-0.89	0.94	-.093	.008	-1.00	0.58	-.169	.027	-0.75	0.84	-.089	.008
	Suppression	-1.34	0.78	-.169	.028	0.04	0.66	.006	.000	-0.74	0.97	-.075	.006
F			2.18				1.58				0.77		
R^2			.04				.03				.02		
Step 2													
	Constant	74.73	4.33			96.64	2.83			68.38	4.67		
	Reappraisal	-0.68	0.91	-.071	.005	-1.08	0.61	-.182	.029	-0.53	0.81	-.063	.004
	Suppression	-1.12	0.78	-.140	.018	0.02	0.68	.003	.000	-0.66	0.94	-.068	.004
	SEE	2.49*	0.95	.248	.062	0.05	0.52	.010	.000	1.52	1.04	.141	.019
	FE	2.38	1.79	.129	.016	-0.40	0.84	-.047	.002	12.79*	4.99	.249	.060
F			3.26				0.83				2.87		
R^2			.12				.03				.10		

Step 3													
	Constant	72.24	4.34			98.41	2.96			67.59	4.71		
	Reappraisal	-0.09	0.92	-.009	.000	-1.14	0.60	-.192	.032	-0.59	0.81	-.070	.005
	Suppression	-1.16	0.76	-.146	.020	-0.24	0.69	-.036	.001	-0.47	0.95	-.048	.002
	SEE	1.99*	0.95	.199	.038	0.33	0.54	.062	.003	1.44	1.04	.134	.017
	FE	0.76	1.86	.041	.001	0.28	0.91	.034	.001	9.79	5.55	.190	.028
	Concordance	12.95*	5.20	.260	.052	-4.82	2.66	-.209	.029	7.21	5.89	.132	.013
F			3.99				1.34				2.60		
R^2			.17				.06				.12		

Note: $*p < .05$

Experiment 1 Discussion

The aim of Experiment 1 was to determine the nature of the relationship between facial expression recognition and facial expressivity, subjective emotional experience, and emotional concordance. Furthermore, the current study aimed to examine the relationship between cognitive reappraisal and expressive suppression and the experience, expression and recognition of emotion. These relationships were assessed at the overall emotion, positively valenced emotion and negatively valenced emotion levels.

It was hypothesised that participants with greater facial expression recognition ability would also experience higher intensity subjective emotional experience, higher facial expressivity, and greater emotional concordance. Results of Experiment 1 supported this hypothesis at the negative emotion level, and provided partial support at the overall emotion level. At the overall emotion level, results indicated that overall facial expression recognition was positively correlated with both facial expressivity, and emotional concordance. Thus, superior facial expression recognition ability was associated with heightened facial expressivity and greater emotional concordance between subjective experience and facial expressivity. When assessed at the negatively valenced level, results indicated facial expression recognition was positively associated with emotional concordance, facial expressivity and subjective emotional experience. Participants who had superior negative facial expression recognition ability also demonstrated greater expressivity of negative emotion, heightened experience of negative emotion, and greater emotional concordance between their experience and expression of emotion. At the positively valenced level, none of the previously discussed relationships were evident.

The hypothesis that facial expressivity and subjective emotional experience would serve as significant, unique predictors of facial expression recognition at the overall, and positive and negative valence levels was partially supported. At the overall emotion level, results indicated that subjective emotional experience is a significant, positive predictor of facial expression recognition performance. Contrary to hypotheses, facial expressivity was not a significant predictor of facial expression recognition performance at the overall level. At the negatively valenced emotion level, despite the significant correlations between facial expression recognition and subjective emotional experience and facial expressivity, and the significance of the full regression model, none of the variables employed were significant predictors of facial expression recognition. Although facial expressivity was a significant, predictor of facial expression recognition when introduced to the model in Step 2, this relationship diminished when accounting for emotional concordance in Step 3. As with the first hypothesis, none of the aforementioned relationships were present when examined at the positively valenced level.

The hypothesis that emotional concordance would account for an additional proportion of variance in facial expression recognition ability, above and beyond that accounted for facial expressivity and subjective emotional experience was supported by the results of the current study. At the overall emotion level, the addition of emotional concordance in the model demonstrated that emotional concordance accounts for variance above and beyond subjective emotional experience and facial expressivity in predicting facial expression recognition ability. The finding that emotional concordance is a significant predictor of facial expression recognition at an overall level is consistent with the notion that higher levels emotional concordance are associated with superior facial expression recognition ability. However, when examining this relationship at the positive and negatively valenced levels, emotional concordance was not a significant predictor of facial expression recognition ability. One explanation for the finding that emotional concordance is a significant predictor at the overall level, but not the positive or negative levels, is due to the nature of the regression models. The overall, positive, and negative valence regression models are all unique models, comprised of different predictor variables. As such, it is important to consider the interplay between each of the predictors within each model when determining the significance of that model. Thus, the discrepant findings between overall and valence level concordance in predicting facial expression recognition may be attributed to the different predictors within each model.

Finally, the hypothesis that greater expressive suppression and cognitive reappraisal would be associated with decreased emotional expression and experience, and decreased accuracy in emotion recognition was partially supported by the results of the current study. At the overall level, greater expressive suppression was significantly associated with decreased facial expression recognition accuracy and decreased facial expressivity. When examining these relationships at a valence level, greater reappraisal of positive emotions was associated with decreased facial expression recognition accuracy and facial expressivity of positive emotions. Additionally, greater expressive suppression of positive emotion was associated with decreased subjective experience of positive emotion. None of the aforementioned relationships were uncovered at the negative emotion level.

The findings that an individual's subjective experience of overall emotion predicts their ability to recognise overall emotions in others is consistent with the *simulationist model* of facial expression recognition, indicating that we recognise emotion by first simulating it within ourselves (Goldman & Sripada, 2005). This finding is also consistent with previous research finding that individuals who have more intense subjective emotional experience also tend to be more sensitive to the emotions of others (Terasawa et al., 2014). Taken together, there is evidence to suggest that those who experience emotion to a higher intensity are also more accurate in identifying the emotions of others. At the negatively valenced level, although facial expressivity was a significant, predictor of facial expression recognition when introduced to the model in Step 2, this relationship diminished when accounting for emotional concordance in Step 3. There are two possible explanations for this: First, this may be as a result of the shared variance between facial expressivity and emotional concordance at the negative emotion level. Results indicated that there was a significant, positive correlation between facial expressivity and emotional concordance. As such, adding emotional concordance to the regression model in Step 3 may reduce the contribution of facial expressivity to facial expression recognition ability. Second, this may be a result of limitations with the study design and the use of the self-report measurement of subjective emotional experience. Self-report subjective emotional experience was measured on a 6-point Likert scale, which may not have provided enough scope for measuring subjective emotional experience. In addition to this, facial expressivity may not have been provoked to a meaningful degree; the clips were chosen to induce moderate emotion (Koval et al., 2013), and thus may not have provoked a high enough intensity of negative emotional expression.

The current study found that, unexpectedly, facial expressivity in response to emotional stimuli is not a significant predictor of facial expression recognition ability in the full regression model, for overall emotion, and neither for positive nor negatively valenced emotion. This finding could be attributed to two possible factors: (1) intensity of film clips and/or (2) measurement of emotion. First, as discussed above, the film clips that were selected from Schaefer et al. (2010) were chosen based on their ability to provoke moderate emotion, in an attempt to avoid ceiling effects (Koval et al., 2013). This may have resulted in a failure to see meaningful effects from facial expressivity as it may be that the clips were not strong enough in provoking the target expressions. Second, it may be that assessing facial expressivity at the valence level is not sufficiently specific to produce meaningful effects; by averaging facial expressivity and facial expression recognition based on positive and negative emotion, we may be overlooking any effects at the discrete emotion level (i.e., sadness, anger disgust, and fear). This is of particular importance in the assessment of negatively valenced emotion, as some negative emotions possess specific motivations and arousal; anger and fear are both negatively valenced emotions, however, anger is associated with an approach-oriented motivation while fear is associated with avoidance-oriented motivation (Mauss & Robinson, 2009). Therefore, it may not be appropriate for our purposes to average across negatively valenced emotions. Further research should be undertaken to investigate the nature of the relationship between facial expressivity and facial expression recognition at the discrete emotion level. The clips in Experiment 1 were selected on the basis of provoking positive and negative emotion, thus these relationships between facial expressivity and facial expression recognition could not be examined at a discrete emotion level. This gap will be addressed in Experiment 2.

The finding that, at the overall emotion level, emotional concordance is a significant predictor of facial expression recognition and explains facial expression recognition ability above facial expressivity and subjective emotional experience provides additional evidence for the *simulationist model*. This result suggests that at least at the overall level, there is a relationship between the degree to which our facial expressions map on to our emotional experience and identifying the facial expressions of others. Emotional concordance was measured across the entirety of the film task regardless of target valence of the clips, as opposed to the measure of facial expressivity which was calculated in response to target film clips. It may be that emotional concordance goes beyond both facial expressivity and subjective emotional experience in explaining facial expression recognition as it is more of a trait-like measure. That is, both facial expressivity and subjective emotional experience were measured in response to target stimuli and required some degree of manipulation to occur. Perhaps emotional concordance accounted for addition variance in facial expression recognition because it was measured across the entire film task and was more measured as a trait-like dimension, as opposed to facial expressivity and subjective emotional experience measured in a situational context.

The results of the current study provide partial support for the *simulationist model* of facial expression recognition, with results revealing that subjective emotional experience is a significant, unique predictor of facial expression recognition at the overall emotion level. However, when examined at a positive-valence and negative valence level, these effects did not carry over. Findings suggest that there are significant associations between the recognition of negatively valenced emotion, and the expression and experience of these emotions, however these do not translate to a predictive relationship. Previous studies have provided some evidence of relationships between facial expressivity and subjective emotional experience when targeting discrete emotions (e.g., Mauss et al., 2005). Given that emotions were assessed at an overall and valence level in the current experiment, it would be necessary to examine the impact of facial expressivity, subjective emotional experience, emotional concordance, and emotion regulation on facial expression recognition at the discrete emotion level. This is of particular importance for negatively valenced emotion as, although some emotions may share emotional valence, arousal and motivation associated with discrete emotions differ.

The iMotions Emotient software adopted in this experiment codes facial muscle movements in order to give an assessment of facial expressivity. When analysing facial expressions of emotion, this software produces a score that represents the likelihood that an observer would identify the observed expression as a particular emotion. In a review, Mauss and Robinson (2009) outline that using observer ratings as a measure of facial expressivity provides an opportunity for emotion specific measurement. Given the findings for facial expressivity, and that the Emotient module is an emotion coding software, perhaps it would be beneficial to assess facial expressivity from a discrete emotion approach. In doing so, this may provide a more robust assessment of this emotion process and its correlates. According to Watson (2000), self-reported emotion should be examined at a dimensional level before examining emotional responding at a discrete emotion level. Thus, a natural progression from the current experiment is to examine these emotion processes from a discrete emotion perspective.

Experiment 2

The results from Experiment 1 suggest evidence for a relationship between subjective emotional experience, facial expressivity, and facial expression recognition at the overall, and negative valence emotion level. There is evidence to suggest that there is a relationship between correlates of emotional experience at the discrete emotion level (e.g., anger; Haslinger et al., 2008). Therefore, research would benefit from assessing the correlates of emotion and their relationship with facial expression recognition from a discrete emotion approach to gain an understanding of these relationships across specific emotions (i.e., happiness, sadness, anger, fear, and disgust). Research has demonstrated that the same neural regions are activated in both the observation and the experience of discrete emotion, as well as moderate correlations between physiological, behavioural and experiential components of emotion in response to emotionally provoking stimuli (e.g., Mauss et al., 2005; Söderkvist et al., 2018; Wicker et al., 2003). However, to date, no studies have determined how the expression and experience of discrete emotion predict the ability to recognise the facial expressions of the same emotion.

Thus, Experiment 2 was designed with three aims in mind. *First*, to determine whether facial expressivity, and subjective emotional experience are significant, unique predictors of facial expression recognition at the discrete emotion level. *Second*, to determine whether emotional concordance explains facial expression recognition above and beyond facial expressivity and subjective emotional experience at the discrete emotion level. *Third*, to determine the nature of the relationship between emotion regulation (i.e., cognitive reappraisal and expressive suppression) and facial expression recognition, subjective emotional experience, facial expressivity and emotional concordance at the discrete emotion level.

It was predicted that, at the discrete emotion level, there would be significant, positive relationships between facial expression recognition, facial expressivity, subjective emotional experience, and emotional concordance. It was also anticipated that facial expressivity and subjective emotional experience would serve as unique predictors of facial expression recognition of the corresponding emotion. That is, for example, the facial expressivity of happiness and the subjective experience of happiness would predict the ability of the individual to recognise happy facial expressions. Furthermore, it was anticipated that when emotional concordance was added into the regression model at the discrete emotion level, it would explain facial expression recognition above and beyond subjective emotional experience and facial expressivity. Finally, based on the findings from Experiment 1, it was hypothesised that expressive suppression would have a significant, negative relationship with facial expression recognition, such that individuals who report greater use of suppression would show reduced facial expression recognition accuracy.

Experiment 2 Method

The method for Experiment 2 was largely the same as that of Experiment 1, with the exception of the sample of participants, and the film task. The demographic questionnaire, emotion regulation questionnaire, emotion recognition task, and procedure were the same as described in Experiment 1.

Participants

The final sample consisted of 116 adults aged between 18 and 58 years (*M* = 22.19, *SD* = 6.86, 81.9% female). Participants were undergraduate psychology students and members of the general community. Exclusion criteria and participant reimbursement were as described in Experiment 1.

Sample Size Justification

Two power analyses were conducted using the pwr package in R version 1.3.1073. As in Experiment 1, the first analysis was to determine the sample size for observing a moderate correlation ($r \geq .30$) with 80% power and $\alpha = .05$. Similarly, the second analysis was to determine the sample size needed for the full model to account for at least 20% of variability, with 80% power and $\alpha = .05$. Results from these analyses indicated that 84, and 56 participants were required to meet these criteria respectively. To be conservative, we recruited 116 participants, giving us 80% power to find a correlation of $r \geq .30$, and a model of $r^2 \geq .20$.

Measures

Film Task

In Experiment 2, we focused on the experience of discrete emotions. In order to assess the subjective experience of discrete emotions an adapted version of the film task employed in Experiment 1 was used. The main difference was in the film clips used, which were selected based on their ability to elicit specific basic emotions: angry, disgusted, fearful, happy, neutral, and sad. The film clips were taken from two validated databases of emotion-eliciting film excerpts (Gross & Levenson, 1995; Schaefer et al., 2010). The databases provide a ranking of the film clips ability to elicit discrete emotions. For example, Trainspotting (2) was ranked highest in Schaefer et al., (2010) for eliciting disgust, and lower for other negative emotions. In order to ensure maximum target emotion elicitation, the highest ranking films for each emotion were used. The current film task followed otherwise a similar format to the film task in Experiment 1, with participants providing an initial rating of their subjective experience of anger, disgust, fear, happiness, neutral, sadness in order to obtain a baseline measure.

Following each excerpt, participants provided ratings of their subjective experience of each of the seven emotions from 0 (not at all) to 100 (extremely). The subjective emotional experience rating scale was modified from Experiment 1 in order to allow more scope to find individual differences in subjective emotional experience. In contrast to the film task in Experiment 1, participants were only required to provide ratings of their subjective emotional experience on one occasion. In Experiment 1, the procedure was designed to be similar to the approach of Koval et al. (2016). However, in the current experiment, adjustments were made to the previous approach in an attempt to focus more on the current aims, and reduce the length of the task (e.g., assess fewer emotions).

Table 4.5

Summary of Sequence, Film, Target Emotion, Duration and Description for Film Clip Task Stimuli

Sequence	Film	Target Emotion	Duration	Description
1	Seven	Fear	1’43’’	A man who is seemingly dead is discovered lying on a bed with his hands tied. He is extremely skinny and has been tortured. Unexpectedly, the man wakes up.

2	The Piano	Anger	0’43’’	A man cuts off his wife’s hand with an axe.
3	There’s Something About Mary	Happiness	2’55’’	A man fights with a dog.
4	Blue (3)	Neutral	0’25’’	A woman is carrying a box while she ascends an escalator.
5	American History X	Anger	1’17’’	A man kills an African American man by smashing his head on the curb.
6	Trainspotting (2)	Disgust	1’44’’	A man suffers from violent diarrhoea in a filthy public bathroom. He then remembers that he had hidden a heroin pill in his anus, and is then forced to search through his excrements for the pill.
7	Dangerous Minds	Sadness	2’08’’	A teacher tells the class that one of their classmates has died.

8	Blue (2)	Neutral	0’25’’	A woman is walking through an alley, meets up with another woman and continues walking.
9	Child’s Play II (Chucky II)	Fear	1’05’’	Chucky beats a teacher with a ruler.
10	Benny and Joon	Happiness	2’01’’	A man plays the fool in a diner.
11	The Champ	Sadness	2’45’’	A boxer dies after a boxing match. His young son appears next to him, crying and pleading for him to wake up.
12	Hellraiser	Disgust	1’30’’	On the floor, the size of two stains are growing, and progressively transforming into a human skeleton monster

Note: Numbers in parentheses are provided in Schaefer et al. (2010) and correspond to different scenes in the same film.

Data Processing

The data processing steps for facial expressivity, subjective emotional experience, emotional concordance, and emotion regulation were the same as in Experiment 1 with only two exceptions. First, in Experiment 1 the subjective emotional experience ratings for positive emotion were computed by averaging across ratings of happiness and amusement for each film clip as these clips were selected for eliciting positively valenced emotions. However, the clips selected in Experiment 2 were selected on the basis that they specifically target happiness. Therefore, positive emotion ratings for Experiment 2 were calculated for consistency across both experiments, but only reflect happiness ratings. Second, in addition to computing the overall, positive, and negative valence averages for facial expressivity, subjective emotional experience, and emotional concordance, the average for each discrete emotion (happy, angry, fearful, disgusted, and sad) across both film clips was also calculated.

Statistical Analyses

To determine whether the film-clips were effective at eliciting the target emotion, a 5 (film: happy, sad, angry, disgusted, afraid) × 5 (emotion rating: happy, sad, angry, disgusted, afraid) repeated measures ANOVA was conducted on the baseline-corrected subjective emotional experience ratings. Significant interactions were investigated using Bonferroni-corrected simple main effects analyses. Shapiro-Wilk analyses revealed normality violations across facial expression recognition, emotional concordance, subjective emotional experience, facial expressivity and suppression and reappraisal, $W(114) \leq .221$, $p \leq .044$. However, normality was assumed due to the adequate sample size ($n > 30$). For all ANOVAs, where sphericity was violated a Greenhouse-Geisser correction was applied.

To determine the nature of the relationship between subjective emotional experience, facial expressivity, emotional concordance, reappraisal, suppressions, and facial expression recognition, a series of bivariate correlations and hierarchical multiple regressions were conducted. The process of adding each variable into the regression model was the same as in Experiment 1. Assessment of plots of standardised residuals revealed that linearity had been met for all regressions. The assumption of independence of residuals was met for all regressions, as assessed by a Durbin-Watson statistics of ≥ 2.25. Homoscedasticity was present in all regressions, as assessed by a visual inspection of a scatterplot of standardised predicted values. There was no evidence of multicollinearity for any of the regressions, as assessed by tolerance values of ≥.64, and VIF values ≤1.55. There was no studentised deleted residuals greater than ±2.5 standard deviations. Leverage values revealed that, for anger, there was 1 case where the leverage value exceeded .155, and for sad there was 1 case where the leverage value exceeded .158. Given that these cases were only marginally higher than their respective cut-off, these cases were included in the final analyses as cases with large leverage values do not necessarily influence the model (Field, 2009). For all regressions, values for Cook's distance were below 1 (≤.258).

Results

Missing Data

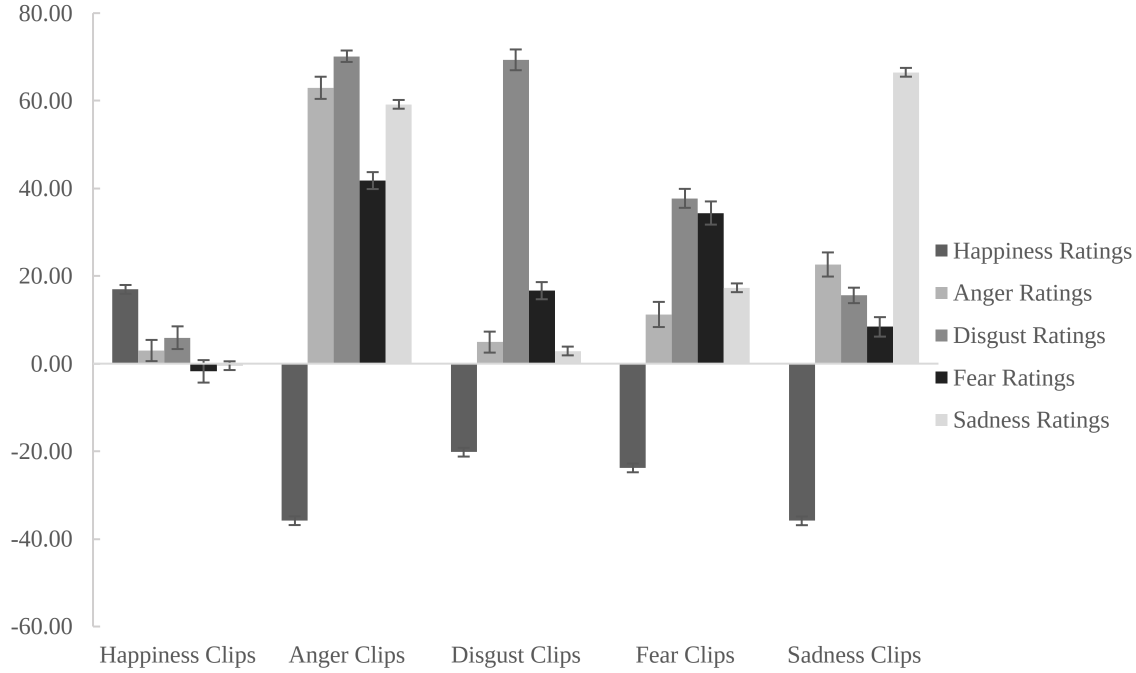
Out of the 118 participants that took part in the current study, all participants completed all tasks. As emotional concordance is calculated by estimating bivariate correlations between subjective emotional experience and facial expressivity, emotional concordance failed to be computed for some emotions for some participants as emotional experience ratings were fixed in some instances. For fear concordance, anger concordance, and sad concordance, there were four (n = 112), two (n = 114), and one (n = 115) cases respectively where this was the case. Thus, there were four cases where overall and negative emotional concordance could not be computed. The sample size for overall and negative emotional concordance ratings was 112. For the hierarchical multiple regressions, missing data were excluded on a listwise basis.

Manipulation Check

Figure 4.3 displays means for each emotion rating, split by target emotion. The 5 × 5 repeated measures ANOVA revealed significant main effects of target emotion, *F* (2.93, 336.34) = 283.23, $p < .001$, $\eta_p{}^2 = .71$, and emotion rating, *F* (2.09, 240.63) = 197.51, $p < .001$, $\eta_p{}^2 = .63$. These main effects were qualified by a significant Target Emotion × Emotion Rating interaction, *F* (6.89, 791.78) = 296.94, $p < .001$, $\eta_p{}^2 = .72$. As shown in Figure 4.3, emotion ratings that correspond to each target emotion were rated highest for happy, disgusted, and sad. Bonferroni-corrected simple main effects analysis revealed that target emotions of happy, disgusted, and sad were the only emotions for which the corresponding emotion ratings were significantly higher than all other emotions, *p*s ≤ .001. For the target emotion of anger, emotion ratings for angry were significantly higher than emotion ratings for happy and fear (*p*s < .001) but were not significantly higher than ratings of sad ($p = 1.00$). There were no significant differences between emotion ratings of angry and disgusted for angry target clips ($p = .059$). For the target emotion of fear, emotion ratings of the corresponding emotion were significantly higher than happy, angry and sad ratings (*p*s < .001), though not significantly different from ratings of disgust ($p = 1.00$).

Figure 4.3

Means and Standard Deviations for Baseline Corrected Subjective Emotion Ratings for Target Emotion Film-Clips



Facial Expression Recognition

The descriptive statistics for facial expression recognition at the overall and valence levels are summarised in Table 4.6, and at the discrete level in Table 4.7. Results from the repeated measures ANOVA indicated that there was a significant effect of emotion on facial expression recognition accuracy, F (3.29, 378.73) = 126.57, p < .001, $\eta_p{}^2$ = .52. Bonferroni-corrected simple main effects analysis revealed that happy facial expressions were recognised significantly more accurately than all other emotions, t (115) ≥ 11.26, ps < .001, d ≥ 1.30. Fearful faces were recognised significantly less accurately than all other emotions, t (115) ≥ 10.07, ps < .001, d ≥ 1.25. There were no significant differences in the recognition of anger, sadness, or disgust, t (115) ≤ 2.73, ps ≥ .074, d ≤ 0.31.

Descriptive Statistics and Correlations

Descriptive statistics for facial expression recognition, emotional concordance, facial expressivity, facial mimicry, subjective emotional experience, suppression and reappraisal are presented in Table 4.6. Bivariate correlations between each of these variables are also summarised in Table 4.6. These statistics are summarised for overall emotion, positively valenced emotion, and negatively valenced emotion.

Overall

Descriptive statistics for facial expression recognition, emotional concordance, facial expressivity, facial mimicry, subjective emotional experience, suppression and reappraisal are presented in Table 4.6. To establish whether overall emotional concordance was significantly different form 0, one-samples t-test were conducted. Overall emotional concordance was significantly different from 0, $t(111) = 18.39$, $p < .001$.

In order to determine whether overall facial expressivity, subjective emotional experience and emotional concordance were related to facial expression recognition, bivariate correlations were estimated. The results of these correlations are summarised in Table 4.6. There was a weak significant, negative correlation between overall facial expression recognition and overall suppression. In addition to this, there was a significant positive correlation between overall subjective emotional experience and overall facial expressivity. Finally, reappraisal was negatively associated with both emotional concordance and facial expressivity at the overall level.

Positive Valence

A one-samples t-test revealed that emotional concordance was significantly different from 0, $t(115) = 14.09$, $p < .001$. To establish whether positive facial expressivity, positive subjective emotional experience and positive emotional concordance were associated with the recognition of positively-valenced faces, bivariate correlations were estimated. The results for these correlations are summarised in Table 4.6. Results demonstrated that there were no significant correlations that emerged with positive facial expression recognition ability. There were significant negative correlations between the suppression of positive emotion and both positive emotional concordance and positive facial expressivity.

Negative Valence

A one-samples t-test revealed that negative emotional concordance was significantly different from 0, $t(111) = 13.39$, $p < .001$. To establish whether negative facial expressivity, negative subjective emotional experience, and negative emotional concordance were related to the recognition of negatively-valenced faces, bivariate correlations were estimated. These correlations are summarised in Table 4.6. With regard to negative facial expression recognition ability, no significant correlations emerged. There was a significant, positive correlation between negative subjective emotional experience and negative facial expressivity. Additionally, there was also a significant, negative correlation between negative subjective emotional experience and negative suppression.

Table 4.6

Means, Standard Deviations, and Bivariate Correlations for Facial Expression Recognition, Concordance, Facial Expressivity, Subjective Emotional Experience, Reappraisal and Suppression at the Overall, Positive Valence and Negative Valence Levels.

Variable	*M*	*SD*	1.	2.	3.	4.	5.	6.
Overall								
1. Facial Expression Recognition	74.6	10.2	-	.11	-.01	-.10	-.30**	-.06
2. Concordance	.3	.2		-	.28**	.04	.01	-.23*
3. Facial Expressivity	0.2	0.2			-	.20*	-.07	-.23*
4. Subjective Experience	18.0	10.9				-	.03	.06
5. Overall Suppression	3.2	1.1					-	.16
6. Overall Reappraisal	2.9	1.0						-
Positive								
1. Facial Expression Recognition	93.5	8.4	-	.13	.15	-.03	-.04	.01
2. Concordance	.5	.3		-	.55**	.30**	-.30**	.07
3. Facial Expressivity	1.6	1.4			-	.27**	-.37**	.01
4. Subjective Experience	17.0	27.6				-	-.14	-.00
5. Positive Suppression	2.7	1.1					-	.13
6. Positive Reappraisal	2.9	1.3						-
Negative								
1. Facial Expression Recognition	69.8	11.5	-	.03	-.09	-.08	.01	-.18
2. Concordance	.2	.2		-	.37**	.05	-.16	.06
3. Facial Expressivity	0.2	0.2			-	.20*	-.26**	-.07

4. Subjective Experience	33.9	15.8				-	-.09	.05
5. Negative Suppression	3.1	1.2					-	.09
6. Negative Reappraisal	3.5	1.5						-

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

Discrete Emotions

In order to determine whether emotional concordance for each discrete emotion (happiness, sadness, anger, fear, and disgust) was significantly different from 0, a series of one-samples t-tests were conducted for each emotion. Descriptive statistics and bivariate correlations for facial expression recognition, emotional concordance, facial expressivity, subjective emotional experience, reappraisal, and suppression are summarised in Table 4.7. For happiness, anger, disgust and sadness, emotional concordance was significantly different from 0, $ts \geq 10.63$, $p \leq .001$. For fear, emotional concordance was not significantly different from 0, $t(111) = 1.50$, $p = .135$.

Bivariate correlations revealed that, for happiness, facial expressivity was positively associated with subjective emotional experience. Additionally, facial expressivity was negatively associated with suppression. There was also a significant, negative correlation between emotional concordance for happiness and suppression, indicating that participants who engaged in greater emotional suppression experience lower emotional concordance. For disgust, facial expressivity was positively associated with subjective emotional experience, and negatively associated with suppression. There was also a significant, negative correlation between subjective emotional experience of disgust and suppression. Finally, for sadness, facial expressivity was positively correlated with subjective emotional experience, and negatively associated with suppression. Both of these correlations were significant.

Table 4.7

Means, Standard Deviations, and Bivariate Correlations for Facial Expression Recognition, Concordance, Facial Expressivity, Subjective Emotional Experience, Suppression and Reappraisal for Discrete Emotions

Variable	*M*	*SD*	1.	2.	3.	4.	5.	6.
Happiness								
1. Facial Expression Recognition	93.5	8.4	-	.13	. 15	-.03	-.04	.01
2. Concordance	.5	.3		-	. 55**	.30**	-.30**	.07
3. Facial Expressivity	1.6	1.4			-	.27**	-.37**	.01
4. Subjective Experience	17.0	27.6				-	-.14	-.00
5. Suppression[i]	2.7	1.1					-	.13
6. Reappraisal[i]	2.9	1.3						-
Anger								
1. Facial Expression Recognition	72.3	18.6	-	-.02	-.10	.06	.02	.02
2. Concordance	.3	.3		-	.55**	.13	-.01	.15
3. Facial Expressivity	0.6	0.5			-	.09	-.18	.03
4. Subjective Experience	63.0	27.3				-	-.14	.10
5. Suppression[ii]	3.1	1.2					-	.09
6. Reappraisal[ii]	3.5	1.5						-
Disgust								
1. Facial Expression Recognition	75.7	13.7	-	-.08	-.02	-.00	.07	-.17

2. Concordance	.3	.3		-	.41**	.33**	-.23*	.05
3. Facial Expressivity	0.8	0.7			-	.35**	-.25**	.01
4. Subjective Experience	69.3	25.6				-	-.28**	-.06
5. Suppression[ii]	3.1	1.2					-	.09
6. Reappraisal[ii]	3.5	1.5						-
Fear								
1. Facial Expression Recognition	53.9	20.4	-	.08	-.10	.02	-.09	-.17
2. Concordance	.0	.3		-	.32**	-.18	.04	.01
3. Facial Expressivity	0.0	0.3			-	.03	.00	-.05
4. Subjective Experience	34.4	28.5				-	-.11	-.05
5. Suppression[ii]	3.1	1.2					-	.09
6. Reappraisal[ii]	3.5	1.5						-
Sadness								
1. Facial Expression Recognition	77.5	15.3	-	.09	.14	.09	-.02	-.18
2. Concordance	.3	.3		-	.42**	.47**	-.14	-.03
3. Facial Expressivity	0.2	0.3			-	.21*	-.21*	-.14
4. Subjective Experience	66.5	27.2				-	-.06	-.02
5. Suppression[ii]	3.1	1.2					-	.09
6. Reappraisal[ii]	3.5	1.5						-

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

[i] Positive, [ii]Negative

Hierarchical Multiple Regressions

In an attempt to replicate the findings from Experiment 1, three hierarchical multiple regressions were conducted at the overall, positive valence and negative valence level. As in Experiment 1, each hierarchical regression consisted of three steps, with the first including expressive suppression and cognitive reappraisal, the second step adding subjective emotional experience and facial expressivity, and the third step including emotional concordance.

The full hierarchical regression predicting *overall facial expression recognition* was not significant, F (5,106) = 2.08, p = .074. accounting for 8.9% of variance in overall facial expression recognition ability. Overall expressive suppression and cognitive reappraisal contributed significantly to the model in Step 1, F (2, 109) = 4.37, p = .015, accounting for 7.4% of variance in overall facial expression recognition. The addition of overall subjective emotional experience and facial expressivity in Step 2 did not significantly improve the model, F_{change} (2, 107) = 0.13, p = .875, only accounting for an additional 0.20% of variance in overall facial expression recognition. The addition of overall emotional concordance did not significantly improve the model in Step 3, F_{change} (1, 106) = 1.48, p = .226, only accounting for an additional 1.3.% of variance in facial expression recognition. Regression coefficients for this model are presented in Table 4.8.

The full hierarchical regression predicting *positive facial expression recognition* was not significant, F (5, 110) = 0.75, p = .591, accounting for only 3.3% of variance in positive facial expression recognition. Expressive suppression and cognitive reappraisal of positive emotion in Step 1 did not contribute significantly to the model, F(2, 113) = 0.03, p = .968, only accounting for 0.10% of variance in positive facial expression recognition. The addition of positive subjective emotional experience and positive facial expressivity did not significantly improve the model in Step 2, F_{change} (2, 111) = 0.86, p = .425, only accounting for an additional 1.5% of variance in positive facial expression recognition. The addition of positive emotional concordance did not significantly improve the model in Step 3, F_{change} (1, 110) = 1.92, *p* = .168, only accounting for an additional 1.7% of variance in positive facial expression recognition ability. Regression coefficients for this model are presented in Table 4.8.

The full hierarchical regression predictive of *negative facial expression recognition* was not significant, *F* (5, 111) = 1.02, *p* = .409, accounting for only 4.6% of the variance in negative facial expression recognition ability. In Step 1, expressive suppression and cognitive reappraisal of negative emotion did not contribute significantly to the model *F*(2, 111) = 1.81, *p* = .169, accounting for just 3.2% of variance in negative facial expression recognition. The addition of negative subjective emotional experience and negative facial expressivity in Step 2 did not significantly improve the model, F_{change} (2, 107) = 0.39, *p* = .678, accounting for an additional 0.7% of variance in negative facial expression recognition. The addition of negative emotional concordance in Step 3 did not significantly improve the regression model, F_{change} (1, 106) = 0.76, *p* = .386, accounting for an additional 0.7% of variance in negative facial expression recognition. Regression coefficients for this model are presented in Table 4.8.

Table 4.8

Summary of Hierarchical Multiple Regression Analyses for Variables Predicting Overall, Positive and Negative Facial Expression Recognition

		Overall				Positive				Negative			
		B	SE B	β	Sr^2	B	SE B	β	Sr^2	B	SE B	β	Sr^2
Step 1													
	Constant	83.23	3.81			94.07	2.66			74.49	3.88		
	Suppression	-2.43*	0.84	-0.27	.070	-0.08	0.75	-0.01	.000	0.08	0.94	0.01	.000
	Reappraisal	-0.33	0.97	-0.03	.001	-0.13	0.61	-0.02	.000	-1.43	0.75	-0.18	.032
F				4.37				0.03				1.81	
R^2				.07				.00				.03	
Step 2													
	Constant	84.25	4.34			92.22	3.15			77.20	4.98		
	Suppression	-2.44*	0.85	-0.27	.071	0.27	0.81	0.04	.001	-0.08	0.98	-0.01	.000
	Reappraisal	-0.37	1.01	-0.04	.001	-0.21	0.61	-0.03	.001	-1.45	0.76	-0.18	.033
	SEE[i]	-0.03	0.09	-0.03	.001	-0.01	0.03	-0.03	.001	-0.04	0.07	-0.05	.003
	FE[ii]	-1.30	4.21	-0.03	.001	0.79	0.61	0.14	.015	-3.26	5.28	-0.06	.003
F				2.22				0.45				1.09	
R^2				.08				.02				.04	

Step 3												
Constant	81.94	4.73			91.20	3.22			76.43	5.06		
Suppression	-2.47*	0.85	-0.27	.072	0.40	0.82	0.05	.002	-0.03	0.98	-0.00	.000
Reappraisal	-0.17	1.02	-0.02	.000	-0.31	0.61	-0.05	.002	-1.50	0.76	-0.19	.035
SEE[i]	-0.03	0.09	-0.03	.001	-0.02	0.03	-0.06	.003	-0.04	0.07	-0.05	.003
FE[ii]	-2.31	4.29	-0.05	.003	0.40	0.67	0.07	.003	-4.86	5.60	-0.09	.007
Concordance	8.00	6.57	.12	.013	3.78	2.72	.16	.017	6.18	7.10	.09	.007
F			2.08				0.75				1.02	
R^2			.09				.03				.05	

Note: * p < .05, [i]Subjective Emotional Experience, [ii]Facial Expressivity

In order to determine the predictors of facial expression recognition ability at the discrete emotional level for sadness, anger, fear, and disgust, four hierarchical multiple regressions were conducted. To avoid duplicating results, a hierarchical multiple regression was not conducted for happiness, as these results were reflected in the regression for positive emotion. As such, refer to Table 4.8 for the results of the hierarchical multiple regression for happiness. As above, each hierarchical regression consisted of three steps, with the first including expressive suppression and cognitive reappraisal, the second step including subjective emotional experience and facial expressivity, and the third block including emotional concordance. See Table 4.9 for full details on each regression model, for each of the discrete emotions (happiness, anger, disgust, fear and sadness). For all discrete emotions the full hierarchical regression predicting the recognition of the corresponding emotion was not significant $F \leq 1.23$, $p \geq .285$.

Table 4.9

Summary of Hierarchical Multiple Regression Analyses for Variables Predicting Facial Expression Recognition of Discrete Emotions

		Anger				Disgust				Fear				Sadness			
		B	SE	β	Sr^2	B	SE	β	Sr^2	B	SE	β	Sr^2	B	SE	β	Sr^2
Step																	
	Constant	69.65	6.36			81.68	4.57			64.36	6.90			82.23	5.11		
	Suppression	1.14	1.53	.07	.005	-0.04	1.10	-.00	.000	-1.01	1.67	-.06	.003	0.38	1.23	.03	.001
	Reappraisal	-0.24	1.23	.02	.000	-1.68	0.88	-.18	.031	-2.08	1.34	-.15	.022	-1.70	0.98	-.16	.026
F		0.29				1.84				1.50				1.51			
R^2		.01				.03				.03				.03			
Step																	
	Constant	62.86	7.98			81.89	6.53			64.89	7.74			77.06	6.62		
	Suppression	1.28	1.55	.08	.006	0.02	1.17	.00	.000	-1.04	1.68	-.06	.003	0.64	1.26	.05	.002
	Reappraisal	-0.37	1.23	-.03	.001	-1.70	0.89	-.18	.032	-2.14	1.35	-.15	.023	-1.52	0.99	-.15	.020
	SEE	0.12	0.07	.16	.025	-0.01	0.05	-.03	.001	-0.01	0.07	-.01	.000	0.04	0.05	.07	.004
	FE	-0.90	3.52	-.03	.001	0.78	1.86	.04	.002	-4.97	6.18	-.08	.006	4.83	4.83	.10	.009
F		0.85				0.96				0.91				1.20			
R^2		.03				.03				.03				.04			

Step																
Constant	62.83	8.01			81.88	6.56			64.67	7.68			77.05	6.65		
Suppression	1.31	1.56	.08	.006	0.00	1.18	.00	.000	-1.10	1.67	-.06	.004	0.64	1.28	.05	.002
Reappraisal	-0.34	1.24	-.03	.001	-1.70	0.89	-.18	.032	-2.18	1.34	-.16	.023	-1.52	1.00	-.15	.020
SEE	0.12	0.07	.16	.026	-0.01	0.06	-.02	.000	0.02	0.07	.02	.001	0.04	0.06	.07	.004
FE	-0.32	4.16	-.01	.000	0.90	1.96	.05	.002	-8.23	6.45	-.13	.014	4.89	5.30	.10	.007
Concordance	-2.08	7.85	-.03	.001	-0.93	4.63	-.02	.000	10.25	6.34	.16	.023	-0.19	6.49	-.00	.000
F			0.69				0.77				1.27				0.95	
R^2			.03				.03				.06				.04	

General Discussion

Experiment 2 aimed to extend on the findings of Experiment 1 at the discrete emotion level. First, Experiment 2 aimed to reproduce the findings of Experiment 1 by examining facial expressivity, subjective emotional experience, facial expression recognition, emotional concordance, and emotion regulation at an overall emotion, positive valence, and negative valence level. Second, Experiment 2 aimed to determine the contribution of facial expressivity and subjective emotional experience to facial expression recognition at the discrete emotion level. Third, the role of emotional concordance in facial expression recognition was assessed at the discrete emotion level. Finally, Experiment 2 sought to determine the role of cognitive reappraisal and expressive suppression in facial expression recognition, subjective emotional experience, facial expressivity and emotional concordance for discrete emotions.

The first hypothesis predicting that facial expressivity and subjective emotional experience would act as significant, unique predictors of facial expression recognition of the corresponding discrete emotion was not supported by the results of the current study. Bivariate correlations revealed facial expression recognition was not significantly associated with the subjective experience of emotion, or facial expressivity at an overall, positive, negative, or discrete emotional level. For the recognition of happy facial expressions, this finding is unsurprising; recognition of happiness reaches an adult level by the age of 5 years (Horning et al., 2012; Rodger et al., 2015). Thus, it may be that the recognition of these emotions is not reliant on assistance from other emotion processes such as experience and expression. The current study demonstrated that there were significant, positive correlations between facial expressivity and subjective emotional experience in the film task at the overall level, positive, and negative emotion levels. When examined at the discrete level, these relationships were present for the expression and experience of happiness and disgust; people who endorsed higher intensity subjective emotional experience of happiness and disgust also demonstrated higher intensity facial expressivity of the corresponding emotions. These findings are consistent with (Ekman et al., 1980) reporting that people who experience higher intensity emotional experience demonstrate congruent facial expressivity. The association between facial expressivity and subjective emotional experience for happiness, disgust, and sadness in Experiment 2 may be because the clips selected for these emotions were more successful in provoking their target emotions than other clips. Indeed, results from the current study indicate that for happiness and disgust film clips, these emotions were rated unequivocally higher than all other emotions, indicating they were effective at eliciting the target emotion.

The second hypothesis that emotional concordance would contribute to facial expression recognition above and beyond facial expressivity was also unsupported. Results demonstrated that emotional concordance was not significantly associated with facial expression recognition at emotion level for any emotion. Furthermore, the addition of emotional concordance into the regression models did not significantly improve the model, demonstrating that emotional concordance does not contribute significantly to facial expression recognition. This is contrary to the findings in Experiment 1, which demonstrated that at an overall level, emotional concordance is a significant predictor of facial expression recognition. The failure in Experiment 2 to replicate the findings of Experiment 1 for emotional concordance highlights the need for future research to seek clarification of the nature of this relationship; is emotional concordance associated with facial expression recognition, or is it a process that was only coincidentally linked in Experiment 1? Previous research has demonstrated that the relationship between emotion components is associated with facial expression recognition abilities, with studies showing that an individual’s facial expression influences their experience of emotion, and our facial expressions and emotional experience also influence our emotion recognition ability (e.g., Davis et al., 2009; Lewis, 2012; Strack et al., 1988). Thus, it seems likely that the failure to replicate the emotional concordance findings of Experiment 1 may be associated with methodological approaches, rather than emotional concordance itself. It may be that the clips in Experiment 2 were more emotive, which may have reduced the variability needed to map individual differences in emotional concordance. The clips in Experiment 2 were selected based on their ability to provoke intense emotional responses, whereas the clips in Experiment 1 were selected to provoke a moderate emotional response and avoid ceiling effects. Therefore, it is possible that the clips in Experiment 2 provoked a higher intensity emotional response across all participants, in turn reducing the magnitude of individual differences in emotional concordance.

The final hypothesis that expressive suppression would have a significant relationship with facial expression recognition was supported by the results of Experiment 2. Correlational analyses demonstrated that greater suppression was significantly associated with decreased facial expression recognition ability at the overall emotion level. Furthermore, the results of Experiment 2 indicated that expressive suppression is a significant, negative predictor of facial expression recognition. The finding that there is a significant, negative relationship between expressive suppression and facial expression recognition at the overall level is novel. Correlational research has indicated that individuals who engage in greater expressive suppression have decreased memory for emotional interactions (Richards & Gross, 2000). The facial expression recognition task employed in both experiments required participants to indicate which emotion was shown after the face had disappeared from the screen, requiring a degree of recall from participants. Therefore, it may be the case that individuals who engaged in greater expressive suppression during the emotional film task, also demonstrated impaired recall of emotional facial expressions thus impeding their facial expression recognition ability.

The software used for measuring participant's facial expressions codes facial expressions multiple times per second during each film clip. Given the complexity of the data, a decision was made to average facial expressions across each film clips, producing a single score for each emotional expression for each film clip. This may have been problematic, as the emotional content of each film clip was not constant throughout the entire film clip. Given that the clips in Experiment 2 were selected based on their ability to provoke intense emotional responses, the emotional content may have been more climactic in nature, compared to the clips in Experiment 1. For example, the clip *Seven* was chosen to elicit fear, however the 1'48'' film clip does not reach its peak until 1'35''. Thus, averaging the measure of emotional expression across this clip would include time where participant's facial expressions are largely neutral (i.e., when there was not much emotional content in the clip). In comparison to Experiment 1, where the clips that were selected were less extreme in provoking emotion in an attempt to avoid ceiling effects (Koval et al., 2013), we may have seen a more consistent measure of facial expressivity, and thus emotional concordance. That is, by selecting clips that are higher in emotional intensity, we may be reducing the individual differences and variability necessary to replicate the relationships in Experiment 1.

To our knowledge, this study was the first to examine the relationship between facial expression recognition and expressive suppression in a healthy adult sample. Previous research in a clinical population has indicated that alexithymia may moderate the relationship between facial expression recognition and expressive suppression (Passardi et al., 2019). The current experiment examined the relationship between facial expression recognition and expressive suppression without accounting for the degree of alexithymia within the current sample. Alexithymia has been linked to poorer facial expression recognition skills in healthy populations (for a review, see Grynberg et al., 2012). In addition to this, individuals with greater alexithymia also tend to engage in greater use of expressive suppression as an emotion regulation strategy (Laloyaux et al., 2015; Preece et al., 2019). Thus, future research would benefit from including alexithymic traits in the regression model when assessing suppression and emotion recognition in healthy adults.

From the results of the current study, several avenues for future research emerge. This research has provided support for the facial feedback hypothesis with the finding that, in most cases, facial expressivity and subjective emotional experience were significantly correlated with each other. This study also demonstrated that emotional suppression may play a significant role in the recognition of emotion in others. However, what remains unclear is the role of emotional concordance in facial expression recognition. As discussed above, emotional concordance was computed by averaging facial expression across the duration of the film clip, including times where expression may be largely neutral. Future research would benefit from analysing facial expressions produced only for portions of the clips with maximal emotional content, providing the opportunity for more refined analyses. In addition to this, future research may benefit from adopting an emotion rating scale for rating emotion during the clips, as opposed to after. This may provide a more robust assessment of emotional concordance and its role in facial expression recognition. Further, this study provided evidence that there may be a predictive relationship between expressive suppression, and the recognition of facial expressions. Given the evidence of this relationship in an adult sample, further research may consider exploring in further by including a wider age bracket, to provide a comparison of age groups. Older adults are a population that have been identified to exhibit deficits in facial expression recognition across all discrete emotions (Ruffman et al., 2008). The inclusion of a greater age range would allow for the assessment of age-related differences in facial expression recognition and in the processes that are associated with emotion recognition (i.e., expressive suppression, or subjective emotional experience).

In summary, the results of the current study elucidate the roles that facial expressivity, subjective emotional experience, emotional concordance, cognitive reappraisal, and expressive suppression play in the recognition of emotional faces. At an overall level and negative level, this current study demonstrates that there are significant associations between the experience and expression of emotion, as well as the suppression and recognition of emotion. Both Experiment 1 and Experiment 2 uncovered novel findings for a relationship between expressive suppression and facial expression recognition across two samples of healthy, younger adults. Such knowledge relating to the traits associated with the recognition of emotion can be useful in future research assessing facial expression recognition across a number of different populations (e.g., older adults, children, and clinical populations).

Chapter 5: Age-Related Differences in the Experience of Emotion and Facial Expression Recognition.

Abstract

Ageing has been associated with changes across several emotion domains, including facial expression recognition, subjective emotional experience, facial expressivity, and emotion regulation. Given that simulationist theories of facial expression recognition suggest that our experience and expression of emotion is tightly linked to our ability to recognise emotional facial expressions, it is important to understand how age-related changes in these processes co-exist. Age-related differences in facial expression recognition, subjective emotional experience, facial expressivity, emotion regulation, and emotional concordance (i.e., the relationship between our experience and expression of emotion) are yet to be examined in a single cohort of older adults. As such, the current study aimed to examine age-related differences in facial expression recognition, subjective emotional experience, facial expressivity, emotional concordance, and emotional regulation in a sample of younger and older adults. Additionally, this study aimed to examine the relationship between these processes in older adults. Healthy younger (n = 42) adults aged 18 – 29 (M = 20.6, SD = 2.6) and older (n = 42) adults aged 60 – 84 (M = 68.87, SD = 7.5) watched emotion eliciting film clips while facial expressivity was simultaneously recorded and analysed using automated facial coding software. Subjective emotional experience ratings were provided after each film clip. Participants then completed a questionnaire reporting on their emotion regulation after the film task, indicating the extent to which they were actively regulating their experience and expression of emotions during the film task. Results indicated that older adults showed significant less facial expression recognition accuracy for fear and sadness, facial expressivity for all emotions, and emotional concordance for all emotions compared to their younger counterparts. Additionally, older adults indicated significantly greater subjective experience of anger and sadness than younger adults. Finally, there were no significant age-related differences in emotion regulation. This study was the first to examine these processes

concurrently, providing evidence that age-related changes in facial expression recognition co-occur with changes in the experience and expression of emotion. Additionally, this study was the first to examine age-related changes to emotional concordance, providing evidence that the relationship between the expression and experience of emotion decreases in older adulthood.

Introduction

The experience of emotions is imperative to our ability to function effectively in social situations, serving as the internal compass that helps us navigate the world around us (Carstensen et al., 2000; Ekman, 1993; Willis et al., 2011b). The experience of emotion is made up of expressive components (e.g., facial expressivity: the extent to which we express our emotions facially) and subjective experience components (e.g., feelings). Ageing is associated with changes across multiple emotion domains, including subjective emotional experience, emotional expression, emotion regulation, and facial expression recognition (e.g., Gross et al., 1997; Urry & Gross, 2010; Vieillard & Gilet, 2013). Given the ageing population, it is important to devote research to understanding the impacts of ageing on emotion processes in order to predict and identify deficits. It is well-established that the ability to accurately recognise facial expressions declines steadily with age, with neurotypical older adults (over 60-years) demonstrating poorer recognition compared to their younger counterparts (18-40 years; for a meta-analysis, see Ruffman et al., 2008). Changes in emotional experience are also observed in older adulthood, including diminished intensity of subjective emotional experience (Gross et al., 1997) and abnormalities in produced facial expressions (Vieillard & Gilet, 2013). Given that prominent models of facial expression recognition (e.g., Goldman & Sripada, 2005) suggest an important role for emotional experience in the process of facial expression recognition, investigating the different aspects of emotional experience (i.e., facial expressivity and subjective emotional experience) in a single study is needed to inform our understanding of the factors that may contribute to age-related declines in facial expression recognition and the context in which facial expression recognition difficulties are experienced.

Facial Expression Recognition in Older Adulthood

A meta-analysis conducted by Ruffman et al. (2008) summarised the age-related differences in facial expression recognition, revealing that older adults demonstrate significant impairments in the recognition of anger, fear, and sadness compared to their younger counterparts. Furthermore, older adults also displayed significantly poorer recognition of happiness, relative to their younger counterparts, although the effect size for this impairment was substantially smaller than the effect size observed for negative emotions. Interestingly, there were no significant differences in recognition between age groups for facial expressions of disgust (Ruffman et al., 2008). More recently, Hayes et al. (2020) reported that the dominant findings across the literature are that older adults demonstrate significant, age-related impairments in the recognition of disgust when accounting for stimulus-type. That is, older adults' preserved recognition of disgust is present with full-intensity photos of disgusted faces, with deficits present for reduced-intensity photographs, and dynamic videos (Hayes et al., 2020). Finally, it has been reported that there are no age-related changes in the recognition of surprised facial expressions, though this emotion is not exclusively positive or negative (Isaacowitz et al., 2007; Noordewier & Breugelmans, 2013). Given that the ability to recognise facial expressions of specific emotions follow different developmental trajectories in early life stages (i.e., the recognition of happy facial expressions reaches an adult level of accuracy by the age of 5, while the recognition of disgust and surprise continues to develop into adolescence; Horning et al., 2012), it is not surprising to see different, emotion-category dependent trajectories of age-related declines in facial expression recognition.

Facial Expression Production

There is evidence to support the existence of a so-called *positivity effect* in the experience of emotion in older adulthood. When expressing emotion via facial expressions, older adults tend to display more positive and less negatively-valenced facial expressions when compared to their younger counterparts (Smith et al., 2005; Vieillard & Gilet, 2013). Studies using facial EMG (a technique used to measure rapid and subtle changes in facial muscle activity; Neidenthal et al., 2001) to measure facial muscle activity in response to emotional music excerpts, film clips, and images have demonstrated that older adults exhibit greater zygomaticus major activation in response to negative stimuli, and diminished corrugator supercilii activity in response to all valenced stimuli, compared to younger adults (Smith et al., 2005; Vieillard & Gilet, 2013). Vieillard and Gilet (2013) suggest that older adults' propensity to produce positive facial expressions in response to negative stimuli may be an attempt to regulate their emotions. However, this tendency to display heightened positive facial expressions is not present when viewing stimuli of low arousal. When viewing happy, sad, and neutral film clips that were low in emotional intensity, there were no significant differences between younger and older adults' degree of facial expressivity (Steenhaut et al., 2018). Taken together, these results suggest that older adults tend to exhibit more positive and less negative facial expressivity regardless of the valence of stimuli, with such age-related effects only associated with stimuli that elicit strong emotional experiences. This is consistent with the notion that older adults produce positive facial expressions of emotion to regulate negative emotion; it could be that positive facial expressions are produced in response to higher intensity emotional stimuli as higher intensity emotional experiences require greater effort to regulate.

Subjective Emotional Experience

The experience of emotion is made up of both expressive (facial expressivity) and experiential (subjective emotional experience) components. As such, it is important to not only consider age-related changes in facial expressivity, but also consider age-related changes in the subjective experience of emotion. When assessing subjective experience at a broad level (e.g., overall emotion, positive affect, and negative affect), studies have suggested that age-related changes in the experience of positive emotion exhibits a U-shaped pattern, with decreasing intensity in the experience of positive affect between the ages of 18- and 50-years of age, but increasing positive affect thereafter (Grühn et al., 2010; Stone et al., 2010). That is, people between 18- and 50-years of age experience lower intensity positive affect than people who are above 50-years of age. Although the intensity of emotional experience can be operationalised in several ways, the literature presented below specifically focuses on self-reported subjective emotional experience ratings.

Research using excerpts of emotion-evoking music and film clips has indicated that older adults report feeling more positive than their younger counterparts for positive, negative, and neutral stimuli (Pearce & Halpern, 2015; Steenhaut et al., 2018; Vieillard & Gilet, 2013). At a valence level, older adults endorse greater pleasure than all other ratings when responding to pleasant, unpleasant and neutral images (Smith et al., 2005). At a discrete emotion level, studies investigating subjective experience to happy music and film clips has indicated that older adults report higher ratings of happiness compared to their younger counterparts (Steenhaut et al., 2018; Vieillard & Gilet, 2013). For the subjective experience of negative emotion, the research findings are less clear. At the valence level, cross-sectional studies indicate that the subjective experience of negative emotion declines after the age of 60-years, with older adults reporting lower average ratings of negative emotional experiences in general, compared to their younger counterparts (e.g., Grühn et al., 2010; Stone et al., 2010). However, when examining specific negative emotions (e.g., anger, sadness, fear, and disgust), the age-related differences are not as clear. For example, some studies have reported no age-related differences in the subjective experience of sadness, and fear in response to music excerpts (Vieillard & Gilet, 2013), and no age differences in ratings of sadness in response to a sad film-clip (Tsai et al., 2000). However, such findings may be a consequence of the nature of the stimuli used across these studies; it may be that the stimuli were not emotionally salient for older adults and thus did not elicit emotions to a meaningful extent. Specifically, Tsai et al. (2000) only used a single film clip to elicit sadness, which consisted of a young boy mourning the death of his father. As such, the content of this film clip may not emotionally resonate with older adults, failing to meaningfully elicit sadness. The importance of emotionally salient stimuli for eliciting sadness in older adults has been supported by a number of studies reporting that older adults report higher subjective experience of sadness compared to younger adults, particularly in response to scenes that were salient for older adults (e.g., Kliegel et al., 2007; Kunzmann & Grühn, 2005; Kunzmann & Richter, 2009; Seider et al., 2011). As such, it may be anticipated that older adults will report greater experience of positive emotion when compared to their younger counterparts, but this may be amplified by the content of the stimuli.

Collectively, these results suggest that there is a broad impact of ageing on the subjective experience of emotion, with older adults generally reporting an increase in the experience of positive emotion and a decrease in the experience of negative emotion (Grühn et al., 2010; Stone et al., 2010). When examining specific negative emotions, these findings suggest that the experience of negative emotion does not seem to mirror the age-related declines reported for facial expression recognition and facial expression production. Conversely, the subjective experience of happiness (a positive emotion) seems to coincide with age-related increases in facial expressivity of positive emotion reported in older adulthood, as it shows an increase with age.

Emotional Concordance

In addition to reviewing the experience of emotion, and the expression of emotion as individual components of emotion, it is important to review evidence for the relationship between these components. Recently, Lougheed et al. (2021) highlighted the importance of assessing emotional concordance (and discordance), suggesting that it provides a more robust assessment of emotional experience. That is, if we only measure one component of emotion at a time (e.g., subjective emotional experience ratings), we are missing crucial information about how these components of emotional experience relate to each other (Lougheed et al., 2021). In younger adults, it has been established that higher levels of facial expressivity for a particular emotion are associated with higher intensity subjective experience of the corresponding emotion (Adelmann & Zajonc, 1989; Mauss et al., 2005). The degree to which facial expressivity and subjective emotional experience relate to each other is referred to as emotional concordance (Mauss et al., 2005). There is a scarcity of research devoted to emotional concordance, though attention to this aspect of emotion is increasing. Mauss et al. (2005) examined the relationship between behavioural (i.e., facial expressions) and experiential (i.e., feelings) responses during an emotional film task. Results indicated that there is an association between behavioural and experiential components of emotion. However, this was established in a sample of younger adults, with an average age of 19 years.

Emotional concordance has not yet been examined in a sample of older adults. Thus, it remains unclear whether the relationship between the components of emotional experience (i.e., facial expressivity and subjective emotional experience) undergo the same age-related changes as these components do individually. As such, the assessment of age-related changes in emotional concordance may assist in understanding whether the age-related changes in the experience and expression of emotion are also observed in the relationship between these components of emotional experience. As discussed above, older adults display a significant increase in the production of positive facial expressions, and no significant, age-related differences in the production of negative facial expressions (Steenhaut et al., 2018; Vieillard & Gilet, 2013). In addition to this, older adults tend to report an increase in the experience of positive emotion, and a significant decrease in the experience of negative emotion (Grühn et al., 2010; Smith et al., 2005; Stone et al., 2010). Given that age-related changes in facial expressivity and subjective emotional experience fluctuate in different ways, is there a weaker relationship between facial expressivity and subjective emotional experience in older adulthood compared to younger adults? To our knowledge, this study will be the first to address this question.

Emotion Regulation

As discussed in previous sections, the experience of emotion involves feelings (i.e., subjective emotional experience), and the outward expression (i.e., facial expressivity) of the emotion. As such, an important consideration in the assessment of age-related changes in emotion is the extent to which older adults employ strategies to regulate their subjective experience and facial expression of emotions. It may be that the extent to which older adults regulate their emotional experiences is associated with the age-related changes we see in other domains, such as subjective emotional experience, facial expressivity and facial expression recognition. Gross (1998) defines emotion regulation as a way of manipulating the emotions we experience in particular situations, and the way in which we express and experience these emotions. The use of emotion regulation strategies in older adulthood are an important consideration as they may account for some of the age-related differences in the expression and experience of emotion. Two commonly employed emotion regulation strategies include cognitive reappraisal and expressive suppression. Reappraisal refers to the processes by which we construe an emotion-eliciting situation in non-emotional terms, while suppression is a response modulation technique used to inhibit the outward expression of an emotion (Gross, 2002). Older adults are thought to typically engage in emotion regulation strategies that maintain positive emotional experience and limit negative experiences (Charles & Carstensen, 2007). Compared to younger adults, the use of emotion regulation strategies in older adults differs in two key ways: (1) type of regulation strategy adopted; and

(2) effectiveness in regulating emotional responses. Older adults use the suppression regulation strategy less frequently than younger adults, though when using it they are similarly effective in reducing the outward expressions of emotion (John & Gross, 2004; Phillips et al., 2008; Shiota & Levenson, 2009). On the other hand, older adults are more likely to adopt reappraisal, focussing their thoughts away from the aversive stimuli, though their attempts at reappraisal are less successful than their younger counterparts (Charles & Carstensen, 2008; Opitz et al., 2012)

Theories Explaining Age-Related Changes in Emotion Recognition and Emotional Experience

Despite the limited research examining the co-occurrence of age-related changes in emotional experience and expression, some theories exist that explain and predict the pattern of results in this domain. The *Socioemotional Selectivity Theory* (Carstensen, 2006) is a theory that explains changes in motivation across the lifespan, that has been used to account for age-related changes in facial expression recognition. This theory posits that we are driven by two types of goals that we work towards across the lifespan: (1) Knowledge and information-based goals; and (2) Goals that focus on emotional life, aiming to derive meaning and invest in activities that hold emotional significance (Carstensen, 2006). As we age, due to the salience of mortality (Carstensen, 1992, 2006; Carstensen et al., 1999), individuals become increasingly aware of their reduced life expectancy. This awareness contributes to a shift in importance, assigning greater weight to emotional goals (as opposed to knowledge and information-based goals) so that experiences are more emotionally important and bring about a sense of satisfaction (Charles & Carstensen, 2007). In essence, the perception of limited future time shifts older adults' motivational goals towards increasing short term positive emotional experiences, and avoiding negative emotional experiences, in an attempt to maintain emotional well-being. To apply this theory to the age-related changes in facial expression recognition, older adults demonstrate a tendency to attend more to positive than negative emotional stimuli, in an attempt to maintain emotion regulation and well-being; a phenomenon known as the *positivity effect* (Carstensen & Mikels, 2005). Scheibe and Carstensen (2010) suggest that less attention to negative stimuli leads to a positivity effect in facial expression recognition, leading to poorer recognition of negative facial expressions. That is, in older adults' poorer recognition of negative emotional facial expressions may be attributed to the decreased attention to negative stimuli in favour of positive ones (Carstensen & Mikels, 2005; Scheibe & Carstensen, 2010).

A key criticism of the *Socioemotional Selectivity Theory* is that the *positivity effect* is not observed in the recognition of all negative emotions (Ruffman et al., 2008). Specifically, older adults show no significant impairments in disgust when compared to their younger counterparts (Ruffman et al., 2008). There are two prominent explanations for the preserved recognition of disgust in older adulthood. First, Ruffman et al. (2008) suggest that an alternative explanation for the selective deficits of the recognition of sadness, anger and fear is that age-related decreases in facial expression recognition ability, may be attributed to age-related changes in the brain (Ruffman et al., 2008). It has been well-documented that adult ageing causes overall degeneration of the brain, with noted age-related changes to the frontal and temporal regions (Bartzokis et al., 2001; Raz et al., 2005). Ruffman et al. (2008) suggest that the age-related changes in facial expression recognition may be due to these observed changes in the frontal and temporal brain regions. For example, while the brain regions that underpin the recognition for disgust (i.e., the basal ganglia) remain intact in older adulthood, the brain regions that have been implicated in the recognition of anger (i.e., the orbitofrontal cortex), sadness (i.e., the cingulate cortex), and fear (i.e., the amygdala; Ruffman et al., 2008) deteriorate with age. The second proposed explanation focuses on the observation that, compared to younger adults, older adults demonstrate differences in eye-gaze when attending to facial expressions. Eye-gaze analysis has revealed that older adults attend more to the mouth region, while younger adults attend more to the eye area during facial expression recognition tasks (Sullivan et al., 2007; Wong et al., 2005). Given that happy, surprised, and disgusted facial expressions involve the mouth as a key facial feature that convey these expressions, particularly in static presentations, this may make them easier for older adults to recognise in comparison to sadness, fear, and anger that show more pronounced deficits.

Another theory that attempts to explain age-related changes in emotion regulation and emotional experience is the *Selection, Optimisation, and Compensation with Emotion Regulation Framework* (SOC-ER; Urry & Gross, 2010). This framework suggests that people choose specific emotion regulation strategies as an indication of available cognitive resources (i.e., internal and external capabilities; Urry & Gross, 2010). It may be that older adults are less successful in employing cognitive reappraisal in regulating their experiences of negative emotion because of a depletion in cognitive resources as a result of age-related changes in the brain (Opitz et al., 2012). Age-related differences in the employment of emotion regulation strategies is an important consideration in the assessment of emotional experience in older adulthood as they can influence the expression and the subjective experience of emotion (Gross, 2002). What is yet to be explored is whether emotion regulation is associated with other emotion processes (e.g., emotion concordance and facial expression recognition ability) in older adults.

Limitations of Previous Research in Relation to Understanding Emotional Experience and Emotion Recognition

No studies have assessed age-related changes in subjective emotional experience, facial expressivity, and facial expression recognition in a single sample. However, some studies have assessed facial expressivity and/or subjective emotional experience and facial expression recognition in some clinical populations including Parkinson's Disease and traumatic brain injury. Findings suggest that diminished facial expressivity and subjective emotional experience co-exist with diminished facial expression recognition (Ricciardi et al., 2017; Wearne et al., 2019). Given that facial expressivity and emotional experience have ties to facial expression recognition ability (e.g., Goldman & Sripada, 2005), a question of interest is whether we see comparable age-related declines in these processes, as well as emotion regulation, and emotional concordance? That is, do we see similarities in age-related changes in the way we recognise, experience, express, and regulate our own emotions in older adulthood? To date, the assessment of age-related changes in the experience of emotion (i.e., facial expressivity and subjective emotional experience) have only been assessed in a limited number of emotion categories (e.g., happiness, sadness, and fear), with inconsistencies across the findings. For example, Steenhaut et al. (2018) found no significant age-related differences in facial expressivity when viewing stimuli that are low in emotional intensity. Furthermore, older adults tend to report higher intensity emotional experience when exposed to stimuli that are emotionally salient to them (e.g., Kliegel et al., 2007). The discrepancies across emotional experience findings could be attributed to the type and intensity of the stimuli adopted in provoking an emotional response. For example, discrepant findings may be ascribed to different arousal levels of stimuli, or different methods of coding facial expressions (e.g., facial EMG, human coders).

In addition to this, the current literature is missing the simultaneous assessment of emotion components and emotion-related skills (i.e., facial expression recognition, facial expressivity, subjective emotional experience, emotional concordance, and emotion regulation) in the same sample of older adults. To provide clear evidence of how age-related differences in facial expressivity, subjective emotional experience and emotion regulation coincide with age-related changes in facial expression recognition these processes should be investigated within the same study to reduce the risk of cohort effects. The two main question to address are: (1) do we see the reported deficits in these four processes in the same sample? (2) are these deficits related?

The current study aimed to investigate the age-related differences in the experience of emotion (i.e., facial expressivity and subjective emotional experience), emotional concordance, emotion regulation, and facial expression recognition in a sample of older and a sample of younger adults. Healthy younger and older adults completed the emotional film task used in Study One, Experiment 2 (Chapter 4), watching emotion-provoking film clips and providing self-report ratings of emotion post clip. In order to measure the degree to which these processes relate to facial expression recognition, participants also completed a facial expression recognition task. To determine the degree to which these processes relate to emotion regulation, participants completed a questionnaire after completing the film task which asked participants to indicate the extent to which they were actively regulating their experience and expression of emotions. Based on the literature reviewed above (e.g., Ruffman et al., 2008), it was predicted that older adults would display poorer recognition of happy, angry, fearful, and sad facial expressions, compared to their younger counterparts. However, it was anticipated that there would be no significant difference in the recognition of disgust between older and younger adults. Given that older adults tend to report greater subjective experience of happiness than their younger counterparts, but no age-related differences in negative emotion (Vieillard & Gilet, 2013), it was also predicted that older adults would report significantly higher subjective experience of happiness, compared to younger adults, but there would be no age-related differences in the experience of negative emotions (i.e., anger, sadness, fear, and disgust). Previous research has indicated that older adults produce significantly more positive facial expressions and significantly less negative facial expressions than their younger counterparts (Vieillard & Gilet, 2013). As such, it was predicted that older adults would display greater facial expressivity of positive emotion (i.e., happiness), and less facial expressivity of negative emotion (i.e., anger, sadness, fear, and disgust), compared to their younger counterparts. Given the reported age-related changes in both facial expressivity, and subjective emotional experience, it was anticipated that older adults would demonstrate significantly lower levels of emotional concordance compared to their younger counterparts, due to the age-related fluctuations in both components of emotional concordance. Finally, it was anticipated that older adults would report greater use of emotion regulation strategies for negative stimuli (i.e., suppression and reappraisal), compared to younger adults. However, given that there are age-related differences in the use and success of emotion regulation (e.g., Opitz et al., 2012), it is anticipated that their emotion regulation attempts would be less successful than younger adults. That is, it was expected that for older adults, there would be no significant relationship between their reported use of emotion regulation, and their experience and expression of emotion. A secondary aim of the current study was to examine the relationships between facial expression recognition, subjective emotional experience, facial expressivity, emotional concordance, and emotion regulation (reappraisal and suppression) in the sample of older adults. In order to address this aim, bivariate correlations were estimated between these processes to examine whether the deficits in facial expression recognition in older adults are related to potential changes in other emotion processes. It was anticipated that decreased accuracy of facial expression recognition ability would be associated with decreased intensity emotional experience and decreased facial expressivity.

Method

The method for Study 2 was the same as that of Experiment 2 in Study 1 (Chapter 4), with the exception of the sample of participants, and the addition of a screening questionnaire for dementia. The demographic questionnaire, post-film questionnaire, emotion recognition tasks, and data processing steps were the same as described in Experiment 2, Study 1.

Participants

The final samples of participants comprised 42 younger adults whose ages ranged from 18 – 29 years (64.3% female), and 42 older adults with ages ranging from 60 – 84 years (64.3% female). The sample of younger adults was a random subset of participants in Experiment 2, Study 1 in Chapter 4 of this thesis. Independent samples t-tests were conducted to determine the degree to which the sample of younger adults matched the sample of older adults. Results indicated that older adults reported significantly more years of education than younger adults, $t(67.06) = 2.30$, $p = .025$, but did not significantly differ for scores on the Test of Premorbid Functioning (TOPF), $t(81) = 1.57$, $p = .120$. Descriptive statistics for education and TOPF scores, and the descriptive statistics for age for both younger and older adults are presented in Table 5.1. Older adults were recruited from the wider community and were compensated with an AUD$20 gift voucher for their time. Exclusion criteria for the current study included a reported history of developmental, psychological and/or neurological conditions, and non-normal or not corrected-to-normal vision and hearing. No participants were excluded on these bases. For older adults, exclusion criteria also included suspected dementia, as assessed by the ACE-III. See Dementia Screening for details.

Table 5.1

Means and Standard Deviations for Matching Criteria for Younger and Older Adults

	Younger Adults *M (SD)*	Older Adults *M(SD)*
Age	20.6 (2.6)	68.7 (7.5)
Years Education	13.7 (1.5)	14.7 (2.4)
TOPF Score	102.3 (12.3)	106.8 (13.8)

Sample Size Justification

The primary analyses for the current study were a series of two-way mixed factorial ANOVAs. As such, power analyses were conducted using the pwr2 package in R version 1.3.1073 to determine the sample size necessary for observing a moderate effect size (${\eta_p}^2 \geq$ .25) for both factors, with 80% power and α = .05. Results indicated that at least 20 participants in each group would be necessary to achieve these parameters. To be conservative, we recruited 42 participants in each group, giving us 80% power to find an effect size of ${\eta_p}^2 \geq .25$.

Measures

Dementia Screening

The Addenbrooke's Cognitive Examination III (ACE-III) was administered to older participants to screen for dementia. This is a brief, valid measure for assessing cognitive functioning, and is significantly correlated with standardised neuropsychological tests (Hsieh et al., 2013). The ACE-III assesses three cognitive domains: attention, language, verbal memory and visuospatial function. Normal cognitive functioning is determined by a score above 82. For the final sample, scores ranged from 83– 99 (*M* = 90.9, *SD* = 5.4). Two older adults were not included in the final sample as they scored below the cut off (excluded scores were 78 and 81).

Procedure

The procedure for Study 2 was the same as that of Study 1, Experiment 2 (Chapter 3), with the addition of the ACE-III. For older adults, the ACE-III was completed at the beginning of the session, after providing written informed consent. Following this, the procedure was the same as outlined in Study 1, Experiment 2.

Data Processing

Facial expression recognition, subjective emotional experience, facial expressivity, emotional concordance and emotion regulation scores were all calculated using the same method as outlined in Study 1, Experiment 2.

Statistical Analyses

To assess age-related differences for each dependent variable at a discrete emotion level, a series of two-way mixed factorial ANOVAs were conducted, with the between subjects factor of Age Group (younger, older) and the repeated measures factor of Emotion (anger, disgust, fear, happiness, and sadness) on each dependent measure (suppression, reappraisal, facial expression recognition, subjective emotional experience, facial expressivity, and emotional concordance). Normality was assumed for each of the analyses as ANOVA is robust to violations of normality with sample sizes over 30 ($n = 84$; Field, 2009). For all ANOVAs, where sphericity was violated a Greenhouse-Geisser correction was applied. Significant Age-Group × Emotion interactions were explored using simple main effects analyses (Bonferroni corrected) comparing the two age groups at each level of emotion.

To examine the relationships between emotion regulation (suppression and reappraisal), subjective emotional experience, facial expressivity, emotional concordance, and facial expression recognition in older adults, a series of Spearman's bivariate correlations were estimated at an overall, and discrete emotion level. Spearman's rho was conducted to account for violations to normality, to minimise the effects of extreme scores. Visual inspection of scatterplots for each correlation revealed that the assumption of monotonic relationships was satisfied. The p-values for correlations were not adjusted to control for the number of correlations as there were specific, directional predictions for several of the correlations. Furthermore, hierarchical multiple regressions were not conducted to determine the predictors of facial expression recognition in older adulthood given the sample size.

Results

Missing Data

As emotional concordance is calculated by estimating bivariate correlations between subjective emotional experience and facial expressivity, concordance could not be computed when participants had no variability in subjective emotional experience ratings. There were three participants with a lack of variability across at least one emotion category: fear (3 cases), anger (1 case), and sadness (1 case). Thus, for emotional concordance, there were 3 cases where overall emotional concordance could not be computed.

Age-Related Differences

Descriptive statistics for facial expression recognition accuracy, subjective emotional experience, facial expressivity, emotional concordance, and emotion regulation (suppression and reappraisal) at the overall level are presented in Table 5.2. The descriptive statistics for facial expression recognition, subjective emotional experience, facial expressivity, and emotional concordance for each discrete emotion are summarised in Figure 5.1. As emotion regulation was measured at the valence level (i.e., positive, and negative emotion), descriptive statistics for suppression and reappraisal were not included in Figure 5.1. To establish whether emotional concordance was significantly difference from 0 for both younger and older adults, a series of one-samples *t*-tests were conducted. Emotional concordance was significantly different from 0 for both older and younger adults at the overall level, ts ≥ 7.39, ps $< .001$. For discrete emotions, emotional concordance was significantly different from 0 for both younger and older adults for all emotions ts ≥ 2.74, $ps \leq .009$, with the exception of fear for both age groups ts ≤ 1.03, ps $\geq .307$.

Table 5.2

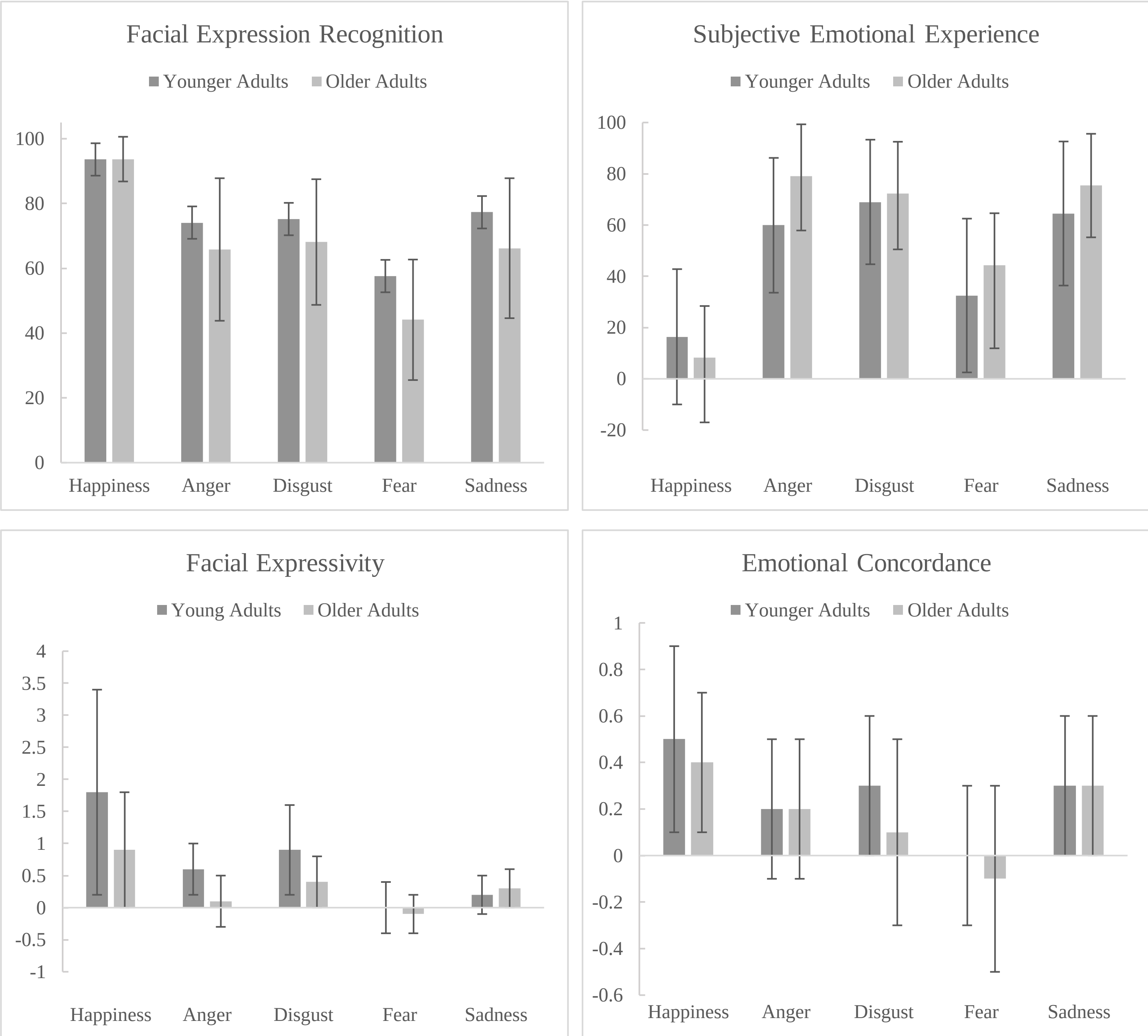
Means and Standard Deviations for Facial Expression Recognition, Subjective Emotional

Experience, Facial Expressivity, Emotional Concordance, Suppression and Regulation at Overall Level for Older Adults and Younger Adults

	Younger Adults *M*(*SD*)	Older Adults *M*(*SD*)
Facial Expression Recognition	75.6(10.4)	67.6(11.6)
Subjective Emotional Experience	16.5(11.2)	26.4(11.7)
Facial Expressivity	0.2(0.3)	0.0(0.2)
Emotional Concordance	0.3(0.2)	0.2(0.2)
Suppression	3.0(1.0)	3.2(1.1)
Reappraisal	2.8(1.0)	2.9(1.4)

Figure 5.1

Means and Standard Deviations for Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity and Emotional Concordance for Younger and Older Adults for Discrete Emotions



Facial Expression Recognition

Results of a two-way mixed ANOVA indicated that there was a significant main effect of emotion on facial expression recognition ability, $F(3.76, 305.81) = 87.29$, $p < .001$, $\eta_p{}^2 = .52$, indicating that facial expression recognition accuracy varied depending on the type of emotion displayed. Happy faces were recognised significantly more accurately than all other emotions, ts(82) ≥ 10.97, $p < .001$, ds ≥ 1.49. Recognition of fearful faces was lower than all other emotions, ts(82) ≥ 7.59, $p < .001$, ds ≥ 0.92. There was no significant difference in the recognition of sadness, anger, and disgust, ts(82) ≤ 0.76, $p \geq .452$, ds ≤ 1.05. The ANOVA results revealed that there was a significant main effect of Age Group, $F(1, 81) = 10.92$, $p = .001$, $\eta_p{}^2 = .12$, indicating that, averaged across emotions, older adults were significantly less accurate in recognising facial expressions than younger adults. There was also a significant Age Group × Emotion interaction, $F\ (3.76, 305.81) = 2.56$, $p = .042$, $\eta_p{}^2 = .03$. Follow-up tests indicated that older adults were significantly less accurate recognising fearful, $t(91) = 2.34$, $p = .022$, $d = 0.48$, and sad facial expressions, $t(91) = 2.17$, $p = .032$, $d = 0.45$, compared to their younger counterparts There was no significant difference between the two groups in the recognition of happy ($p = .647$), angry ($p = .415$) and disgusted faces ($p = .089$).

Subjective Emotional Experience

Results from a two-way mixed ANOVA revealed that there was a significant main effect of emotion on subjective emotional experience, $F(3.10, 254.27) = 129.85$, $p < .001$, $\eta_p{}^2 = .61$, indicating that intensity of subjective emotional experience varied depending on the emotion category. Follow-up analyses indicated that happiness was experienced with the lowest intensity, compared to all other emotions, ts(83) ≥ 5.93, p ≤.001, ds ≥ 0.90. Fear was experienced with significantly lower intensity than all other negative emotions, ts(83) ≥ 9.22, p ≤. 001, $d \geq 1.08$. There was no significant difference in the experience of anger, sadness and disgust, $ts(83) \leq 0.31$, $ps \geq .645$, $ds \leq 0.05$. Results from the ANOVA also indicated that there was no significant main effect of age group on emotional experience, $F(1, 82) = 3.67$, $p = .059$, $\eta_p{}^2 = .04$, indicating that the intensity of emotional experience did not differ significantly between older and younger adults. There was a significant Age Group × Emotion Interaction, $F(3.28, 268.65) = 5.11$, $p = .001$, $\eta_p{}^2 = .06$. Follow-up analyses revealed that compared to younger adults, older adults reported significantly more intense subjective experience of anger, $t(82) = 3.68$, $p < .001$, $d = 0.98$, and sadness, $t(82) = 2.05$, $p = .044$, $d = 0.60$.

Facial Expressivity

Results indicated that there was a significant main effect of emotion category on facial expressivity, $F(1.85, 151.30) = 60.72$, $p < .001$, $\eta_p{}^2 = .43$, suggesting that intensity of emotional expression varied depending on the emotion category. Follow-up analyses indicated that happiness was expressed greater than all other emotions, $ts(83) \geq 5.42$, $p < .001$, $ds \geq 0.99$. Fear was expressed significantly less than all other emotions, $ts(83)$ 4.93, $p < .001$. Facial expressivity of disgust was significantly greater than all other negative emotions, $ts(83) \geq 4.31$, $p < .001$, $ds \geq 0.65$. Finally, facial expressivity of anger was significantly greater than sadness, $t(83) = 3.62$, $p = .001$, $d = 0.54$. The ANOVA also revealed that there was a significant main effect of age group on facial expressivity, $F(1, 82) = 27.51$, $p < .001$, $\eta_p{}^2 = .25$, indicating that older adults displayed less facial expressivity. In addition to these significant main effects, there was also a significant Age Group × Emotion interaction, $F(1.85, 151.30) = 4.95$, $p = .010.$, $\eta_p{}^2 = .06$. Follow-up analyses revealed that older adults were significantly less expressive than their younger counterparts across all emotions, $t(91) \geq 2.02$, $p \leq .048$, $ds \geq 0.31$.

Emotional Concordance

Results from a two-way mixed ANOVA indicated that there was a significant main effect of emotion on participants' level of emotional concordance, *F* (3.54, 279.68) = 28.63, $p <$ .001, $\eta_p{}^2$ = .27, suggesting that the degree to which participants' emotional concordance varied depending on emotion category. Concordance for happiness was significantly higher than all other emotions, *t*s ≥ 3.97, p < .001, *d*s ≥ 0.46. Additionally, concordance for fear was significantly lower than all other emotions, *t*s ≥ 4.82, *p* < .001, *d*s ≥ 0.75. There was no significant difference in concordance for sadness, anger, and disgust, *t*s ≤ 2.51, *p* ≥ .093, *d*s ≤ 1.09. There was also a significant main effect of age group on emotional concordance, *F* (1, 79) = 4.91, *p* = .030, $\eta_p{}^2$ = .06, indicating that older adults experience significantly less emotional concordance across all emotions than younger adults. There was no significant Age Group × Emotion interaction, *F* (3.54, 279.68) = 1.47, *p*= .219, $\eta_p{}^2$ = .02.

Emotion Regulation

For overall emotion, results from an independent samples t-tests indicated that there was no significant age-related differences in the employment of emotion regulation strategies (suppression and reappraisal), *ts* (82) ≤ .291, *ps* ≥ .505, *d*s ≤ 0.11. For positive emotion, there were no significant age-related differences in the use of suppression (Older adults: *M* = 2.7, *SD* = 1.5; Younger adults: *M* = 2.6, *SD* = 1.1) and reappraisal (Older adults: *M* = 2.9, *SD* = 1.2; Younger adults: *M* = 2.9, *SD* = 1.2), *t*s (82) ≤ 0.25, *p*s ≥ .802, *d*s ≤ 0.07. Additionally, for negative emotion, there were no significant, age-related differences in the use of suppression (Older adults: *M* = 3.0, *SD* = 1.3); Younger adults: *M* = 2.9, *SD* = 1.2) or reappraisal (Older adults: *M* = 3.5, *SD* = 1.4; Younger adults: *M* = 3.2, *SD* = 1.2), *t*s (82) ≤ 0.27, *p*s ≥ .354, *d*s ≤ 0.16.

Relationships Between Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity, Concordance, and Regulation for Older Adults

Bivariate correlations for older adults are summarised in Table 5.3. There was a significant, negative correlation present between facial expression recognition and subjective emotional experience. Thus, older adults who reported higher intensity emotional experience performed worse on the facial expression recognition task at an overall level than those with lower intensity emotional experience.

Table 5.3

Bivariate Correlations for Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity, Emotional Concordance, Suppression and Reappraisal for Older Adults for Overall Emotion.

	1.	2.	3.	4.	5.	6.
1. Facial Expression Recognition	-	-.40*	.05	-.05	-.11	-.09
2. Subjective Emotional Experience		-	-.06	.09	-.05	.05
3. Facial Expressivity			-	.25	-.22	.02
4. Emotional Concordance				-	.10	-.24
5. Suppression					-	.21
6. Reappraisal						-

Discrete Emotions

Bivariate correlations at the discrete emotion level for older adults are summarised in Table 5.4. For *happiness*, the only significant correlation observed was a negative correlation between happy facial expressivity and the suppression of positive emotions, indicating that lower happy facial expressivity was associated with greater suppression.

With regard to *anger*, there was a significant, negative correlation between the subjective emotional experience of anger and the use of reappraisal. Such that older adults who reported lower intensity experience of anger also reported engaging in greater use of reappraisal to regulate their emotions. In addition to this, there was also a significant, negative correlation between the subjective emotional experience of anger, and anger facial expressivity. As such, older adults who reported higher subjective experience of anger demonstrated lower facial expressivity of anger.

For *disgust, fear*, and *sadness*, there was a significant, positive correlation between facial expressivity and emotional concordance. In addition to this, there was a significant, negative correlation between facial expressivity and reappraisal for *disgust*. Such results indicate that greater facial expressivity of disgust was associated with decreased use of reappraisal.

Table 5.4

Bivariate Correlations for Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity, Emotional Concordance, Suppression and Reappraisal for Older Adults for Discrete Emotions

Variable	1.	2.	3.	4.	5.	6.
Happiness						
1. Facial Expression Recognition	-	-.18	-.00	-.04	-.05	-.07
2. Subjective Emotional Experience		-	.16	.29	-.16	.07
3. Facial Expressivity			-	.20	-.33*	.02
4. Emotional Concordance				-	-.22	.07
5. Positive Suppression					-	.10
6. Positive Reappraisal						-
Anger						
1. Facial Expression Recognition	-	-.05	.00	-.10	-.15	.01
2. Subjective Emotional Experience		-	-.36*	-.05	-.22	-.40**
3. Facial Expressivity			-	.53**	.14	.22

4. Emotional Concordance				-	-.03	.13
5. Negative Suppression					-	.28
6. Negative Reappraisal						-
Disgust						
1. Facial Expression Recognition	-	-.00	.03	-.02	-.05	.11
2. Subjective Emotional Experience		-	.19	.22	.08	.03
3. Facial Expressivity			-	.49**	-.21	-.31*
4. Emotional Concordance				-	-.08	-.01
5. Negative Suppression					-	.28
6. Negative Reappraisal						-
Fear						
1. Facial Expression Recognition	-	-.10	-.08	-.05	-.02	.01
2. Subjective Emotional Experience		-	.12	.04	-.04	.00
3. Facial Expressivity			-	.47**	.00	.02
4. Emotional Concordance				-	.13	-.30
5. Negative Suppression					-	.28
6. Negative Reappraisal						-
Sadness						
1. Facial Expression Recognition	-	-.17	.02	.03	-.14	-.13
2. Subjective Emotional Experience		-	-.01	.01	-.23	-.08
3. Facial Expressivity			-	.39*	-.25	-.16
4. Emotional Concordance				-	-.20	.15
5. Negative Suppression					-	.28
6. Negative Reappraisal						-

Discussion

The primary aim of the current study was to concurrently examine the age-related differences in facial expression recognition, the experience of emotion (i.e., facial expressivity and subjective emotional experience), emotional concordance, and the use of emotion regulation strategies. Regarding the primary aim, older adults displayed significantly poorer facial expression recognition ability, performing significantly worse than younger adults in the recognition of fearful and sad expressions, but not other negative emotions. Such findings provide partial support for the hypothesis. Contrary to predictions, despite performing worse than younger adults, older adults were not significantly different in their recognition of happy and angry facial expressions. In line with predictions, there were no age-related differences in the recognition of disgusted facial expressions. Findings for an age-related decline in the recognition of fear and sadness are consistent with previous findings of age differences between younger and older adults in the literature (Ruffman et al., 2008). However, the lack of age-related differences in the recognition of anger is not consistent with previous research (Ruffman et al., 2008). Though the findings for the recognition of happiness were unexpected, they were not surprising. A meta-analysis found that older adults possess a reduced ability to recognise facial expressions of happiness, however the effect size for this difference was markedly smaller in comparison to the age differences found for other emotions (Ruffman et al., 2008). Age-related differences in the recognition of happy facial expressions has not been reliably demonstrated across a range of studies, with several studies reporting no age-related differences in the recognition of happy faces (Sullivan & Ruffman, 2004a, 2004b; Ziaei et al., 2021). The lack of age-related differences in the recognition of disgusted facial expressions was in line the current study's predictions, and previous research (Ruffman et al., 2008). It has been established that older adults' recognition of disgust remains intact into older adulthood when responding to full-intensity stimuli (e.g., Ruffman et al., 2008; Hayes et al., 2020). The lack of age-related differences in the recognition of disgust and happiness may be explained by differences in eye-gaze between younger and older adults. Older adults attend more to the mouth region, while younger adults devote greater attention to the eye region during facial expression recognition tasks (Sullivan et al., 2007; Wong et al., 2005). Given that happiness and disgust involve the mouth as a key facial feature that conveys these emotions in static presentation, eye-gaze may explain the lack of age-related differences in recognition for these expressions.

The experience of emotion in the current study was examined in two ways: (1) facial expressivity, and (2) ratings of subjective emotional experience. In regard to facial expressivity, older adults were found to produce significantly less facial expressivity across all emotions compared to their younger counterparts. Such findings provide partial support for the prediction that older adults would report significantly less expressivity for negative emotion, but greater expressivity of positive emotion (i.e., happiness). The findings for reduced expression of negative affect are consistent with facial EMG findings that older adults display significantly reduced facial muscle movement for negative facial expressions in response to unpleasant images (Smith et al., 2005). However, the finding that older adults also demonstrated reduced facial expressivity of happiness is not consistent with predictions, or previous research (Steenhaut et al., 2018; Vieillard & Gilet, 2013). Previous studies have reported that older adults exhibit either an increase in the expression of happiness (Vieillard & Gilet, 2013), or no age differences at all (Steenhaut et al., 2018; Tsai et al., 2000). One possible explanation for the differing results between the current study and previous research is a variation in methodology. Vieillard and Gilet (2013) reported that older adults demonstrate increased positive facial expressivity compared to their younger counterparts when listening to excerpts of scary music. However, the current study used film clips that were validated to produce happiness. Another study reported no significant age differences in the expression of happiness when using human coders to code facial movements (Tsai et al., 2000). The discrepant findings between Tsai et al. (2000) and the current study may be because the current study used computer software that automatically detects and codes facial expressivity. The use of computer coding software is advantageous for analysing the facial muscle movements of older adults as it may be more likely to detect the subtle muscle movements that are masked by the reduced elasticity of the skin. Thus, the use of such software diminishes the degree of subjectivity that is associated with human coders as it is more sensitive to subtle facial muscle movements than the naked eye (Kulke et al., 2020; Stöckli et al., 2018). As such, it may be the case that the current study found an age-related decrease in positive facial expressivity as computer coding software was used capturing subtle facial muscle movements.

The second measurement of emotional experience in the current study was the subjective ratings of emotional experience from participants. Contrary to hypotheses, results demonstrated that older adults reported significantly greater intensity experience of sadness and anger, with no age-related differences for any other emotions. These findings differ from previous research reporting that older adults do not report age-related differences in ratings of sadness (Tsai et al., 2000; Vieillard & Gilet, 2013). One possible explanation for the increase in negative emotions in the current study is the rating scale. To our knowledge, Tsai et al. (2000) is the only other study assessing age-related differences in the experience of emotion in response to film clips. In their study, Tsai et al. (2000) used a rating scale ranging from 0-8 for participants to rate their emotional experience, whereas the current study adopted a scale of 0-100. It may be that older adults had greater range to express their subjective experience of emotion in the current study, leading to greater endorsement of anger and sadness compared to their younger counterparts. The finding that there were no age-related differences in the experience of happiness differs to findings of previous research reporting that older adults report significantly higher experience of happiness in response to emotion provoking pictures (Smith et al., 2005) and music excerpts (Vieillard & Gilet, 2013). Given that the increase in positive emotional experience is well supported by theoretical approaches such as the positivity bias (Carstensen & Mikels, 2005), there may be a methodological explanation for the discrepant findings of the current study. It has been reported across a number of studies that older adults reveal a higher intensity emotion rating compared to their younger counterparts in response to scenes that are salient for older adults (Kliegel et al., 2007; Kunzmann & Grühn, 2005; Kunzmann & Richter, 2009; Seider et al., 2011). Thus, the diminished experience of happiness in older adulthood reported in the current study may be reflective of the salience of the stimuli for happiness implemented here. That is, rather than a systematic decrease in the experience of happiness in older adulthood, it may be the stimuli for inducing happiness in the current study was not relatable for the older adults in the current sample. The film clips used in the current study were taken from a validated bank of film clips for eliciting discrete emotions (Schaefer et al., 2010). However, these clips were validated on a sample of younger adults with an average age of 19.6 years. Although the clips used in the current study were validated for eliciting discrete emotions, they have not been validated for use in a sample of older adults. Therefore, future research would benefit from producing a bank of validated film clips for use in samples of older adults.

In addition to examining the age-related differences in two facets of emotional experience (facial expressivity and subjective emotional experience), the current study also sought to examine age-related differences in the degree to which these two facets relate to each other (emotional concordance). To our knowledge, no other study has examined the age-related difference in emotional concordance in a sample of older adults. Results of the current study suggested that, in line with predictions, older adults exhibit significantly lower levels of emotional concordance than their younger counterparts. Such findings suggest that, as we age the extent to which our components of emotional experience relate to each other decreases. Previous research has indicated that the production of positive facial expressions increases in older adulthood, with a significant decrease in the production of negative facial expressions (Vieillard & Gilet, 2013). Additionally, there is an age-related increase in the subjective experience of positive emotion, but inconsistencies in findings for the experience of negative emotion (Tsai et al., 2000; Vieillard & Gilet, 2013). As such, it is unsurprising that there is an age-related decrease in emotional concordance, as there appears to be a lack of convergence between components of emotional experience in older adulthood. These novel findings highlight new avenues for future research. Are the changes in the relationship between the expression and the experience of emotion underpinned by changes to neural pathways, or other physiological responses? Future research would benefit from examining whether changes in the relationship between expressivity and experience are associated with changes to physiological indicators of emotional experience (e.g., heart rate, galvanic skin response).

The final aspect of the primary aim of the current study was to determine the age-related differences in the use of emotion regulation strategies. It was anticipated that older adults would report greater use of emotion regulation strategies for negatively-valenced stimuli, but this would be less successful than their younger counterparts. That is, despite reporting higher use of regulation strategies, there would be no significant correlation between their emotion regulation and their subjective emotional experience ratings. Contrary to predictions, the current study did not find any evidence of age-related differences in the use of emotion regulation strategies between older and younger adults. Furthermore, results of the current study suggested that there was no significant correlation between older adults' use of emotion regulation strategies, and their subjective emotional experience ratings in the film clip task at any level of emotion (i.e., overall, negative, and discrete emotion), with the exception of anger. For anger, there was a significant, negative correlation between cognitive reappraisal and subjective emotional experience. Such findings provide partial support for the hypotheses as subjective emotional experience ratings were not significantly associated with the use of emotion regulation in older adults. The finding that there were no significant age-related differences in the use of emotion regulation strategies is consistent with some previous research, reporting that emotion regulation is preserved in older adulthood (Pedder et al., 2016). Pedder et al. (2016) suggest that there are no significant age-related differences in the use of emotion regulation, as older adults exhibit less facial activity to begin with. This is consistent with the findings of the current study, indicating that older adults produce significantly less facial expressivity compared to their younger counterparts. Contrary to this, some studies have reported that older adults differ from younger adults in the type of emotion regulation that they use, and the effectiveness in regulating their emotions (John & Gross, 2004; Phillips et al., 2008; Shiota & Levenson, 2009). A possible explanation for the conflicting results in the current study is associated with the way in which emotion regulation was measured, as emotion regulation was measured after the film clips and with respect to how they regulated emotion during the clips, as opposed to with a general measure. As mentioned previously, the film clips used in the current study were sourced from a validated bank of emotion-inducing film clips. Thus, it may be that the emotional experiences that were provoked in older adults from these film clips were not of a high enough intensity to require regulating. For example, the negative film clips may not have provoked high enough intensity negative emotion to require older adults to regulate their emotions. Future research would benefit from sourcing film clips that are validated for use on a sample of older adults.

A secondary aim of the current study was to examine the relationships between facial expressions recognition, subjective emotional experience, facial expressivity, emotional concordance, and emotion regulation (reappraisal and suppression) in the same sample of older adults. Results indicated that there was a significant, negative correlation between facial expression recognition and subjective emotional experience at the overall emotion level. Such a finding indicates that higher intensity emotional experiences are associated with poorer facial expression recognition ability. However, when examining these relationships at the discrete emotion level, there were no significant relationships between facial expression recognition and other facets of emotional experience. The finding that older adults' diminished facial expression recognition ability is associated with higher intensity emotional experience is an interesting avenue for future research for two key reasons. First, as the current experiment did not control for the number of correlations due to specific, directional hypotheses, it may be the case that the significant correlations that emerged are Type 1 errors. As such, future research may wish to incorporate this consideration in attempts to replicate these findings. Second, due to the limited sample size, the current study was not able to directly compare the strength of the relationships between facial expression recognition and other facets of emotional experience between older and younger adults. As such, future research would benefit from examining whether there are significant differences in the relationships between facial expression recognition, subjective emotional experience, facial expressivity, emotional concordance, and emotion regulation between younger and older adults. In addressing this limitation, and building on the results of the current study, we could gain an understanding of how the relationships between emotion processes differ between older and younger adults.

In summary, the results of the current study elucidate the age-related differences facial expressivity, subjective emotional experience, emotional concordance, and facial expression recognition ability. To our knowledge, the current study was the first to explore these age-related differences in the same sample. In general, the current study found evidence for diminished performance in recognition of fearful and sad facial expressions, and diminished expression of emotion for all discrete emotions (i.e., happiness, sadness, fear, anger, and disgust), and the concordance of emotion in older adults. The subjective emotional experience of most emotions remained intact, with increased experience of anger and sadness in older adulthood. Furthermore, there were no age-related differences in the use of regulation strategies between younger and older adults. The results of the current study are contrary to predictions borne out of the *Socioemotional Selectivity Theory* or *Selection, Optimisation, and Compensation with Emotion Regulation Framework,* as older adults did not experience greater positive emotional experience, or increased use of regulation strategies. The results of the current study provide a step forward in the understanding of age-related changes in emotion processes, as they indicate that the age-related deficits in facial expression recognition co-occur with an age-related increase in subjective emotional experience and decreases in facial expressivity and emotional concordance. This study was one of the first to examine these processes concurrently. Understanding the impact of such age-related changes to facial expression recognition, emotional concordance, subjective emotional experience, and facial expressivity could help in explaining the change in socioemotional functioning in older adulthood.

Chapter 6: A Novel Film Task for Inducing and Measuring Subjective Emotional Experience in Children

Abstract

Childhood is a period where a number of important skills develop, including the ability to experience, express and recognise emotion. Facial expression recognition ability has been well researched in children, but there is limited research investigating subjective emotional experience and facial expressivity in childhood. Given the lack of tools to measure emotion in childhood, this study sought to develop and validate a novel film task to induce and measure discrete emotions (i.e., anger, disgust, fear, happiness, and sadness) in children. Additionally, this study also aimed to use this film clip task to assess relationships between subjective emotional experience, facial expressivity, emotional concordance, facial expression recognition ability, and emotional conceptual knowledge in children. A sample of typically developing children aged 6-12 years (*n* = 66) watched 12 emotional film clips and provided subjective emotional experience ratings of five basic emotions (i.e., afraid, angry, disgusted, happy, and sad) after each clip. Participants' facial expressivity was recorded and analysed by computer software while watching each film clip. To measure facial expression recognition and emotional conceptual knowledge, participants completed labelling tasks, assigning emotion labels to facial expressions, or vignettes. Results of the current study validated 10 film clips to be used for inducing and measuring discrete emotion in children. Results of bivariate correlations also indicated that higher levels of emotional conceptual knowledge were associated with superior facial expression recognition across emotion categories, and for some discrete emotions (i.e., anger and disgust). This study presents a novel film task that can be used to address research questions about the experience and expression of emotion in typically developing children, and across clinical populations.

Introduction

The ability to experience, express and recognise emotions appropriately in childhood is essential for effective social development. Emotions are known to be multifaceted, consisting of three interrelated components: physiological, subjective, and behavioural/expressive components (Levenson et al., 1990). To date, a large proportion of developmental research into emotion has focussed on how the ability to recognise emotion in others develops (e.g., Herba & Phillips, 2004; Rodger et al., 2015). Comparatively, there is a scarcity of research devoted to how the experience of emotion develops over the course of childhood. The experience and recognition of emotion in childhood is important for social development, with research suggesting that children who are more emotionally expressive, and who have a better understanding of their emotional experiences, have better peer relationships (Asher, 1983; Cassidy et al., 1992; Denham et al., 1990). For example, children with greater expression of positive affect (e.g., happiness) are rated higher in friendliness and assertiveness, and are seen as more likeable to their peers (Denham et al., 1990). Positive peer relationships are an indicator of social competence, which has important links to mental and physical health (Spitzberg, 2003). As such, it is important to understand how the recognition, expression and experience of emotion develop during childhood.

Much of our understanding of the development of emotion is borne out of studies examining the developmental trajectories of aspects of emotional understanding (e.g., facial expression recognition and conceptual understanding of emotion). This research reveals that these capacities are gradually acquired during childhood (e.g., Bayet & Nelson, 2019; Rodger et al., 2015; Russell & Widen, 2002). For example, between the ages of 2 and 4 years, there is a significant improvement in the conceptual understanding of emotions (i.e., the understanding of the beliefs, bodily reactions, feelings, facial expressions, actions, and consequences attributed to an emotion) and categorisation of facial expressions of emotions

(Russell & Widen, 2002). Behavioural studies have demonstrated that improvements in *facial expression recognition* are associated with general development, with increasing accuracy and speed of recognition observed across childhood (Herba & Phillips, 2004). The acquisition of facial expression recognition begins at the valence level (i.e., positive/negative emotions), with children able to differentiate between positive and negative emotions early in development (e.g., Herba & Phillips, 2004; Rodger et al., 2015). Subsequent to the ability to differentiate valence, the recognition of discrete emotions (e.g., happiness, sadness etc) develops systematically between the ages of 2 and 12 years, with marked improvements and unique developmental trajectories for each emotion during this period (e.g., Herba & Phillips, 2004; Rodger et al., 2015). Assessment of the pattern of development for the recognition of discrete emotions has demonstrated that happy facial expressions are recognised the earliest, with accuracy reaching adult level of recognition by age 5 (Horning et al., 2012; Rodger et al., 2015). However, there is less consensus in the literature about the trajectories of other discrete emotions. Following happiness, the recognition of sadness and anger are frequently cited to be most accurately recognised, followed by surprise and disgust (for a review, see Herba & Phillips, 2004; Widen, 2013). In mapping of the development of facial expression recognition, there is a steep improvement in the recognition of disgust, neutral, and anger expressions with age, with the recognition of surprise and sadness following a more gradual trajectory of acquisition (Rodger et al., 2015). Research adopting dynamic photographs of facial expressions morphing from a neutral expression to 100% emotionality has demonstrated that children (5-11 years) were significantly worse than adolescents (12-17 years) in recognising facial expressions of surprise and disgust (Horning et al., 2012). Such findings provide support for the idea that there is considerable development of facial expression recognition ability during childhood.

The development of *conceptual knowledge of emotion* (also referred to as emotion scripts) is likely to play a role in the experience and the recognition of emotion in childhood. The development of emotional conceptual knowledge was first examined some decades ago in research presenting 3- to 8-year-old children with short stories, in which they were asked to identify the protagonists' emotion by selecting the appropriate emotional face from afraid, angry, happy, and sad faces (Borke, 1971). Results demonstrated that 3-year-old children were most accurate in identifying happiness, followed by sadness and then anger. Furthermore, children aged 6- to 8-years demonstrated highest accuracy in recognising happiness, followed by fear, and then sadness. The finding that children in the higher age bracket (6-8 years old) were more accurate in recognising fear than children in the lower age bracket (3 years) indicates that the understanding of fear develops across childhood. Across the entire age range (3-8 years old) anger showed the least improvement in recognition, being continually misidentified as sadness (Borke, 1971). The primary drawback of this experimental method is that children were required to first recognise facial expressions to be able to assign them to stories. As such, it is difficult to disentangle emotional conceptual knowledge from facial expression recognition from these findings. More recently, research has disentangled emotional conceptual knowledge from facial expression recognition by asking children to assign lexical labels to static pictures of facial expressions, and short stories. Widen and Russell (2010) reported that children (4- to 10-years old) were more accurate in assigning emotion labels to stories than facial expressions. These effects were particularly prominent for fear and disgust (Widen & Russell, 2010). Nelson et al. (2013) used the same method, but with dynamic displays of emotion, as opposed to static images of facial expressions. Results indicated that, even with dynamic displays of emotion, children were still more accurate in assigning emotion labels to stories, instead of facial expressions (Nelson et al., 2013). Taken together, the above findings highlight that emotional conceptual knowledge is acquired over the course of development. In addition to this, the improvement in emotional conceptual knowledge appears to parallel the improvements seen with facial expression recognition ability (Widen & Russell, 2011). As such, the discussed research suggests that the acquisition of emotional conceptual knowledge may underpin facial expression recognition ability.

There is scarcity of research examining how the experience and expression of emotion develops during childhood. Of the limited studies, various methodological approaches including subjective self-report, facial electromyography (EMG), and physiological measures (e.g., skin conductance) have been employed. To date, the self-reported experience of emotion in children has been examined by only a small number of studies, with evidence suggesting that the way children experience emotion may be different from adults (McManis et al., 2001). Research_ENREF_28 comparing children (7-10 years) to adolescents' and adults' self-report ratings of valence and arousal of emotionally provoking images shows that children tend to rate pleasant pictures as significantly more emotionally arousing than unpleasant pictures, with no significant differences in arousal ratings between unpleasant and neutral pictures (McManis et al., 2001). This contrasts with adults' self-report ratings, as adults tended to rate unpleasant pictures as significantly more arousing than neutral pictures (McManis et al., 2001). Such findings suggest that adults and children experience emotions in different ways. Contrary to these findings, when using emotion-provoking film clips, children (6-12 years) tend to follow the same response trend in arousal and valence ratings as adults (von Leupoldt et al., 2007). This research, however, has only assessed the valence of film clips (as opposed to discrete emotions), so we are only gaining a superficial assessment of subjective emotional experience. Research would thus benefit from addressing the experience of emotion in children using a discrete emotion approach.

As previously mentioned, the subjective experience of emotion has been assessed in children. However, facial expressivity (the extent to which we facially express our emotions while experiencing them) is a facet of emotional experience that is yet to be examined in children. Facial EMG has predominantly been used to measure facial mimicry (the imitation of another's non-verbal displays of emotion; Hess & Blairy, 2001) with research investigating facial muscle reactions to emotional facial expressions revealing that typically developing children produce mimicry responses in a similar pattern to adults in response to happy and angry faces (Beall et al., 2008). However, unlike adults, children also produced fearful expressions in response to angry faces, suggesting the experience of fear as opposed to a mimicry response (Beall et al., 2008). Research has demonstrated that actively blocking the mimicry response in children slows the speed of facial expression recognition in children (e.g., Deschamps et al., 2012; Geangu et al., 2016; Lydon & Nixon, 2014). Such findings indicate that facial muscle reactivity is associated with facial expression recognition ability. Moreover, such findings provide insight into the similarities between children and adults in the expression of emotions, while highlighting the differences at a discrete emotion level. Furthermore, given facial expression recognition develops with age, there may be a developmental link between recognition and expression of emotion. The aforementioned studies provide insight into the mimicry responses and their relationships with the perception and recognition of emotion, as opposed to measuring facial expressivity as an indicator of emotional experience.

The lack of research into the expression of emotion (both facially and self-report) in children may be due to a lack of an experimental paradigm to induce and measure discrete emotions in typically developing children. To our knowledge, there are no tasks that have been designed to both induce and measure discrete emotions children. A meta-analysis assessing the effectiveness of different emotion-induction techniques (e.g., film clips, stories, or music) in adults reported that film is the most effective method for inducing positive and negative affect (Westermann et al., 1996). The use of emotional film clips is a popular and successful method of emotion induction and has several advantages: it is easy to implement in a lab setting; it has been shown to elicit physiological arousal that is associated with emotion; it is useful in providing a simulation of reality without the ethical and practical problems that are associated with real-life techniques (Schaefer et al., 2010). To date, there are a number of studies employing an adult sample that have demonstrated the effectiveness of film to elicit both positive and negative affect, but also discrete emotions, such as anger, disgust, fear, sadness, and happiness (e.g., Gross & John, 2003; Rosenberg & Ekman, 1994; Schaefer et al., 2010; Westermann et al., 1996). As such, the primary aim of the current study was to develop a film clip task that is appropriate for inducing and measuring subjective emotional experience of discrete emotion in children.

Despite the effectiveness of the use of film in inducing emotion in adults (Schaefer et al., 2010), to date only four studies have adopted the use of film when eliciting emotion in children. Three studies have used film clips to elicit emotion in order to measure the physiological correlates (e.g., heart rate, brain activity, and respiratory sinus arrhythmia) of emotional experience (Davis et al., 2016; Theall-Honey & Schmidt, 2006; Wilhelm et al., 2006). While only one study has used film to induce and measure the self-reported subjective experience of positive, negative and neutral affect in children. von Leupoldt et al. (2007) showed children (aged 6-12 years) film clips that were intended to elicit pleasant, neutral and unpleasant emotional states, obtaining self-report affective ratings of valence and arousal subsequent to the presentation of each film clip. In regard to valence ratings, results demonstrated that children’s ratings of emotional valence followed the same response trend as adults. Ratings of arousal were significantly greater for pleasant and unpleasant stimuli, when compared to the neutral film, with the unpleasant film being rated as significantly more arousing than the pleasant film. Although von Leupoldt et al. (2007) provided insight into emotional experience of children in response to film clips, the results are limited for two reasons. First, the results only inform the valence and arousal of emotional experience in children and did not provide insight into the development of discrete emotions. Second, von Leupoldt et al. (2007) only used three emotional film clips, which may decrease external validity. Given that we understand that there are differing trajectories for the development of the recognition of discrete facial expressions (Herba & Phillips, 2004), and emotional conceptual knowledge (Widen & Russell, 2010, 2011), it is important to assess the development of subjective emotional experience at a discrete emotion level. As discussed earlier, the recognition of happy facial expressions reaches adult levels of accuracy by age 5, while the recognition of other emotions improves gradually with age (Horning et al., 2012; Rodger et al., 2015). In order to progress research in this field, there is a need for suitable tasks to measure emotional experience in children. Given the different developmental trajectories in the recognition of emotion, it is important to develop a task to induce discrete emotions to allow the assessment of differing trajectories in the experience of these emotions. As such, the current study aimed to develop a film clip task for inducing and measuring the experience of discrete emotion in children.

Not only would the development of an emotion inducing film task allow us to investigate the experience and expression of emotion in children, but it would also allow us to investigate the relationship between the experience of emotions (i.e., facial expressivity and subjective emotional experience) and facial expression recognition ability. Numerous models have been proposed to explain facial expression recognition, including the *simulationist model* of facial expression recognition proposed by Goldman and Sripada (2005). The *simulationist model* of facial expression recognition suggests that when we observe a facial expression, we automatically mimic the observed expression, which in turn induces the subjective experience of the associated emotion, facilitating the accurate recognition of the facial expression. Data from both neuropsychological and behavioural studies have provided support for the *simulationist model* of facial expression recognition demonstrating associations between facial mimicry, subjective emotional experience and facial expression recognition (e.g., Besel & Yuille, 2010; Hess & Blairy, 2001; Neidenthal et al., 2001). The inconsistencies in the findings for facial mimicry (e.g., Wagenmakers et al., 2016), has highlighted the need to investigate facial expressivity as a potential correlate of facial expression recognition ability. Although the *simulationist model* has received empirical support, the majority of this evidence has been provided by studies using an adult sample (e.g., Haslinger et al., 2008; Lewis, 2012; Strack et al., 1988). Thus, there is a scarcity of research that has been devoted to understanding the relationship between the experience and expression of emotion, and how these processes relate to facial expression recognition in typically developing children.

Children begin to experience emotion in infancy, with these early experiences described as innate (White, 2013). However, it has been suggested that children's emotional experiences reflect the child's increasing ability to recognise and label their emotional experiences over the course of development (Immordino-Yang, 2011). As one of the processes of the development of emotional experience is the understanding of emotions, it is important to consider emotional conceptual knowledge when measuring subjective emotional experience. It has been suggested that children's experiences over the course of development allow for emotional conceptual knowledge to evolve and develop (Widen & Russell, 2011). It may be that a child's emotional experiences have an impact on their conceptual understanding of emotions, and vice versa, which may have an impact on their ability to recognise the emotional expressions of others. However, it remains unclear how emotional conceptual knowledge is associated with children's facial expression recognition ability, and subjective and expressive components of emotional experience.

One aim of the current study was to examine the relationships between these two aspects of emotional understanding (i.e., facial expression recognition and emotional conceptual knowledge), indicators of emotional experience (i.e., subjective and expressive components), and the relationship between the indicators of emotional experience (i.e., emotional concordance) during childhood. By developing a tool to measure and induce discrete emotions, it will enable us to look at the relationship between these different skills.

Emotional experience is an aspect of emotion that is reported to have ties to the recognition of emotion in adults: the same neural regions are activated in the experience of emotion and the recognition of emotional faces (e.g., Wicker et al., 2003), with co-occurring deficits in these abilities (e.g., Neal & Chartrand, 2011). Given this relationship, there may be correspondence between the development of emotional experience and the development of emotion recognition. Research examining facial expression recognition in some clinical populations (e.g., children with psychopathic tendencies) supports the notion that a child's propensity to subjectively experience emotions is associated with their ability to recognise the facial expressions of others. Psychopathy is characterised by unemotional traits, and a pervasive disregard and lack of empathy towards others (American Psychiatric Association, 2013). Children who display psychopathic tendencies have also been reported to have significant deficits in the recognition of facial expressions of negative emotion (Blair & Coles, 2000; Stevens et al., 2001). Such findings may indicate that unemotional traits are associated with impairments in facial expression recognition ability. Thus, such studies point to the possibility that there may be a relationship between facial expression recognition and the subjective experience of emotion, however to date, there is a lack of direct evidence.

Given facial expression recognition develops with age, self-reported subjective emotional experience and facial expressivity may follow a similar trend. Furthermore, some clinical populations with developmental disorders (e.g., individuals with Autism Spectrum Disorder, exhibit abnormalities in the relationship between facial expressivity and subjective emotional experience) also display abnormalities in facial expression recognition (e.g., Trevisan et al., 2018). Thus, suggesting the degree of concordance between emotion responding systems may be linked to facial expression recognition ability; perhaps facial expressivity and subjective emotional experience in isolation are not related to facial expression recognition ability, but it may instead be the relationship between these components of emotion that are associated with recognition ability. The interest in assessing the subjective emotional experience, and facial expressivity of discrete emotion in children, highlights the importance of developing a valid and reliable measure to address these questions.

Therefore, the current study aimed to fill the present gaps in the literature by achieving three outcomes. *First*, the current study aimed to develop and validate a children's film clip task for evoking discrete emotions (i.e., anger, disgust, fear, happiness, and sadness). Validation was conducted using two measures of emotional experience: the behavioural expression (i.e., facial expressivity) and the self-reported emotion in a sample of children. Facial EMG has been a useful tool in measuring facial muscle reactivity, however, there are limitations that are associated with this methodological approach. The use of facial EMG requires the placement of electrodes on the participants face, which is an obtrusive approach that may alter the natural, facially expressed responses of participants (Van Boxtel, 2010). The obtrusive nature of facial EMG is particularly problematic for research on a child population. By using facial expression recognition software to measure facial expressivity, we can increase the naturalistic quality of the research task (Dente et al., 2017). In order to allow research to look at relationships with facial expression recognition, the film clip task focused on five basic emotions: anger, disgust, fear, sadness, and happiness, as well as neutral. To measure self-report subjective emotional experience, and facial expressivity of discrete emotions in children, the film clips selected for the film clip task were intended to induce each of the five basic emotions. The film clip task that was developed is based on the task developed by Koval et al. (2013) but was adapted in a number of ways to be suitable for children. *Second*, the current study aimed to use this film clip task to assess the relationships between the self-report experience of emotion, facial expressivity, emotional concordance, facial expression recognition, and emotional conceptual knowledge.

It was predicted that the film clip task would successfully induce emotional experience in children. That is, the film excerpts selected for the film clip task would evoke a significantly higher subjective experience and facial expressivity of the *target* emotion compared to all other emotions (e.g., film clips targeting happiness would produce significantly greater subjective experience of happiness compared to all other emotions). It was also hypothesised, based on the *simulationist model* of facial expression recognition (Goldman & Sripada, 2005), that there would be a significant relationship between facial expression recognition, facial expressivity, the intensity of subjective emotional experience, and emotional concordance at an overall level, and for discrete emotions. Higher levels of facial expressivity, higher intensity subjective emotional experience, greater emotional concordance, and greater emotional conceptual knowledge would be related to superior facial expression recognition abilities.

Method

Participants

The final sample comprised 66 typically developing children aged 6-12 years (*M* = 9.0, *SD* = 1.9, 65% female) recruited from the general community via advertisements online, and in local school newsletters. Although emotion recognition emerges earlier than 6-years old, this age range was selected to ensure that children were of an age to have the necessary comprehension skills to understand and undertake the tasks. The sample was split into two groups to examine any age effects in each of the tasks. Thus, the sample was divided into a group of 34 younger children ranging from 6 – 8.8 years (*M* = 7.1, *SD* = 0.9, 64.5% female) and 31 older children ranging from 9.1 – 12.9 years (*M* = 10.7, *SD* = 1.1, 67.6% female). Eligibility criteria included normal or corrected-to-normal vision and hearing, with no history of developmental or psychological disorders, and no attentional or behavioural concerns. The Autism Spectrum Quotient (AQ; Baron-Cohen et al., 2001) described below, was used to screen for autistic traits. Three participants scoring above ≥ 76 on the AQ, indicative of a suspected autism spectrum disorder, were excluded from the final sample.

Sample Size Justification

The primary analyses for the current study were a series of two-way mixed factorial ANOVAs. As such, power analyses were conducted using the pwr2 package in R version 1.3.1073 to determine the sample size necessary for observing a moderate effect size (${\eta_p}^2 \geq .25$) for both factors, with 80% power and $\alpha = .05$. Results indicated that at least 20 participants in each group would be necessary to achieve these parameters. To be conservative, we recruited 66 participants (34 younger, and 31 older children) giving us 80% power to find an effect size of ${\eta_p}^2 \geq .25$.

Measures

Screening Measures

Autism Spectrum Quotient: Child. The Autism Spectrum Quotient: Child (AQ; Baron-Cohen et al., 2001) was used as a screening measure to assess autistic traits. It is a 50-item parent-report measure assessing five areas of deficit associated with Autism Spectrum Disorder: social skills, attention switching, attention to detail, communication, and imagination. The AQ is reported to have excellent test-retest reliability, and reasonable construct and face validity (Baron-Cohen et al., 2001). Each question is rated on a 4-point Likert Scale, ranging from 0 – definitely agree to 3 – definitely disagree. The minimum score on the AQ is 0, which is indicative of no autistic traits, while the maximum score is 150, which is reflective of full endorsement of autistic traits (Baron-Cohen et al., 2001).

Primary Measures

Film Clip Task.

Stimuli. The initial step in gathering the stimuli for the film clip task was the selection of a number of excerpts from films corresponding to six emotion categories: afraid, angry, disgusted, happy, sad and neutral/relaxed. The initial set of stimuli comprised 51 film clips, ranging from 0’26’’ to 3’00’’ in length. From these 51 film clips, three researchers watched all film excerpts and ranked the intensity of subjective emotional experience evoked by each film clip, for each emotion category. For each emotion category, the animated and non-animated films with the highest intensity ratings were selected. Film clips were sourced from films and TV shows with an Australian G or PG classification. Table 6.1 presents the final selection of 12 film clips used in the film clip task, including the target emotion, clip length, time in film, description of scene, and sequence in the film clip task.

Table 6.1

Film Clip Task Stimuli

Sequence	Film	Target Emotion	Duration	Time in Film	Type	Description

1	Harry Potter and the Philosopher's Stone (2001)	Angry	1'51''	4:06 – 5:57	Non-animated	Harry is forced to cook his family breakfast, and then threatened by Uncle Vernon.
2	The Fox and the Hound (1981)	Afraid	1'26''	1:15:41 – 1:17:07	Animated	The dog and the fox are attacked by a large bear.
3	Shrek: Forever After (2010)	Disgusted	0'26''	53:02 – 53:29	Animated	Shrek and Donkey attend a dinner where the ogres are eating bugs. Donkey does a trick to make eyeballs come out of his nose.
4	Home Alone 2: Lost in New York (1992)	Neutral (relaxed)	0'27''	4:28 – 4:56	Non-animated	Plane pulls away from the gate and prepares for take-off.
5	Marley and Me (2008)	Sad	1'19''	1:45:08 – 1:46:26	Non-animated	Sick dog is at the vet, and the owner is saying goodbye before the dog gets euthanised.
6	The Fox and the Hound (1981)	Happy	1'02''	17:47 – 18:49	Animated	Baby fox and puppy meet and play.
7	The Lion King (1994)	Sad	1'55''	35:54 – 37:49	Animated	Simba finds Mufasa dead after stampede, tries to call for help and starts crying while crawling under Mufasa's paw.

8	Cinderella (1950)	Angry	1’22’’	40:15 – 41:37	Animated	Ugly stepsisters ruin Cinderella’s dress.
9	Lemony Snicket’s: A series of unfortunate events	Afraid	1’58’’	25:59 – 27:52	Non-animated	The children are stuck in a car on the train tracks, and a train is fast approaching.
10	The Lion King (1994)	Neutral (relaxed)	0’30’’	1:01 – 1:31	Animated	Scenes of animals and landscapes
11	Merry Christmas, Mr Bean (1992)	Happy	1’59’’	17:26 – 19:25	Non-animated	Mr Bean wakes up on Christmas morning, opens gifts and prepares lunch for himself and his teddy.
12	Man vs Wild: Season 1 Episode 7	Disgusted	1’00’’	12:10-13:11	Non-animated	Bear Grylls eats a giant Rhino Beetle larvae and it explodes.

Film Clip Task Procedure. The film clip task was developed based on the methodology used in the task from Koval et al. (2016), with a number of adjustments implemented to make the task suitable for children. The task comprised presentation of 12 film clips (see Table 6.1). Following each film clip, participants provided ratings of their subjective experience of five basic emotions (i.e., afraid, angry, disgusted, happy, and sad) and relaxed[2]on a scale from 0 (not at all) to 6 (very much). The rating scale was explained to the children by providing a picture of water cups filled to varying degrees. The cups were labelled 0-6, and participants used these cups to explain how much they were experiencing each emotion (i.e., 6 [very much] was a full glass of water).

At the commencement of the film clip task, participants were advised that they would be watching a series of film clips, and that they would be asked to rate how each of these film clips made them feel. Participants were asked to sit as still as possible and avoid touching/obscuring their face for the duration of the task. In order to provide children with an opportunity to practice providing ratings, participants watched a practice film clip before starting the main film clip task and provided ratings of their subjective experience of the six emotions (i.e., afraid, angry, disgusted, happy, sad, and relaxed). Following the practice trial, and prior to the commencement of the film clip task, participants provided a baseline measure of their current emotional state, by providing an initial rating of their subjective experience of each emotion assessed.

The film clip task was completed one-on-one with a researcher, with participants moving at their own pace through the subjective emotional experience ratings. In order to control for the varying emotion dynamics between the clips, film clip order was initially randomised, and then presented in the same fixed sequence across participants (see Table 6.1 for the film

[2] In order to account for varied understandings of 'neutral', participants were instead asked to report how 'relaxed' each film clip made them feel.

clip sequence). The order that the subjective experience ratings (i.e., afraid, angry, disgusted, happy, relaxed, and sad) were completed following each film clip was also initially randomised for each clip, and then presented in the same fixed order after the film clip for each participant. After completing the subjective ratings of emotion after viewing each film clip, participants were shown a neutral stimulus (a picture of a ball of yarn) for 15 seconds. This task was programmed using iMotions Survey Module (www.imotions.com).

Facial expressivity was measured during the film clip task using facial expression recognition software (iMotions Emotient Module; www.imotions.com) providing an assessment of the facial expressivity of all emotions simultaneously. The Emotient toolbox automatically codes facial muscle movements according to five basic emotions (i.e., happy, anger, fear, sad, and disgust). The evidence scores produced by the Emotient module represent the likelihood of a target emotion being present. The evidence scores are similar to a z-score, in that larger, positive values indicate that you have a strong, positive effect. For example, an evidence score of +2 for happiness indicates that the expression is 100 times more likely to be coded as happiness by a human coder than not.

Emotional Conceptual Knowledge. Conceptual knowledge of emotion was assessed using a task where participants were required to match emotion-eliciting vignettes to emotion labels. The stimuli comprised 60 vignettes, some of which were sourced from various research papers, and others developed specifically for this study (see Appendix C for vignettes). There were ten vignettes for each emotion category (afraid, angry disgusted, happy, neutral, and sad). Participants were required to specify which emotion the main character in the vignette was feeling from one of the six emotion labels presented along the bottom of the screen (afraid[3], angry, disgusted, happy, neutral, sad). In order to account for

[3] To make the emotion easier for children to understand, fear was referred to as 'afraid'

varying levels of reading ability, the vignettes were presented in both auditory (read aloud by the researcher) and visual (presented in the centre of the screen) format. To ensure that participants were able to read/understand the labels, participants were required to read the emotion labels aloud to the researcher to before commencing the task. In order to respond, participants either selected the response themselves, or provided a verbal response to the researcher who selected the response. Each vignette was presented individually on a white background, scaled to be the same size of 1024 pixels by 768 pixels. Vignettes were presented in a randomised order with an inter-trial interval of 500ms. Vignette and response options remained on the screen until the participant (or researcher) provided their response with a mouse click. This task was programmed and presented using SuperLab 5 (Cedrus Corp.). A correct response was assigned a score of 1, and incorrect responses were scored 0. Thus, higher scores on this task indicated superior emotional conceptual knowledge. In order to aid interpretation of emotional conceptual knowledge, the percentage of correct responses for each emotion level was calculated. Overall emotional conceptual knowledge was calculated by summing accuracy scores across happiness, anger, sadness, disgust, and afraid and converting to the percentage of correct responses.

Facial Expression Recognition Task. In order to assess facial expression recognition ability, participants completed a facial expression recognition task developed for the purpose of the current study. Stimuli comprised 72 emotional faces, exhibiting angry, disgusted, afraid, happy, neutral, and sad facial expressions. In order to account for in-group effects, equal numbers of child and adult faces were presented. There were 12 faces presented for each emotion category (six adult and six children). Adult faces were sourced from the NimStim set of facial expressions (Tottenham et al.) and child faces were sourced from the Child Affective Facial Expression (CAFE) set (LoBue & Thrasher, 2014).

Faces were scaled to be the same size of 375 pixels by 450 pixels, with 5cm by 7cm viewing resolution. Faces were presented one at a time, on a white background in a randomised order with an inter-trial interval of 500ms. At the beginning of the task, to confirm understanding of each emotion, participants read aloud the emotion labels to the researcher and explained what it meant to experience each emotion. Participants were required to select whether the emotion displayed was afraid, angry, disgusted, happy, neutral, or sad. In order to account for varying degrees of computer ability, participants either provided their responses by using the mouse to select their response, or verbally providing their response to the researcher who recorded their response. The face and the label options remained on the screen until the participant (or researcher) indicated their response with a mouse click. A correct response was assigned a score of 1, with an incorrect response assigned a 0. Thus, higher scores on this task are indicative of superior facial expression recognition ability. In order to aid interpretation of facial expression recognition accuracy, the percentage of correct responses for each emotion level was calculated. Overall facial expression recognition ability was calculated by summing accuracy scores across adult and child expressions of happiness, anger, sadness, disgust, fear and neutral, and calculating percentage correct from all faces.

Procedure

At the beginning of the session, participants' parents/legal guardians provided written informed consent for their child's participation in the study and completed the demographic questionnaire, and the AQ. In addition to this, assent was gained from participants prior to the commencement of any tasks.

In order to motivate children and encourage active participation, the research was presented using a particular theme. In an individual session, participants were informed that they were going to be a part of our 'Face Bureau of Investigation (FBI)' and that they would be completing a series of tasks that will train them in the skills that they require to be FBI agents. Each task was presented to participants as a series of 'missions', with each child presented with a chart to accumulate stickers to mark the corresponding mission as complete. After completing all their 'missions' (i.e., tasks), children were presented with a personalised certificate and name badge. In order to motivate children to complete the film clip task and remain still throughout, participants selected a small toy that they were allowed to keep after completing the task.

Participants always completed the emotional conceptual knowledge task first to avoid the other tasks influencing participants' understanding of emotion. The film clip task was completed second, and the facial expression recognition task last. All tasks were viewed on a 15-inch Lenovo ThinkPad monitor (screen size, 1920 pixels by 1080 pixels) or a 27-inch iMac (5120 pixels by 2880 pixels) at a viewing distance of approximately 60cm.

Data Processing

Subjective Emotional Experience

To determine if the target emotion was successfully elicited, the subjective emotional experience ratings for each emotion were extracted for each participant, separately for each film clip. To remove the influence of current emotional state from subjective emotional experience ratings, a baseline correction was applied. To do this, the baseline emotion rating provided at the beginning of the task was subtracted from the subjective emotional experience rating during the film clip task. For example, the baseline rating of happiness was subtracted from the subjective emotional experience rating of happiness during Mr Bean.

To examine the relationships with other tasks, the average emotion-specific subjective emotional experience was calculated in response to the relevant target clip. For example, the average subjective emotional experience of happiness was calculated by averaging each participants' experience of happiness during the two happy film clips. In order to obtain a measure of overall subjective emotional experience, the average of the experience of anger, disgust, fear, happiness, and sadness was computed. To apply baseline corrections to these metrics, the baseline rating of each emotion was subtracted from the average experience of each emotion for each target emotion for the film clips. For example, the baseline rating of happiness was subtracted from the average of happiness ratings in response to happy target clips. To apply a baseline correction to overall subjective emotional experience, the average experience of all emotions for baseline ratings was calculated and subtracted from overall subjective emotional experience. The baseline corrected subjective emotional experience variables were used for all analyses.

Facial Expressivity

To determine if the target emotion was successfully elicited, the facial expressivity scores for each emotion, for each film clip were extracted. To appropriately assess the change in participants' facial expressivity during the film clip, and account for the influence of individual differences a baseline correction was applied. Neutral film clips were used as the baseline as they were not emotion provoking, and thus provide a baseline measure for facial expressivity of each emotion. First, the average expression of each emotion across each neutral film clip was calculated, and then averaged across both clips. In order to achieve a baseline correction, the facial expressivity of the relevant emotion recorded during neutral film clips was subtracted from the facial expressivity of the relevant emotion during each film clip. For example, the baseline facial expressivity of anger was subtracted from the facial expressivity of anger during Cinderella.

To produce a single measure of afraid, angry, disgusted, happy, sad and neutral facial expressivity to examine the relationships with other tasks, the average facial expressivity of each emotion in response to each film clip was extracted from the Emotient module. For example, the average of angry facial expressivity in response to each angry film clips was computed, and then the average of both was computed. In order to obtain a measure of overall facial expressivity, the average of all emotional facial expressivity was calculated. To apply a baseline correction to each emotion, the average of each emotion expressed during neutral clips was calculated, and then subtracted from the facial expressivity recorded in response to the emotion film clips. For example, the average happy facial expressivity during both neutral film clips was subtracted from the facial expressivity that was recorded in response to film clips targeting happiness. The baseline-corrected happiness scores for each happy clip were then averaged to obtain a single, baseline-corrected measure for happiness. To apply a baseline correction to overall facial expressivity, the average facial expressivity of all emotions in response to neutral clips was computed and subtracted from overall facial expressivity. The baseline corrected facial expressivity variables were used for all analyses.

Emotional Concordance

In order to generate a measure of emotional concordance between subjective emotional experience and facial expressivity for each participant, the average intensity of facial expressivity for happiness, anger, disgust, fear, and sadness for each film clip (regardless of the target emotion) was obtained. In addition to this, the subjective emotion ratings for the same emotions after each film clip (regardless of the target emotion) were also extracted. A measure of concordance for each emotion was obtained by estimating the bivariate correlations between facial expressivity and subjective emotional experience for each emotion across all film clips, separately for each participant. To obtain a measure of overall emotional concordance, the average of emotional concordance for all emotions was calculated.

Statistical Analysis

To determine whether the film clips were effective in eliciting the target emotion, a series of 2×6 mixed model ANOVAs with the between subjects factor Age Group (younger, older) and repeated measures factor Emotion Category (afraid, angry, disgusted, happy, neutral, and sad) were conducted for subjective emotional experience ratings, and facial expressivity scores for each film clip. The same analyses were also undertaken on performance accuracy in the emotional conceptual knowledge tasks. Although there were no specific hypotheses regarding differences between younger and older children in any of the tasks, age group was included as a factor in analyses to demonstrate whether performance on these tasks differ with age. To determine whether there were significant differences across older and younger children in facial expression recognition, and whether accuracy differed depending on face age (i.e., child face or adult face), a Three-Way ANOVA was conducted. The between subjects factor was Age Group (younger, older), and two repeated measures factors consisting of Emotion Category (afraid, angry, disgusted, happy, neutral, and sad), and Face Age (child, adult). Assumption testing revealed normality violations across emotion ratings, facial expressivity. However, given the adequate sample size (n = 66), and adequate group sizes (younger children: n = 31, older children: n = 34) and that ANOVA is robust to violations of normality, data were not transformed (Field, 2009). The Greenhouse-Geisser correction was applied in all instances where the sphericity assumption was violated. Significant main effects results were investigated using Bonferroni-corrected pairwise comparisons, and significant interactions were investigated used simple main effects analyses (Bonferroni corrected).

To examine the relationship between age, facial expression recognition, emotional conceptual knowledge, subjective emotional experience, facial expressivity, and emotional concordance, a series of Spearman’s bivariate correlations regressions were conducted.

Spearman's rho was conducted due to the violations to normality, and to minimise the effects of extreme scores. Visual inspection of scatterplots for each correlation revealed that the assumption of monotonic relationships was satisfied.

Results

Subjective Emotional Experience

Table 6.2 displays the mean and standard error of subjective emotional experience ratings for each film clip[4], with the highest average rating for each film clip highlighted in grey. The mean and standard error of subjective emotional experience ratings for each film clip, split by age group are displayed in Appendix D.

[4] For consistency in reporting, fear is referred to as 'afraid' for the subjective emotional experience ratings, facial expression recognition task, and emotional conceptual knowledge task as these were the labels provided to children.

Table 6.2

Means and Standard Error for each Emotion Rating for Each Film Clip

	Afraid	Angry	Disgusted	Happy	Relaxed	Sad
	M (SE)	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Lemony Snicket (Afraid 1)	2.8(0.3)	1.4(0.3)	0.2(0.2)	-2.5(0.3)	-2.7(0.23)	2.0(0.3)
Fox and the Hound (Afraid 2)	2.8(0.3)	1.4(0.3)	0.6(0.2)	-2.4(0.3)	-3.0(0.3)	2.4(0.3)
Harry Potter (Angry 1)	1.1(0.2)	1.6(0.3)	0.7(0.2)	-1.5(0.3)	-1.7(0.2)	1.3(0.3)
Cinderella (Angry 2)	1.1(0.3)	2.7(0.3)	1.1(0.3)	-2.4(0.3)	-2.3(0.3)	2.1(0.3)
Born Survivor (Disgusted 1)	1.5(0.3)	0.6(0.2)	4.8(0.3)	-2.9(0.4)	-3.2(0.3)	0.4(0.2)
Shrek Forever After (Disgusted 2)	0.7(0.2)	0.3(0.1)	3.5(0.3)	-1.2(0.3)	-2.0(0.3)	0.3(0.2)
Mr Bean (Happy 1)	-0.2(0.1)	0.0(0.1)	0.1(0.1)	0.8(0.3)	-0.7(0.2)	-0.1(0.1)
Fox and the Hound (Happy 2)	-0.1(0.1)	0.0(0.1)	-0.1(0.2)	0.6(0.2)	-0.5(0.2)	-0.2(0.1)
Home Alone (Neutral 1)	0.3(0.2)	0.2(0.1)	-0.2(0.1)	-0.6(0.3)	-0.6(0.2)	0.1(0.2)
The Lion King (Neutral 2)	-0.2(0.1)	0.0(0.1)	-0.2(0.2)	0.1(0.2)	-0.2(0.2)	0.1(0.2)
Marley and Me (Sad 1)	1.3(0.3)	0.3(0.1)	-0.1(0.2)	-2.7(0.3)	-2.6(0.3)	3.6(0.3)
The Lion King (Sad 2)	1.6(0.3)	0.6(0.2)	-0.0(0.2)	-2.5(0.3)	-2.6(0.2)	3.7(0.2)

Note: The target emotion rating for each clip is highlighted in grey.

Afraid Clips

Lemony Snicket. There was a significant effect of emotion category on reported subjective emotional experience after viewing the film clip, *F* (2.64, 166.30) = 78.68 $p <$ .001, $\boldsymbol{\eta_p}^2$ = .56. However, there was no significant main effect of age group on emotion ratings, *F* (1, 63) = 0.54, $p = .464$, $\boldsymbol{\eta_p}^2$ = .01. In addition to this, there was no significant Emotion Category × Age Group interaction, *F* (2.64, 166.30) = 0.54, $p = .630$, $\boldsymbol{\eta_p}^2$ = .01. Bonferroni pairwise comparisons revealed that afraid ratings were significantly higher than those of anger, disgust, happiness, and relaxed (*ps* < .001). Although the ratings for afraid were greater than sadness, this difference was not significant ($p = .071$).

Fox and the Hound (Afraid). Results indicated there was a significant effect of emotion category on reported subjective emotional experience after viewing this clip, *F* (2.20, 138.84) = 96.05, $p < .001$, $\boldsymbol{\eta_p}^2$ = .60. However, there was no significant main effect of age on emotion ratings, *F* (1, 63) = 0.78, $p = .381$, $\boldsymbol{\eta_p}^2$ = .01. Additionally, there was no significant Emotion Category × Age Group interaction, *F* (2.20, 138.84) = 0.65, $p = .537$, $\boldsymbol{\eta_p}^2$ = .01. Bonferroni pairwise comparisons revealed that ratings of afraid after viewing the film clip were significantly greater than anger, disgust, happiness, and relaxed (*p*s < .001). The afraid ratings were greater than sadness, however, this did not reach significance ($p = .399$).

Anger Clips

Harry Potter. Results indicated there was a significant effect of emotion category on reported subjective emotional experience when viewing the clip, *F* (2.66, 167.60) = 34.00, $p < .001$, $\eta_p{}^2 = .35$. There was no significant main effect of age group on emotion ratings, *F* (1, 63) = 0.001, $p = .970$, $\eta_p{}^2 < .001$, nor a significant Emotion Category × Age Group interaction, *F* (2.66, 167.60) = 1.16, $p = .325$, $\eta_p{}^2 = .02$. Bonferroni pairwise comparisons revealed that ratings for angry were significantly greater than disgusted, happy, and relaxed (*p*s $< .01$). Angry ratings were not significantly greater than ratings of afraid, and sadness ratings (*p*s = 1.00).

Cinderella. Results indicated there was a significant effect of emotion category on reported subjective emotional experience when viewing the clip, F (2.81, 177.04) = 63.20, $p < .001$, $\eta_p{}^2 = .50$. There was no significant main effect of age group on emotion ratings, F (1, 63) = 0.25, $p = .618$, $\eta_p{}^2 <.01$, nor was there a significant Emotion Category × Age Group interaction, F (2.81, 177.04) = 0.18, $p = .899$, $\eta_p{}^2 <.01$. The results of Bonferroni pairwise comparisons demonstrated that ratings of angry were significantly greater than those of afraid, disgusted, happy, and relaxed (*p*s $< .001$). Angry ratings were not significantly greater than those of sadness ($p = .321$).

Disgust Clips

Born Survivor. Results revealed that there was a significant effect of emotion category on reported subjective emotional experience when viewing the clip, F (2.62, 162.33) = 111.79, $p <.001$, $\eta_p{}^2 = .64$. There was no significant main effect of age group on emotion ratings, F (1, 62) = 0.10, $p = .750$, $\eta_p{}^2 <.01$. Additionally, there was no significant Emotion Category × Age Group interaction, F (2.62, 162.33) = 0.98, $p = .395$, $\eta_p{}^2 = .02$. Bonferroni pairwise comparisons revealed that ratings of disgust were significantly higher than all other emotions (*p*s $< .001$).

Shrek Forever After. There was a significant effect of emotion category on reported subjective emotional experience when viewing this clip, F (2.61, 164.57) = 67.31, $p < .001$, $\eta_p{}^2 = .52$. There was no significant main effect of age group on emotion ratings, F (1, 63) = 0.02, $p = .903$, $\eta_p{}^2 < .001$. Additionally, there was no significant Emotion Category × Age Group interaction, F (2.61, 164.57) = 0.74, $p = .512$, $\eta_p{}^2 = .01$. Bonferroni pairwise comparisons revealed that ratings of disgust were significantly higher than all other emotions (*ps* < .001).

Happy Clips

Mr Bean. There was a significant effect of emotion category on reported subjective emotional experience when viewing this clip, *F* (2.97, 186.95) = 9.39, $p < .001$, $\eta_p{}^2 = .13$. There was no significant main effect of age group on emotion ratings, *F* (1, 63) = 3.29, $p = .075$, $\eta_p{}^2 = .05$. In addition to this, there was no significant Emotion Category × Age Group interaction, *F* (2.97, 186.95) = 0.89, $p = .445$, $\eta_p{}^2 = .01$. Bonferroni pairwise comparisons revealed that happy ratings were significantly greater than afraid, relaxed, and sad (*p*s ≤ .022) when viewing Mr Bean. Happy ratings were not significantly greater than either angry or disgusted ratings (*p*s ≥. 070).

Fox and the Hound (Happy). Results revealed a significant effect of emotion category on reported subjective emotional experience when viewing this clip, *F* (2.96, 186.66) = 6.32, $p < .001$, $\eta_p{}^2 = .09$. There was no significant main effect of age group on emotion ratings, *F* (1,63) = 0.47, $p = .495$, $\eta_p{}^2 = .01$. Additionally, there was no significant Emotion Category × Age Group interaction, *F* (2.96, 186.66) = 0.20, $p = .897$, $\eta_p{}^2 < .01$. Bonferroni pairwise comparisons revealed that happy ratings were significantly higher than that of afraid, relaxed, and sad (*p*s ≤ .034). Happy ratings were not significantly greater than those of angry or disgusted (*p*s ≥ .131).

Neutral Clips

Home Alone. Results revealed a significant effect of emotion category on reported subjective emotional experience when viewing this clip, *F* (3.02, 190.16) = 5.22, $p = .002$, $\eta_p{}^2 = .08$. There was no significant main effect of age group on emotion ratings, *F* (1, 63) = 0.09, $p =.767$, $\eta_p{}^2 < .01$. Additionally, there was no significant Emotion Category × Age Group interaction, *F* (3.02, 190.16) = 0.76, $p = .518$, $\eta_p{}^2 = .01$. Bonferroni pairwise comparisons revealed that ratings of relaxed were significantly lower than those of afraid and angry (ps ≤ .036). Relaxed ratings were not significantly greater than those of disgusted, happy, or sad (ps ≥ .206).

Lion King (Neutral). Results revealed no significant effect of emotion category on reported subjective emotional experience when viewing this clip, F (3.10, 195.49) = 0.97, p = .412, $\eta_p{}^2$ = .02. In addition to this, there was also no significant main effect of age group on emotion rating, F (1, 63) = 0.02, p = .901, $\eta_p{}^2$ < .001. Furthermore, there was no significant Emotion Category × Age Group interaction, F (3.10, 195.49) = 0.78, p = .513, $\eta_p{}^2$ = .01.

Sad Clips

Marley and Me. Results indicated that there was a significant effect of emotion category on reported subjective emotional experience when viewing this clip, F (2.18, 137.13) = 96.67, p < .001, $\eta_p{}^2$ = .61. There was no significant main effect of age group on emotion ratings, F (1,63) = 0.01, p = .938, $\eta_p{}^2$ < .001. Furthermore, there was no significant Emotion Category × Age Group interaction, F (2.18, 137.13) = 0.76, p = .478, $\eta_p{}^2$ = .01. Bonferroni pairwise comparisons indicated that ratings of sadness were significantly higher than all other emotions (ps < .001).

The Lion King (Sad). Results indicated that there was a significant effect of emotion category on reported subjective emotional experience when viewing this clip, F (2.64, 166.35) = 101.47, p < .001, $\eta_p{}^2$ = .62. There was no significant main effect of age group on emotion ratings, F (1, 63) = 1.26, p =.265, $\eta_p{}^2$ = .02. Furthermore, there was no significant Emotion Category × Age Group interaction, F (2.64, 166.35) = 0.56, p = .618, $\eta_p{}^2$ = .01. Bonferroni pairwise comparisons indicated that ratings of sadness were significantly higher than all other emotions (ps < .001).

Facial Expressivity

Table 6.3 presents the mean and standard error of facial expressivity for each emotion for each film clip, with the highest emotional expression highlighted in grey. For Harry Potter, Cinderella, Mr Bean, and Born Survivor, the target emotion was expressed the highest. The mean and standard error of facial expressivity for each emotion, for each age group, per film clip are displayed in Appendix E.

Table 6.3

Means and Standard Error for Each Emotional Expression for each Film Clip

	Afraid *M (SE)*	Angry *M (SE)*	Disgusted *M (SE)*	Happy *M (SE)*	Sad *M (SE)*
Lemony Snickets (Afraid 1)	0.2(0.1)	0.3(0.1)	0.1(0.1)	-0.6(0.1)	0.1(0.1)
Fox and the Hound (Afraid 2)	-0.1(0.1)	0.3(0.1)	0.1(0.1)	-0.6(0.1)	0.1(0.1)
Harry Potter (Angry 1)	-0.0(0.1)	0.1(0.0)	0.1(0.1)	-0.3(0.1)	0.1(0.1)
Cinderella (Angry 2)	0.1(0.1)	0.3(0.1)	0.1(0.1)	-0.3(0.1)	0.1(0.1)
Born Survivor (Disgusted 1)	0.2(0.1)	0.0(0.1)	0.8(0.1)	0.6(0.1)	-0.2(0.1)
Shrek Forever After (Disgusted 2)	0.0(0.1)	-0.1(0.1)	0.3(01)	0.4(0.2)	-0.2(0.1)
Mr Bean (Happy 1)	0.1(0.1)	-0.1(0.1)	0.4(0.1)	1.4(0.2)	-0.5(0.1)
Fox and the Hound (Happy 2)	-0.0(0.1)	0.1(0.1)	0.1(0.1)	-0.2(0.1)	0.1(0.0)
Marley and Me (Sad 1)	-0.1(0.0)	0.2(0.1)	0.1(0.1)	-0.4(0.1)	0.2(0.0)
The Lion King (Sad 2)	-0.1(0.1)	0.2(0.1)	0.1(0.1)	-0.5(0.1)	0.2(0.1)

Note: The target emotion is highlighted in grey.

Afraid Clips

Lemony Snickets. Results indicated that there was a significant effect of emotion category on facial expressivity while watching Lemony Snickets, F (2.13, 133.87) = 18.01, $p < .001$, $\eta_p^2 = .22$. There was no significant main effect of age on facial expressivity, F (1, 63) = 2.55, $p = .115$, $\eta_p^2 = .04$. Additionally, there was no significant Emotion Category × Age Group interaction, F (2.13, 133.87) = 1.54, $p = .218$, $\eta_p^2 = .02$. Bonferroni pairwise comparisons demonstrated that facial expressivity of fear was significantly higher than happy facial expressivity ($p < .001$). Facial expressivity of fear was not significantly greater than angry, sad, and disgusted facial expressivity (ps = 1.00).

Fox and the Hound (Fear). Results indicated that there was a significant effect of emotion category on facial expressivity while watching the Fox and the Hound (Fear), F (1.96, 123.51) = 21.23, $p < .001$, $\eta_p^2 = .25$. There was no significant main effect of age on facial expressivity, F (1, 63) = 0.98, $p = .327$, $\eta_p^2 = .01$. Additionally, there was no significant Emotion Category × Age Group, F (1.96, 123.51) = 0.43, $p = .786$, $\eta_p^2 = .01$. Bonferroni pairwise comparisons demonstrated that facial expressivity of fear was significantly higher than facial expressivity of happiness ($p < .001$), and significantly lower than anger expressivity ($p < .001$). Facial expressivity of fear was not significantly greater than that expressed for disgust or sadness (ps ≥ .065).

Anger Clips.

Harry Potter. Results revealed that there was a significant effect of emotion category on facial expressivity while watching Harry Potter, F (1.99, 125.41) = 5.68, $p = .004$, $\eta_p^2 = .08$. There was no significant main effect of age on facial expressivity, F (1, 63) = 0.06, $p =.813$, $\eta_p^2 < .01$. Furthermore, there was no significant Emotion Category × Age Group interaction, F (1.99, 125.41) = 0.35, $p = .708$, $\eta_p^2 = .01$. Bonferroni pairwise comparisons revealed that facial expressivity of anger was significantly higher than facial expressivity of happiness (p =

.034). Facial expressivity of anger was not significantly higher than that of fear, sadness or disgust (ps ≥ .282).

Cinderella. Results revealed that there was a significant effect of emotion category on facial expressivity when viewing Cinderella, F (1.99, 125.42) = 8.42, p < .001, $\eta_p{}^2$ = .12. There was no significant main effect of age, F (1, 63) = 3.75, p = .057, $\eta_p{}^2$ = .06. Furthermore, there was no significant Emotion Category × Age Group interaction, F (1.99, 125.42) = 1.45, p = .239, $\eta_p{}^2$ = .02. Bonferroni pairwise comparisons indicated that facial expressivity of anger was significantly higher than that of happiness (p < .009). Facial expressivity of anger was not significantly greater than that of fear, sadness, or disgust (ps ≥ .170).

Disgust Clips

Born Survivor. Results indicated that there was a significant effect of emotion category on facial expressivity while viewing Born Survivor, F (2.04, 126.16) = 19.45, p < .001, $\eta_p{}^2$ = .24. There was no significant main effect of age on facial expressivity, F (1, 62) = 3.42, p =.069, $\eta_p{}^2$ = .05. Furthermore, there was no significant Emotion Category × Age Group interaction, F (2.04, 126.16) = 3.04, p = .050, $\eta_p{}^2$ = .05. Bonferroni pairwise comparisons demonstrated that facial expressivity of disgust was significantly higher than that of fear, anger, and sadness (ps < .001). Facial expressivity of disgust was not significantly greater than that of happiness (p = 1.00).

Shrek Forever After. Results revealed that there was a significant effect of emotion category on facial expressivity while watching Shrek Forever After, F (1.98, 124.96) = 7.59, p = .001, $\eta_p{}^2$ = .11. In addition to this, there was also a significant main effect of age, F (1, 63) = 6.31, p = .015, $\eta_p{}^2$ = .09, indicating that facial expressivity was greater for older children. However, there was no significant Emotion Category × Age Group interaction, F (1.98, 124.96) = 0.28, p = .758, $\eta_p{}^2$ < .01. Bonferroni pairwise comparisons revealed that facial expressivity of disgust was significantly higher than that of fear, anger, and sadness (*p*s ≤ .018). There was no significant difference between facial expressivity of disgust and happiness (p = 1.00).

Happy Clips

Mr Bean. Results revealed that there was a significant effect of emotion category on facial expressivity when viewing Mr Bean, F (1.48, 93.27) = 50.00, p < .001, $\eta_p{}^2$ = .44. There was no significant main effect of age on emotion ratings, F (1, 63) = 0.30, p = .587, $\eta_p{}^2$ = .01. Furthermore, there was no significant Emotion Category × Age Group interaction, F (1.48, 93.27) = 0.24, p = .716, $\eta_p{}^2$ < .01. Bonferroni pairwise comparisons revealed that facial expressivity of happiness was significantly higher than that of all other emotions (*p*s < .001).

Fox and the Hound (Happy). Results revealed that there was a significant effect of emotion category on facial expressivity when viewing Fox and the Hound (Happy), F (2.38, 149.74) = 3.39, p = .029, $\eta_p{}^2$ = .05. There was no significant main effect of age on facial expressivity, F (1, 63) = 1.38, p = .244, $\eta_p{}^2$ = .02. Furthermore, there was no significant Emotion Category × Age Group interaction, F (2.38, 149.74) = 1.14, p = .337, $\eta_p{}^2$ = .02. Bonferroni pairwise comparisons indicated that their facial expressivity of happiness was not significantly greater than any other emotion (*p*s ≥ .170).

Sad Clips.

Marley and Me. Results revealed that there was a significant effect of emotion category on facial expressivity when viewing Marley and Me, F (1.99, 125.25) = 17.90, p < .001, $\eta_p{}^2$ = .22. In addition to this, there was a significant main effect of age on facial expressivity, indicating that younger children were significantly more expressive, F (1, 63) = 4.15, p = .046, $\eta_p{}^2$ = .06. However, there was no significant Emotion Category × Age Group, F (1.99, 125.25) = 0.64, p = .528, $\eta_p{}^2$ = .01. Bonferroni pairwise comparisons demonstrated that facial expressivity of sadness was significantly higher than that of fear and happiness (*p*s ≤ .006). Facial expressivity of sadness was not significantly greater than that of anger and disgust (*p*s = 1.00).

Lion King (Sad). Results indicated that there was a significant effect of emotion category on facial expressivity while viewing Lion King (Sad), F (1.84, 115.94) = 26.03, $p < .001$, $\eta_p{}^2 = .29$. In addition to this, there was also a significant main effect of age on facial expressivity, indicating that younger children were more expressive, F (1, 63) = 4.76, $p = .033$, $\eta_p{}^2 = .07$. However, there was no significant Emotion Category × Age Group interaction, $F(1.84, 115.94) = 0.38$, $p = .826$, $\eta_p{}^2 = .01$. Bonferroni pairwise comparisons demonstrated that facial expressivity of sadness was significantly higher than that of fear and happiness (*p*s < .001). Facial expressivity of sadness was not significantly greater than that of anger or disgust (*p*s ≥ .556).

Descriptive Statistics

Means and standard deviations for facial expression recognition, conceptual knowledge, subjective emotional experience, facial expressivity, and emotional concordance at the overall level are presented in Table 6.3. Descriptive statistics for facial expression recognition, conceptual knowledge, subjective emotional experience, facial expressivity, and emotional concordance for each discrete emotion are summarised in Figure 6.1.

Table 6.4

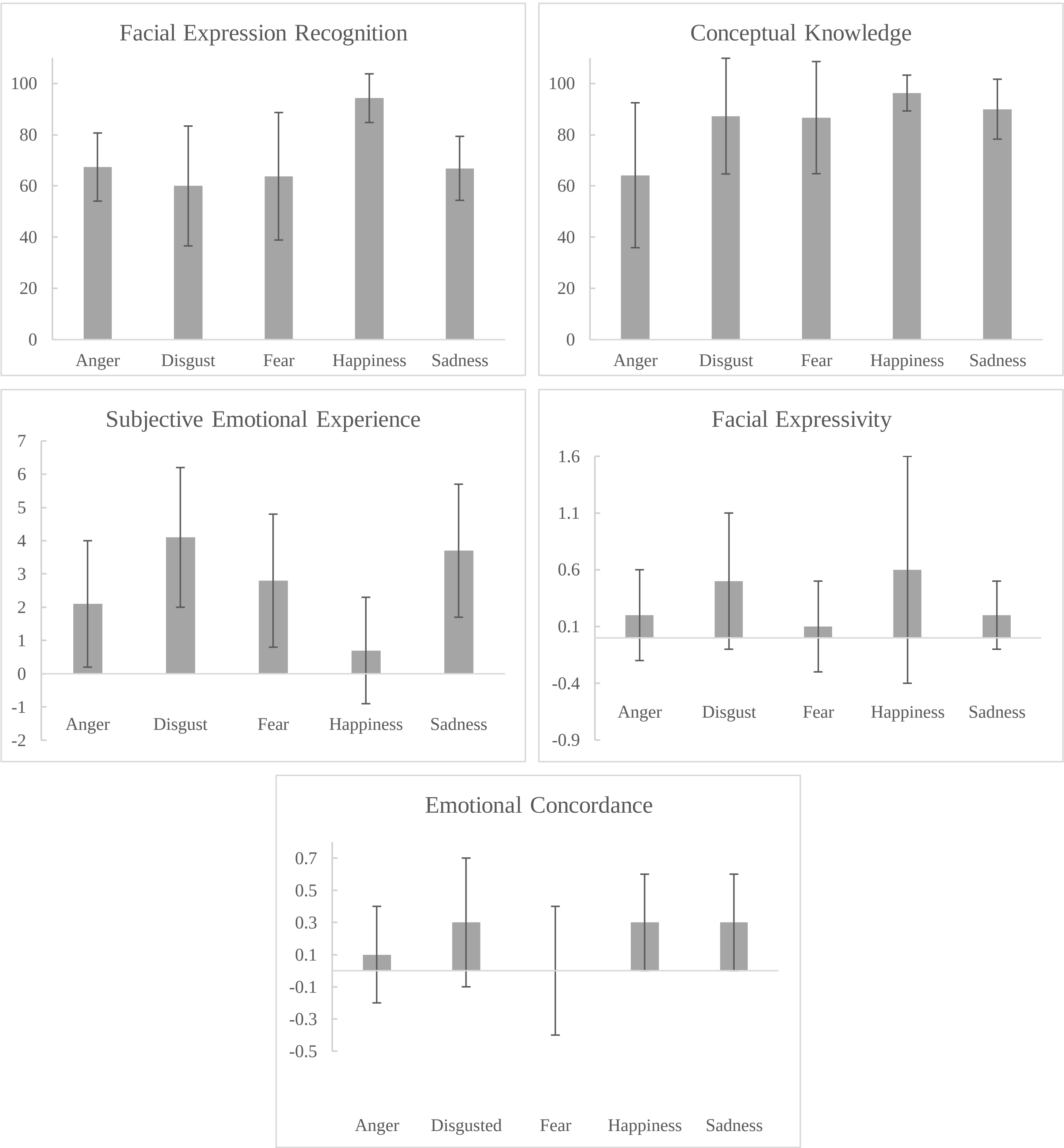
Means and Standard Deviations for Facial Expression Recognition, Conceptual Knowledge, Subjective Emotional Experience, Facial Expressivity, and Concordance at the Overall Level

	M	*SD*
1. Facial Expression Recognition	73.5	8.1
2. Conceptual Knowledge	82.9	14.7
3. Subjective Emotional Experience	0.6	0.8
4. Facial Expressivity	0.1	0.2
5. Concordance	0.2	0.2

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

Figure 6.1

Means and Standard Deviations for Facial Expression Recognition, Conceptual Knowledge, Subjective Emotional Experience, Facial Expressivity, and Emotional Concordance for Discrete Emotions



Facial Expression Recognition Performance

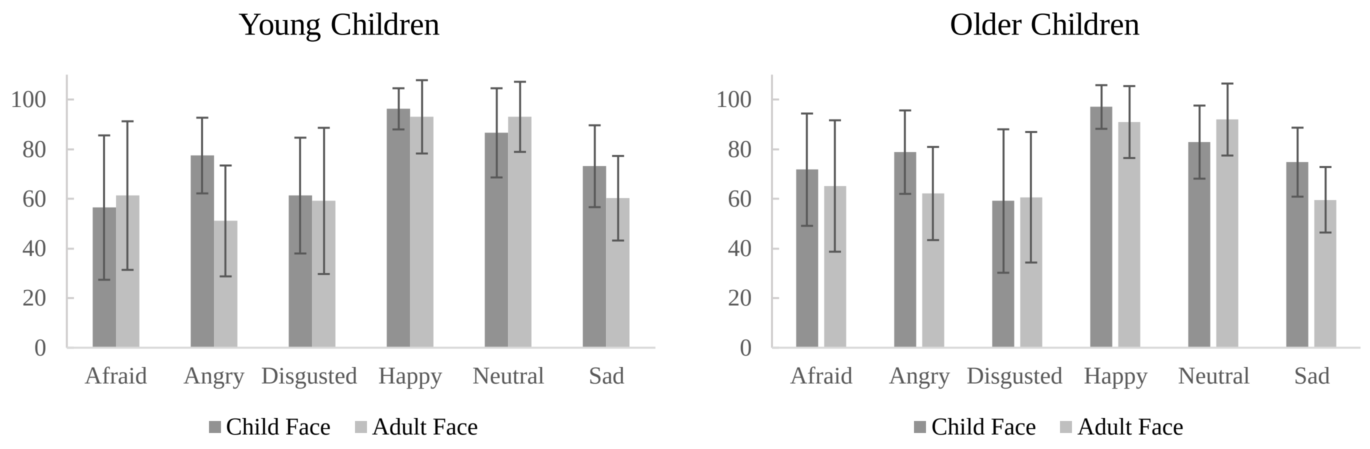
The descriptive statistics for facial expression recognition for each emotion category, split by child age (older, younger) and face age (child, adult) are summarised in Figure 6.2. Results of the three-way mixed model ANOVA demonstrated that there was a significant effect of the emotion category on recognition performance, F (3.45, 214.09) = 47.06, $p <$ .001, $\eta_p{}^2$ = .432. In addition to this, there was a significant main effect of face age on emotion recognition performance, F (1, 62) = 28.59, p <.001, $\eta_p{}^2$ = .316. There was no significant effect of age group on recognition performance, F (1, 62) = 1.12, p = .295, $\eta_p{}^2$ = .018. With regard to interactions, there was no significant Emotion Category × Age Group interaction, F (3.45, 214.09) = 1.26, p = .280, $\eta_p{}^2$ = .020. However, there was a significant Emotion Category × Face Age interaction, F (4.03, 249.90) = 16.39, p <.001, $\eta_p{}^2$ = .209. Finally, there was no significant Emotion Category × Age Group × Face Age interaction, F (4.03, 249.90) = 1.90, p = .110, $\eta_p{}^2$ = .029.

The significant main effect of emotion was examined using pairwise comparisons with a Bonferroni correction. Results indicated that the recognition of happy and neutral facial expressions was significantly more accurate than the recognition of angry, disgusted, afraid, and sad faces (ps < .001). There was no significant difference in accuracy in the recognition of happy facial expressions and neutral facial expressions (p = .097). There were no significant differences in facial expression recognition accuracy for negative emotions (ps ≥ .501).

Simple effects analyses were conducted to investigate the significant Emotion Category × Face Age interaction. Results revealed that for the recognition of angry, happy, and sad faces, child faces were recognised significantly more accurately than adult faces (ps ≤ .012). For the recognition of neutral faces, adult faces were recognised with significantly greater accuracy than child faces (p <.001). There were no significant differences between adult and child faces for the recognition of afraid or disgusted faces ($ps \geq .759$).

Figure 6.2

Means and Standard Deviations for Facial Expression Recognition for Adult and Child Faces, by Age Group



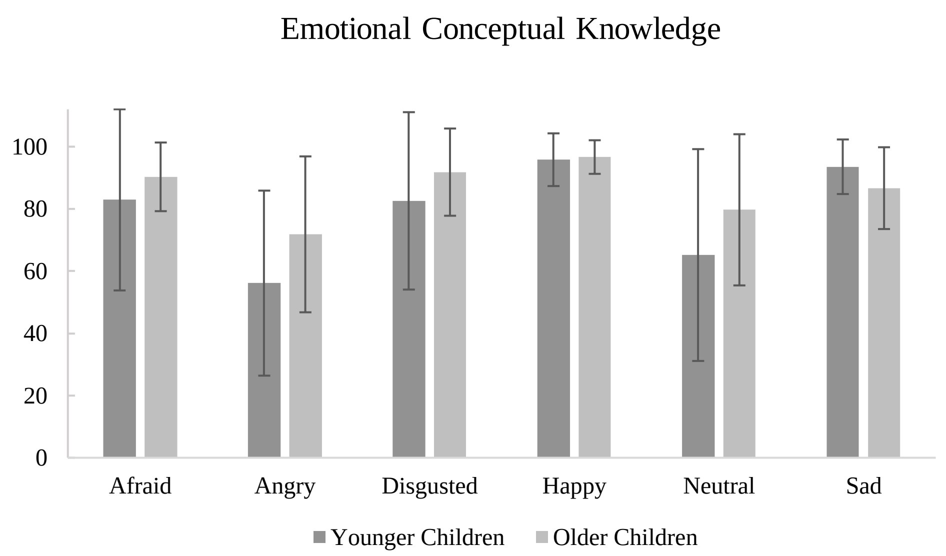
Emotional Conceptual Knowledge Performance

The descriptive statistics for emotional conceptual knowledge for each emotion category, split by child age (older, younger) is summarised in Figure 6.3. Results of a 2 x 6 mixed model ANOVA indicated that there was a significant main effect of emotion category on emotional conceptual knowledge performance, F (3.47, 214.95) = 30.79, $p < .001$, ${\eta_p}^2 = .33$. There was no significant main effect of age on emotional conceptual knowledge performance, F (1,62) = 3.56, $p = .064$, ${\eta_p}^2 = .05$. However, there was a significant Emotion Category × Age Group interaction, F (3.47, 214.95) = 3.88, $p = .007$, ${\eta_p}^2 = .06$. To investigate the significant Emotion Category × Age interaction, simple main effects (Bonferroni corrected) comparisons were conducted. Results revealed there were no significant differences between younger and older children for any emotion ($ps \geq .102$).

The significant main effect of target emotion was investigated using pairwise comparisons with a Bonferroni correction. Emotional conceptual knowledge accuracy was highest for happiness, compared to all other emotions (*p*s ≤ .014). Accuracy in emotional conceptual knowledge was lowest for neutral vignettes compared to all other emotions (*p*s < .001), except angry (*p* = .277). Angry vignettes were identified with significantly less accuracy than sad, disgusted and afraid vignettes (*p*s < .001). There were no significant differences in conceptual knowledge of afraid, sad and disgusted (*p*s = 1.00).

Figure 6.3

Means and Standard Deviations for Emotional Conceptual Knowledge for Each Emotion Category by Age



Bivariate Correlations

Overall

In order to determine whether overall facial expressivity, subjective emotional experience, emotional concordance and emotional conceptual knowledge were associated with facial expression recognition ability, bivariate correlations were estimated. The results of these correlations, along with the means and standard deviations for these variables are summarised in Table 6.4. Facial expression recognition accuracy was significantly positively correlated with conceptual knowledge accuracy. Overall facial expression recognition accuracy was not significantly correlated with facial expressivity, subjective emotional experience, or emotional concordance.

Table 6.5

Bivariate Correlations for Age, Facial Expression Recognition, Conceptual Knowledge, Subjective Emotional Experience, Facial Expressivity, and Emotional Concordance at the Overall Level

	1.	2.	3.	4.	5.	6.
1. Age	-	.00	.15	.03	-.17	.08
2. Facial Expression Recognition		-	.40**	.01	.12	-.07
3. Conceptual Knowledge			-	-.12	.08	.21
4. Subjective Emotional Experience				-	.18	.17
5. Facial Expressivity					-	-.05
6. Concordance						-

Discrete Emotions

Emotional conceptual knowledge accuracy for angry and disgusted vignettes was significantly and positively associated with facial expression recognition accuracy of the respective emotions. There were no significant relationships between subjective emotional experience, and facial expressivity and facial expression recognition across all discrete emotions. Spearman’s correlations are summarised in Table 6.5.

Table 6.6

Bivariate Correlations for Age, Facial Expression Recognition, Conceptual Knowledge, Subjective Emotional Experience, Facial Expressivity, and Emotional Concordance for Discrete Emotions

	1.	2.	3.	4.	5.	6.
Angry						
1. Age	-	.12	.19	.17	-.03	-.09
2. Facial Expression Recognition		-	.29*	-.00	.19	.01
3. Conceptual Knowledge			-	.06	.18	.30*
4. Subjective Emotional Experience				-	-.08	.02
5. Facial Expressivity					-	.36**
6. Concordance						-
Disgusted						
1. Age	-	-.03	.19	-.03	.13	.24
2. Facial Expression Recognition		-	.38**	-.01	-.16	-.02
3. Conceptual Knowledge			-	.02	.11	.10
4. Subjective Emotional Experience				-	.02	.26*
5. Facial Expressivity					-	.67**
6. Concordance						-

Afraid						
1. Age	-	.14	.10	-.07	.14	-.15
2. Facial Expression Recognition		-	.21	.10	.01	.17
3. Conceptual Knowledge			-	.01	-.04	.00
4. Subjective Emotional Experience				-	.27*	.26*
5. Facial Expressivity					-	.25
6. Concordance						-
Happy						
1. Age	-	-.03	-.12	.22	.07	.18
2. Facial Expression Recognition		-	.08	.16	.10	-.01
3. Conceptual Knowledge			-	-.03	.09	-.07
4. Subjective Emotional Experience				-	.25*	.22
5. Facial Expressivity					-	.19
6. Concordance						-
Sad						
1. Age	-	-.03	-.16	.11	-.09	-.03
2. Facial Expression Recognition		-	.02	-.17	.24	.07
3. Conceptual Knowledge			-	-.17	-.14	-.09
4. Subjective Emotional Experience				-	.11	.27*

5. Facial Expressivity	-	.43**
6. Concordance		-

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

Discussion

The primary aim of the current study was to develop and validate a children's film clip task to elicit facial expressions and subjective experience of five basic emotions: afraid, angry, disgusted, happy, sad, as well as neutral. The present study tested the effectiveness of 12 film clips in eliciting emotions by measuring self-report subjective emotional experience ratings and facial expressivity. Secondary aims were to use the developed film clip task to assess the relationships between facial expressivity, subjective emotional experience, emotional conceptual knowledge, emotional concordance, and facial expression recognition for discrete emotions in children.

The hypothesis that the film clip task would be a valid and reliable way to measure subjective emotional experience amongst children was largely supported. Analyses were conducted for each of the 12 film clips to measure their effectiveness of eliciting the target emotion (e.g., happy subjective emotional experience ratings in response to happy film clips). For all clips, with the exception of those selected to be emotionally neutral, the target emotion was elicited the highest, however it was not always elicited significantly higher than other emotions. For example, *Lemony Snickets* (fear target) induced fear higher than all other emotions, but this was not significantly higher than sadness. This is perhaps not surprising, as it is consistent with findings in previous studies validating film clips in adults (Schaefer et al., 2010). Schaefer et al. (2010) suggested that it is difficult to elicit discrete emotions in isolation, as often the experience of emotion consists of a combination of discrete emotions. It may be plausible that, instead of eliciting a discrete emotional response, these film clips provoked a combination of emotions. For example, the film clip *Cinderella* (targeting an anger response) may have also provoked the experience of sadness because *Cinderella* has her dress destroyed by her step-sisters and step-mother. Thus, children may have endorsed anger, but also endorsed sadness as an empathetic response for the protagonist. *Home Alone* (neutral target) was the only clip where the target emotion was rated significantly lower than other emotions (i.e., afraid and angry). A possible explanation for this is the nature of the scene. *Home Alone* depicted a plane waiting at the airport for take-off. It may be the case that the depiction of a plane at an airport provoked negative emotion (e.g., fear) in children as a result of prior experience with air travel. While *Home Alone* was not validated for eliciting a neutral response, *The Lion King* (neutral) did not elicit any emotion, as reflected in the absence of significant difference in subjective experiences across all emotions measured. When examining the film clips for age-related differences in the experience of emotion, results indicated there was no effect of age, nor were there any interactions between emotion ratings and age group. Thus, these clips appear to elicit emotion consistently across two age groups, suggesting that they are appropriate for measuring evoked emotion in children aged 6- to 12-years.

In addressing the hypothesis that the film clip task would produce the expressive component of emotional experience, as measured by facial expressivity, this hypothesis was only supported for the *Mr Bean* film clip, which targeted happy emotional expression. For *Harry Potter* (anger target), *Cinderella* (anger target), *Lion King* (sad target), and *Born Survivor* (disgust target) film clips, the target emotional expression was expressed more so than all other expressions, however, these differences were not always significant. Contrary to predictions, for *Fox and the Hound* (happy target), happy facial expressions were produced significantly less than anger facial expressions. For *Marley and Me* (sad target), *Lemony Snickets* (fear target) and *Fox and the Hound* (fear target), anger was expressed the most of all facial expressions, though in some instances this was not significantly different from the target emotion. As discussed above, it is often difficult to provoke emotion in isolation Schaefer et al. (2010), thus it may be that the film clips targeting negative emotions may not have successfully produced these discrete emotions in isolation. For both film clips targeting a disgust response (*Born Survivor* and *Shrek Forever After*), happiness was expressed to a greater degree than disgust. There are at least two possible explanations for this finding. First, abnormalities in the production of disgust facial expressions in response to disgust clips may be due to a lack of experience and knowledge of this emotion. Indeed, the recognition and conceptual understanding of disgust is one of the last emotions to develop (e.g., Camras & Allison, 1985). A second possible explanation may relate to the fact that the film clips targeting disgust may produce a combination of disgust and happiness. For example, in Born Survivor the protagonist eats a bug and explodes, and this may produce both disgust and amusement inducing expressions of happiness alongside expressions of disgust. Although disgust was endorsed the highest in self-report ratings, it may be that participants expressed a mixture of emotions across the film clip but endorsed disgust after the clip as this was the most predominant emotion they felt in response to these clips.

A secondary aim of the current study was to determine the extent to which a child's facial expressivity, subjective emotional experience, emotional concordance, and emotion conceptual knowledge is associated with their facial expression recognition ability. Contrary to hypotheses, at an overall emotion level there were no significant relationships between facial expressivity, subjective emotional experience, emotional concordance, and facial expression recognition. At a discrete emotion level, emotional concordance was not significantly associated with facial expression recognition for any emotion. Afraid and happy subjective emotion ratings were positively correlated with facial expressivity of the corresponding emotion, but not with the recognition of that emotion. The finding that the experience and expression of fear and happiness are linked in children is consistent with patterns observed in adult samples: adults who are more emotionally expressive also tend to report higher intensity subjective emotional experience of the corresponding emotion (Ekman et al., 1980; Reisenzein et al., 2013). For emotional conceptual knowledge, results indicated that there were no significant relationships present between the experience and expression of emotion and emotional conceptual knowledge at any emotion level. However, the results of the current study largely supported the hypothesis of a relationship between conceptual knowledge and facial expression recognition. There were significant, positive correlations present between emotional conceptual knowledge and facial expression recognition at an overall emotion level, and for two discrete emotions (anger and disgust). There were no significant correlations present between the emotional conceptual knowledge of happiness, fear, or sadness and the recognition of their respective facial expressions. One possible explanation for this is that children tend to perform at ceiling in the recognition of happiness and sadness, as these are the first emotions to emerge and develop in the acquisition of emotion concepts and recognition of emotion (Smiley & Huttenlocher, 1989; Vicari et al., 2000). This is partially in line with the results of the current study, as happiness was the most well-recognised facial expression.

The discovery of a positive relationship between emotional conceptual knowledge and facial expression recognition ability at an overall level, and for anger and disgust is consistent with findings from previous research. It has been reported that children are more accurate in identifying disgust in a conceptual knowledge task, as opposed to a facial expression labelling task (Nelson et al., 2013; Widen & Russell, 2010). This is consistent with findings from the current study that superior conceptual knowledge is associated with superior facial expression recognition ability at the overall level, and for anger and disgust. Fong et al. (2020) reported that performance in an emotional conceptual knowledge task was associated with age, whereas performance in a facial expression labelling task was associated with emotion type. This is consistent with the notion that the acquisition of facial expression recognition follows different trajectories depending on the emotion (Rodger et al., 2015). The results of the current study indicate that there is a clear relationship between facial expression recognition ability and emotional conceptual knowledge. As such, emotional conceptual knowledge may explain the gradual increase in facial expression recognition across development; as children age, they develop the conceptual understanding of emotions, which informs their facial expression recognition ability.

One unexpected finding was that facial expressivity and subjective emotional experience were not correlated with the recognition of the relative emotion at the overall level, or for any discrete emotions. Given that links are found between the expression, experience and recognition of emotion amongst adult and older adult samples (e.g., Bailey et al., 2009; Scheibe & Carstensen, 2010), we expected to see this relationship in some form amongst our sample of children. The lack of relationship between the expression and experience of emotion and facial expression recognition in children may be indicative of reliance on an additional process throughout development; perhaps facial expression recognition is more contingent on a child's level of emotional conceptual understanding as opposed to their experience and expression of emotion. The results of the current study provide support for the notion that facial expression recognition is associated with emotional conceptual knowledge, as there were significant, positive relationships present between conceptual knowledge and facial expression recognition at the overall level, and for anger and disgust.

The findings of the current study highlight several avenues for future research. First, the results of the current study demonstrate that the use of film is effective in manipulating and measuring changes in subjective emotional experience in children. For all film clips (with the exception of neutral clips), the target emotion was rated higher than all other emotions, thus validating these clips. The fact that most film clips elicited a combination of emotions is consistent with the use of film clips to provoke emotion an adult sample, with Schaefer et al. (2010) suggesting that it is difficult to elicit emotion in isolation. Despite this, in four out of the twelve film clips used in the current study, the target emotion was endorsed significantly higher than all other emotions. However, for facial expressivity, this was not reliably the case. Although some film clips failed to elicit the target emotion higher than all other emotions (e.g., Harry Potter), the film clips did not have a significant effect on the type of emotions that were expressed. There may be two explanations for these non-significant findings. First, the method for aggregating facial expressivity scores was to compute the average facial expression across each film clip to produce a single score for each emotional expression, for each film clip. Averaging emotions across the film clips may be problematic as the target emotion may not be expressed across the entire clip. Thus, if children experience multiple emotions, it may be difficult to identify the most prevalent emotion from facial expressivity scores. As such, subjective emotional experience scores may be more appropriate measure of emotion to validate the film clips, as it is easier to determine the emotion that was experienced the highest. A second explanation is associated with the limitations of the software used. The subjective experience ratings for most clips endorsed the target emotion higher than all other emotions, indicating that these clips were successful in eliciting the target emotion. Thus, it may be the case that facial expressivity of the target emotion was not detected by the Emotient module. There are two possible reasons for the Emotient module failing to detect the facial expressivity of the target emotion. First, it may be the case that participants were not displaying the target emotion. Emotion regulation is associated with a decrease in the outward expression of facial expressions (Gross, 2002). As such, it may be the case that children were regulating their facial expressions, thus producing no, or little, facial expressivity of emotion. This study did not account for emotion regulation, thus future research may wish to include this in their protocols. Second, it may be the Emotient module is not an effective tool for measuring facial expressivity in children. It has been reported in the body of literature associated with computer coding that the Emotient module software is sensitive to changes in viewing angle and overall visibility of the face

(Dente et al., 2017). Efforts were made to ensure that children sat as still as possible during the film clips, however it may be the case that children's emotional reactions to the film clips obscured their face, inhibiting the Emotient module's ability to read and analyse facial expressions.

This study was the first to use these film clips as a method of emotion induction in children, as there is no bank of validated film clips for induction of discrete emotions in children. The development of this film task introduces a novel tool for research on emotional development, providing a way to measure and induce the experience of emotion in several child populations. By using the emotional film task, future research is now able to address a number of different research questions concerning differences between neurotypical children, and children with developmental disorders who experience differences in the experience of emotion (e.g., Autism Spectrum Disorder, Williams syndrome; Järvinen-Pasley et al., 2010; Losh & Capps, 2006) to understand when these changes first emerge and investigate relationships with other emotion processes (e.g., facial expression recognition). The validation of the emotional film task opens avenues for future research. Researchers may wish to use this film task to examine if there are predictive relationships between subjective emotional experience and other emotion processes in larger samples of children. This film task could also be used to examine differences in emotional experience between children of different age-groups. Although the current study did not observe age-related differences in the subjective experience of emotion, studies using larger samples may be able to identify differences that may exist. As such, the development and validation of an emotion film task for use in samples of children provides a significant step forward for research into emotional development.

In summary, the results of the current study present a significant step forward in the methodology for emotion induction in children. The current study was the first study to validate film clips for eliciting the subjective experience of discrete emotion in children. Within this novel film clip task, children produced subjective experience ratings that were indicative of successful emotion elicitation. In addition, the current study examined the relationships between the subjective experience, facial expressivity, conceptual knowledge, and recognition of emotion in children. Results indicated positive relationships between conceptual knowledge and facial expression recognition of anger and disgust. Such results indicate that children who have higher conceptual understanding of these emotions have greater accuracy in recognising these facial expressions. In developing this film clip task, the current study developed and validated a measure for examining subjective emotional experience in children, as well as providing insights for the relationships between emotional conceptual knowledge, facial expression recognition, subjective emotional experience and facial expressivity.

Chapter 7: Thesis Review and Discussion

Introduction and Chapter Overview

The studies that form this thesis were designed to measure facial expression recognition, subjective emotional experience, facial expressivity, and emotional concordance across three populations (younger adults, older adults, and children). The main objectives were to:

1. Examine the predictors of facial expression recognition performance in younger adults (Chapter 4)
2. Examine age-related differences in the experience (subjective emotional experience) and expression (facial expressivity) of emotion, emotional concordance, emotion regulation and facial expression recognition between older and younger adults (Chapter 5)
3. Develop and validate an emotional film task for use in a sample of children (Chapter 6)
4. Examine the relationships between subjective emotional experience, facial expressivity, emotional concordance, emotional conceptual knowledge, and facial expression recognition in children (Chapter 6)

This chapter will address the findings from these three studies and discuss how they contribute to our understanding of the experience and expression of emotion, and related processes, including their relationship to not only each other, but also facial expression recognition ability. This chapter concludes with a discussion of the implications of these results, and future directions.

Study 1

Facial expression recognition has received an extensive amount of research attention, with studies devoted to understanding its development (Rodger et al., 2015) and decline (Ruffman et al., 2008) across the lifespan. As outlined in Chapter 4 (Study 1), the *simulationist model* of facial expression recognition posits that we recognise the emotions of others by simulating them within ourselves (Goldman & Sripada, 2005). This approach suggests that when we mimic the emotion of others, we read our own expression which facilitates the interpretation of the observed emotion (Oberman et al., 2007). As such, it would be expected that our facial expressions produced under emotion inducing circumstances should correlate with our self-reported emotional experience, and thus our ability to recognise facial expressions of emotion.

To date there is a scarcity of research devoted to understanding how facial expressivity (the extent to which we facially express our emotions) and the subjective emotional experience may relate to facial expression recognition. Furthermore, there is a lack of research that has been devoted to emotional concordance, emotion regulation and the extent to which these emotion processes predict facial expression recognition ability. These three notable gaps in the current literature are what formed the basis for the first study.

The first aim of Study 1 was to examine whether facial expressivity, subjective emotional experience and emotion regulation served as unique predictors of facial expression recognition. Second, Study 1 also aimed to determine if emotional concordance significantly predicted facial expression recognition ability, over and above facial expressivity, subjective emotional experience, and emotion regulation. This was examined across two experiments; the first experiment examined these relationships with a dimensional approach, assessing emotion at an overall, and valence (positive, and negative) level, while the second experiment examined these relationships at a discrete emotion (i.e., angry, fearful, happy, disgusted, sad) level.

Summary of Results

In Experiment 1, analyses at the overall emotion level revealed that facial expression recognition ability positively correlated with emotional concordance, and facial expressivity. Additionally, there was a significant, negative correlation with facial expression recognition and expressive suppression. At the positive emotion level, there was a significant, negative correlation between facial expression recognition and cognitive reappraisal, indicating that greater use of reappraisal was associated with poorer facial expression recognition of positive emotions. At the negative emotion level, facial expression recognition ability was positively correlated with emotional concordance, facial expressivity, and subjective emotional experience.

These relationships were examined with a series of hierarchical multiple regressions. Results indicated that subjective emotional experience was a significant, unique predictor of facial expression recognition at the overall level. As such, participants who reported greater subjective emotional experience across all emotions were also more accurate in recognising facial expressions. This is consistent with existing literature, outlining that individuals who have more intense subjective emotional experience also tend to be more sensitive to the emotions of others (Terasawa et al., 2014).

In Experiment 1, overall emotional concordance was also identified as a significant predictor of overall facial expression recognition ability and accounted for variance in facial expression recognition above facial expressivity and subjective emotional experience. However, when examining these relationships at a valence level (positive and negative), facial expressivity, subjective emotional experience, and emotional concordance were not significant predictors of facial expression recognition ability. Additionally, facial expressivity did not significantly predict facial expression recognition ability at any level of emotion (i.e., overall, positive, negative). The finding for relationships at the overall emotion level, but not the valence level may be attributed to a reduction in variability when breaking down emotional concordance at a positive and negative emotion level. In examining emotional concordance at an overall level, it may be the case there is enough variability in concordance for an obvious relationship with facial expression recognition. As such, when examining concordance at a valence level, the variability in concordance explaining facial expression recognition ability may be washed out.

Consistent with the *simulationist model*, these results suggest that, at the overall level, there is a relationship between the degree to which our facial expressions map onto our emotional experience and our accuracy identifying the facial expressions of others. To our knowledge, this is the first time a relationship between facial expression recognition and emotional concordance has been reported. As such, the finding that emotional concordance significantly predicts facial expression recognition ability presents a novel finding to the body of literature on facial expression recognition. However, it should be noted that this relationship was not observed across both experiments, thus this finding provides only initial evidence for the predictive relationship between emotional concordance and facial expression recognition.

In Experiment 2, the predictors of facial expression recognition ability were examined at an overall and valence level (positive and negative), as well as a discrete emotion level. Unlike Experiment 1, the results of Experiment 2 indicated that none of the variables of interest were significant predictors of facial expression recognition. As discussed in Chapter 6, the lack of replication of the findings between Experiment 1 and Experiment 2 may be attributed to the stimuli that was used in Experiment 2. The film clips used in Experiment 2 were selected on the basis that they would provoke intense emotional experience. As such, it may be the case that the clips used in Experiment 2 produced higher intensity emotional experience across all participants, reducing the magnitude of individual differences necessary to identify a relationship with facial expression recognition ability.

Interestingly, Experiment 2 demonstrated that expressive suppression was a significant, negative predictor of facial expression recognition ability at an overall emotion level. As such, people who exhibited greater suppression of their own facial expressions were less accurate when identifying the expressions of others. To our knowledge, there is only one other study that has assessed the relationship between facial expression recognition and expressive suppression. Passardi et al. (2019) reported that alexithymia may moderate the relationship between facial expression recognition and expressive suppression in a clinical sample (individuals with post-traumatic stress disorder). Given that alexithymia has been linked to poorer facial expression recognition skills in healthy populations (for a review, see Grynberg et al., 2012), future research would benefit from including alexithymic traits in the regression model when assessing suppression and emotion recognition in healthy adults.

When taken together, the results for Experiment 1 and Experiment 2 in Study 1 suggest that the subjective experience of emotion, and emotional concordance may be related to facial expression ability. People who experience higher intensity emotional experience, and greater concordance between their subjective emotional experience and facial expressivity tend to be more accurate in recognising facial expressions of emotion. Furthermore, the extent to which we suppress our expression of emotion may also relate to our ability to recognise the emotions of other people.

Contributions of Study 1

Although Study 1 provided evidence of several relationships between emotion processes and facial expression recognition, there are two key findings that make a significant contribution to the current literature. First, the finding that emotional concordance may predict facial expression recognition ability presents a significant step forward. To date, there is a scarcity of research devoted to emotional concordance and facial expression recognition ability. It is well-established in the literature that an individual's facial expressions are associated with their experience of emotion, and our facial expressions and subjective emotional experience are related to our facial expression recognition ability (Davis et al., 2009; Lewis, 2012; Strack et al., 1988). However, it has not yet been demonstrated how the relationship between our facial expressions and our subjective emotional experience relate to our ability to recognise facial expressions of emotion. The current study indicated that emotional concordance may be a significant, positive, predictor of facial expression recognition ability. This finding provides partial support for the *simulationist* model by indicating that the relationship between our facial expressivity and subjective emotional experience may have a predictive role in our facial expression recognition ability. Such findings are the first of their kind and can be used in guiding future research in facial expression recognition. This may be of relevance to examining facial expression recognition in populations with known deficits in this ability (see Study 2 of the current research).

The second key contribution of Study 1 is the finding that expressive suppression is negatively associated with facial expression recognition ability. This study found that people who engage in greater expressive suppression are less accurate in the recognition of emotional facial expressions. Both Experiment 1 and Experiment 2 uncovered novel findings for a negative relationship between expressive suppression and facial expression recognition across two samples of healthy, younger adults. However, this relationship was only significant in the regression model in Experiment 2. To our knowledge, research investigating facial expression recognition ability does not typically consider expressive suppression, and how it may relate to facial expression recognition ability. Thus, the findings from Study 1 highlight two key ventures for future research. First, future research should aim to replicate the finding that expressive suppression is significantly negatively associated with facial expression recognition ability. Second, future research should also include expressive suppression as a control variable in studies investigating individual differences in facial expression recognition ability.

Limitations of Study 1

There were inconsistencies in the results between Experiment 1, and Experiment 2. In Experiment 1, subjective emotional experience and emotional concordance were significant predictors of facial expression recognition ability. However, Experiment 2 failed to replicate these findings. In addition to this, Experiment 2 indicated that expressive suppression was a significant predictor of facial expression recognition ability, in contrast in Experiment 1 this relationship was only associative. As such, there were two aspects of the methodology that may account for these discrepant findings.

First, two different film tasks were used across the two experiments. The film task for Experiment 1 was originally designed to evoke emotion at a valence (i.e., positive and negative) level, eliciting a moderate emotional response to avoid ceiling effects (Koval et al., 2013). The clips selected for the film task in Experiment 2, however, were selected with the intention of eliciting discrete emotion, and were thus selected on their ability to provoke a higher intensity emotional response at a discrete emotional level. As such, the failure to replicate the concordance findings of Experiment 1 may be associated with the difference in the film tasks. As clips were selected on the basis that they provoke higher intensity emotion, it may be the case that the clips in Experiment 2 provoked a higher intensity emotional response across all participants, reducing individual differences in emotional concordance. For the purposes of Experiment 2, it was necessary to develop an emotional film task with clips that provoked higher intensity emotional experience for two reasons:

1. The film clips in the original task were selected to provoke positive and negative emotion, and not specific, discrete emotions. As such, it would

not be appropriate to use this task to provoke and measure discrete emotions.

2. Schaefer et al. (2010) emphasise that it is difficult to elicit discrete emotions in isolation. Therefore, to ensure the maximum target emotion elicitation, it was important that the films that were selected were ranked highest for their target emotion.

The second potential limitation of Study 1 may relate to the method used for producing a single score for each emotional expression for each clip. The software used for measuring participant's facial expressivity (iMotions Emotient module) codes facial expressions multiple times per second during each film clip. Given the complexity of the data, a decision was made to average facial expressions across each film clip, producing a single score for each emotion, for each film clip. This method may underestimate facial expressivity, as the emotional content of each film clip was not constant throughout the entire clip. Given that the clips in Experiment 2 were selected based on their ability to provoke intense emotional responses, the emotional content of the clips may have been more climactic in nature, compared to Experiment 1. Consequently, averaging the measure of emotional expression across this clip would mean that this metric included time where the participant's facial expressions are largely neutral (i.e., where there was not much emotional content in the clip). The film clips in Experiment 1 were chosen on the basis that they were less extreme in provoking emotion, which means that we may see a more accurate measure of facial expressivity, and thus concordance in the first experiment. That is, by selecting clips that are higher in emotional intensity, we may be reducing the individual differences and variability necessary to replicate the relationships in Experiment 1. Given that all studies in this thesis were conducted concurrently, both Study 2, and Study 3 will also be subject to this limitation.

Study 2

Study 2 (Chapter 5) of this thesis was devoted to examining age-related differences in emotional experience and expression, emotional concordance, and facial expression recognition in a single cohort of older adults, compared to a sample of younger adults. It has been well reported that older adults demonstrate significant, age-related impairments in the recognition of anger, fear, and sadness compared to their younger counterparts (Ruffman et al., 2008). However, the age-related changes in the subjective experience of emotion, facial expressivity, and emotional concordance have received less attention. Furthermore, the research that has been devoted to facial expressivity and subjective emotional experience (e.g., Steenhaut et al., 2018; Vieillard & Gilet, 2013) have not examined these aspects of emotion, and how they may relate to facial expression recognition within the same sample of older adults, increasing the risk of cohort effects. These notable gaps in the current literature informed the approach to Study 2 in this thesis. As such, the aim of Study 2 was to investigate the age-related differences in the expression (i.e., facial expressivity) and subjective experience of emotion, emotional concordance, emotion regulation and facial expression recognition in single sample of older adults, compared to a sample of younger adults.

Summary of Results

Results showed that older adults displayed significantly poorer facial expression recognition ability for fearful and sad facial expressions, with no age-related differences in disgusted, angry, and happy facial expressions. These findings are largely consistent with research on age-related changes to facial expression recognition ability (Ruffman et al., 2008). With regard to the facial expressivity, older adults produced significantly less facial expressivity across all emotions, compared to their younger counterparts. Additionally, older adults also self-reported significantly higher subjective emotional experience of sadness and anger compared to younger adults, with no other age-related differences. The findings for facial expressivity are inconsistent with previous research which has indicated that older adults exhibit either an increase in the expression of happiness (Vieillard & Gilet, 2013), or no age-related differences at all (Steenhaut et al., 2018; Tsai et al., 2000). Furthermore, the finding that older adults did not differ significantly to younger adults in the experience of happiness is also not consistent with previous research. Previously, it has been reported that older adults report significantly higher experience of happiness (Smith et al., 2005; Vieillard & Gilet, 2013). Given that the increase in positive emotional experience is well supported by theoretical approaches such as the positivity bias (Carstensen & Mikels, 2005), it may be the case that the findings in the current research are associated with the methodological approach. It has been reported across a number of studies that older adults report a higher intensity emotion rating compared to their younger counterparts in response to scenes that are salient for older adults (Kliegel et al., 2007; Kunzmann & Grühn, 2005; Kunzmann & Richter, 2009). Therefore, the lack of significant differences in the experience of happiness in older adulthood reported in the current study may reflect the salience of the stimuli for happiness implemented here. Given that the films used in this study were validated for use in a sample of younger adults (Schaefer et al., 2010), it may be the case that they did not elicit happiness in older adults to a significant intensity.

Finally, the results of this study showed that there were no age-related differences in the use of emotion regulation strategies (expressive suppression and reappraisal). Most notably, results of Study 2 demonstrated that older adults show significantly lower levels of emotional concordance compared to younger adults for all emotions. Such findings indicate that as we age, the degree of correspondence between our subjective experience of emotion and facial expressivity declines.

Contributions of Study 2

The results from Study 2 make two, key contributions to the current literature. First, to our knowledge, the current study was the first to examine age-related differences in subjective emotional experience, facial expressivity, emotional concordance, emotion regulation and facial expression recognition in the same sample of older adults. Using the same sample of older adults to examine age-related differences in these aspects of emotion and related processes, and their relationships to facial expression recognition, provides strong evidence for the co-existence of age-related declines in concordance of all emotions, diminished facial expressivity of all emotions, and difficulty recognising facial expressions of fear and sadness.

The second contribution of Study 2 is the finding that older adults exhibit an age-related decrease in their level of emotional concordance. To our knowledge, this study was the first to demonstrate that older adults display less concordance between facial expressivity and subjective emotional experience compared to their younger counterparts. Such findings suggest that, as we age, the extent to which our experience and expression of emotion relate to each other decreases. These findings indicate that although we see age-related changes in subjective emotional experience and facial expressivity individually, the relationship between these two components of emotion weakens. Given that no other research has examined this relationship, the finding that emotional concordance decreases in older adulthood is a valuable contribution to the current literature around emotion and ageing. This finding suggests that in older adulthood, there appears to be a disconnect between the components of emotional experience.

Limitations of Study 2

The film clips used in the current study were taken from a validated bank of film clips for eliciting discrete emotions (Schaefer et al., 2010), which were validated on a sample of younger adults with an average age of 19.6 years. Although these clips were validated for eliciting discrete emotions, they have not been validated for use in a sample of older adults. As such, the film clips used offer a potential limitation, as a number of studies using film as an induction technique reveal higher intensity emotion ratings compared to their younger counterparts in response to scenes that are salient for older adults (Kliegel et al., 2007; Kunzmann & Grühn, 2005; Kunzmann & Richter, 2009; Seider et al., 2011). It was expected that older adults would experience significantly greater intensity subjective experience of happiness. However, results indicated that there were no age-related differences in the experience of happiness. It may be the case that the film clips used in the current study were not relatable for older adults, thus not eliciting happiness to a high degree. As such, the lack of an increase in the subjective experience of happiness in older adulthood reported in the current study may reflect the salience of the film clips. The objectives of this study were to examine age-related differences in the subjective experience of emotion (and other emotion processes), with this research being conducted concurrently with Study 1. As such, a pragmatic decision was made to draw from the validated bank of film clips for younger adults to remain consistent with the protocols used in the original film task from Experiment 1 of Study 1.

A second limitation associated with Study 2 is associated with the size of the sample of older adults. Study 2 recruited 42 older adults to examining age-related differences in the experience, expression, concordance, regulation, and recognition of emotion. As there were only 42 older adults in this sample, this study had insufficient power to use regression analyses to provide clarity as to whether it may be a lack of concordance that underpins declines in emotion recognition.

Study 3

A large proportion of research on the development of emotion has focussed on how facial expression recognition ability develops throughout childhood (Herba & Phillips, 2004;

Rodger et al., 2015). Comparatively, there is a scarcity of research devoted to how the experience of emotion, and its components, develop over the course of childhood. Given the scarcity of research into the experience of emotion in childhood, there are also a lack of suitable tasks to induce and measure emotion in children. The research aims of Study 3 (Chapter 6) were borne out these fundamental gaps in the current literature. Based on the methodology of Studies 1 and 2, Study 3 aimed to develop and validate an emotional film task to induce and measure the subjective experience and facial expressivity of discrete emotions in children. A secondary aim of Study 3 was to use this task to measure the relationships between facial expression recognition, subjective emotional experience, facial expressivity, emotional concordance, and emotional conceptual knowledge in children.

Summary of Results

The outcome of this study was the development and validation of a film task for the induction and measurement of five basic emotions (fear, anger, disgust, happiness, and sadness) in children. When examining the film clips for age-related differences in the experience of emotion, there was no effect of age, nor significant interactions between emotion ratings and age group. As such, the results of this study suggest that these clips elicit emotion in a consistent way in younger and older children, indicating that they are appropriate for measuring subjective emotional experience in children aged 6-12 years. Results showed that the target emotion was endorsed significantly greater than all other emotions for each film clip (except for neutral clips). Despite the target emotion being elicited the highest, it was not always elicited significantly higher than other emotions (e.g., happy clips, anger clips, and sad clips).

Results of Study 3 showed no significant relationships between facial expressivity or subjective emotional experience and facial expression recognition. This was the case both at an overall level, and at a discrete emotion level. Unlike the results from research with adults

(Study 1), there were no significant relationships between emotional concordance and facial expression recognition in children. Interestingly, the results of the current study indicated that there were strong, positive relationships present between facial expression recognition and the child's level of emotional conceptual knowledge. That is, children who had greater emotional conceptual knowledge were also more accurate recognising facial expressions. This result was uncovered at the overall emotion level, and for anger and disgust. It has been reported that children tend to perform at ceiling in the recognition of happiness and sadness (Smiley & Huttenlocher, 1989; Vicari et al., 2000), thus the lack of relationship between conceptual knowledge (or any other variable) with facial expression recognition for these emotions is unsurprising. Given that the accurate recognition of anger and disgust is acquired later in childhood compared to other emotions (Herba & Phillips, 2004; Widen, 2013), it may be the case that conceptual understanding of these emotions is a precursor to recognising the expression of them.

Contributions of Study 3

The validated film clip task for children is an important addition for research assessing the subjective experience of discrete emotion in children because it fills a key gap in the current literature. Prior to the current research, the self-report subjective experience of emotion had only been examined by a small number of studies, with only one other study using film to induce emotion (von Leupoldt et al., 2007). von Leupoldt et al. (2007) used film to examine the experience of emotion in children, but only assessed this at a valence (i.e., positive and negative emotion) level, and not at a discrete emotion level. By examining subjective emotional experience at a valence level, we do not gain a robust assessment of subjective emotional experience, potentially overlooking some of the patterns that may occur across discrete emotions. The film task that was developed and validated in Study 3 presented a significant step forward in the methodology used for emotion induction in children, as it was the first to validate film clips for eliciting the subjective experience of discrete emotion in children. By using the emotional film task, future research is now able to address a number of different research questions concerning differences between neurotypical children, and children with developmental disorders who experience differences in the experience of emotion (e.g., Autism Spectrum Disorder, Williams syndrome; Järvinen-Pasley et al., 2010; Losh & Capps, 2006) to understand when these changes first emerge and investigate relationships with other emotion processes (e.g., facial expression recognition).

Given the lack of tools for measuring the subjective experience of emotion and how they may relate to facial expression recognition in children, the results of this study present a significant step forward in the field. To our knowledge, Study 3 was the first to measure emotional experience, facial expressivity, emotional concordance, facial expression recognition, and emotional conceptual knowledge in children. By using the newly developed film task in the current sample, we were able to successfully induce emotion to assess how the experience of emotion (and expressivity and concordance) may relate to facial expression recognition ability. The results of the current study indicated that subjective emotional experience, expressivity, and concordance do not appear to have a relationship with facial expression recognition ability in childhood. However, there appears to be an important relationship between a child's level of emotional conceptual knowledge and facial expression recognition ability.

Limitations of Study 3

First, while the target emotion ratings were higher than all other emotions for all emotion clips, the target emotion was not always significantly higher than some emotions (e.g., anger ratings in response to anger clips were not significantly higher than sadness rating). Such results indicate that the film clips may produce a combination of emotions, as opposed to a single emotion in isolation. This issue is notable, but consistent with concerns outlined by

Schaefer et al. (2010), suggesting that it is difficult to elicit discrete emotions in isolation, as often the experience of emotion consists of a combination of discrete emotions. As such, children may have endorsed anger but also endorsed sadness in response to anger clips as an empathetic response to the protagonist.

The second limitation of this study is associated with the results for facial expressivity. Of the 12 film clips employed in the current study, only 2 induced the facial expressivity of the target emotion significantly higher than other emotions. The non-significant findings may be attributed to the limitations of the software that was used, as opposed to serving as an indicator of the validity of the clips. It has been discussed in the literature around computer coding software that, in some cases, the Emotient module has difficultly disentangling the emotions from one another (Dente et al., 2017). This is particularly the case when there are changes in viewing angle and overall visibility of the face (Dente et al., 2017). Although efforts were made to ensure children sat a still as possible and did not cover their faces during the film clips, it may be the case that the children's emotional reactions to the film clips obscured their face, impacting the Emotient module's ability to read and analyse their expressions. For example, in Born Survivor, the protagonist eats a bug which explodes out of his mouth. Some children may have reacted to this clip by covering their mouths in a disgusted reaction, which would have reduced the Emotient module's ability to record their disgusted facial reaction. As such, it may be the case that the Emotient module is not the best measure of facial expressivity in children. One way to overcome this limitation in future research may be to replicate this study using a different measure of expressivity (e.g., human coding etc.). This would determine whether the lack of facial expressivity of the target emotion is related to the limitations of the Emotient module in a sample of children, or the video clips themselves.

General Implications of the Findings and Future Directions

The studies included in this thesis have several, broad implications for our general understanding of the processes related to facial expression recognition, and research methods for inducing and measuring emotional experience in childhood. There are three primary implications that are borne out of the results of the studies in this thesis, including:

1. The contribution of emotional concordance to facial expression recognition
2. The age-related differences in emotional concordance
3. The measurement of subjective emotional experience in children

First, the finding for a significant (and sometimes predictive) relationship between emotional concordance and facial expression recognition has implications for theories around facial expression recognition. The *simulationist model* of facial expression recognition posits that facial feedback underpins our ability to recognise the facial expressions of others (Goldman & Sripada, 2005). That is, when we view an emotional facial expression, we automatically mimic this expression, inducing the subjective feelings associated with the emotion through facial feedback, which in turn facilitates the accurate recognition of the observed emotion. The facial feedback hypothesis suggests that a person's own facial muscle movements or facial expressions can influence their own emotional experience (Buck, 1980). As such, the findings from Study 1 in this thesis provide necessary support for this approach by demonstrating two things: First, that there is a significant association between our facial expressions and our subjective experience of the same emotion. This was evident by the presence of concordance. Second, that our emotional concordance is significantly associated with our ability to recognise the facial expressions of others. The findings from Study 1 provide support for the theory of facial feedback (and thus the *simulationist model*) as they indicate that those who have greater concordance between their facial expressivity and subjective emotional experience also tend to have greater accuracy in recognising the emotions of others.

Several future directions emerged from the findings and limitations of Study 1 of this thesis. First, for measuring emotional concordance, future research would benefit from analysing facial expressions produced for only portions of the film clips with the maximal emotional content. This would provide the opportunity for more refined analyses, and potentially overcome the lack of replication between Experiment 1 and Experiment 2 in Study 1 of this thesis. A second recommendation for future research is the incorporation of an emotion rating scale for emotion ratings during the film clips. This will assist in providing a more robust assessment of the fluctuations in subjective emotional experience across the clips (like the measurement of facial expressivity) to obtain a correlation between facial expressivity and subjective emotional experience within the film clip. By incorporating these recommendations, future research should unpack the relationship between emotional concordance and facial expression recognition.

To our knowledge, this research was the first to examine the age-related differences in the concordance between facial expressivity and subjective emotional experience. Results indicated that older adults demonstrate reduced emotional concordance when compared to their younger counterparts. That is, the relationship between older adults' facial expressivity and subjective experience of emotion was weaker. It has been highlighted recently that it is important to examine the concordance between emotion processes when examining emotional experience (Lougheed et al., 2021). As such, this research has provided further support for the need to include a measure of concordance in research on emotional experience and ageing, as there are important, age-related changes in the concordance between facial expressivity and subjective emotional experience. Future research would benefit from further unpacking this relationship; are the age-related changes in emotional concordance underpinned by changes to neural pathways, or other physiological responses? It would be beneficial to examine whether the decrease in the relationship between expressivity and experience is associated with changes to other physiological indicators of emotional experience (e.g., heart rate, galvanic skin response). In addition to this, future research would benefit from employing a larger sample of older and younger adults to understand how subjective emotional experience, facial expressivity, emotional concordance, and emotion regulation may relate to, and explain the age-related differences in facial expression recognition. By employing a larger sample, future research would have sufficient power to conduct analyses that provide clarity about the contribution of these processes to the age-related differences in facial expression recognition.

Third, this thesis has implications for research into the experience of emotion in childhood. A key contribution of this research is the development and validation of a film clip task to be used for inducing discrete emotions in children. This has significant implications for future emotion research in children. There is now a bank of 10 film clips that have been validated for the induction of discrete emotions in a sample of children that researchers can draw from in future research protocols. The development of this tool broadens the scope of research into the experience of emotion in childhood. This tool will assist researchers in addressing important questions, such as examining if there are differences in the experience of emotion between neurotypical children, and children with developmental disorders (e.g., Autism Spectrum Disorder). The current research project used this task to examine if there are relationships between the experience, expression, and recognition of emotion in children. The current study found that there were no meaningful differences between children who were 6-8 years old, and children who were 9-12 years old. Future research would benefit from using this task with a larger sample of children to assess if there are predictive relationships between subjective emotional experience and other emotion processes in a larger sample of children.

Conclusion

Prior to this series of three studies, gaps in the current literature existed regarding the predictors of facial expression recognition, age-related changes in emotion processes, and the measurement of emotional experience in childhood. The results of this thesis provide a significant step forward in our understanding of the processes that are associated with facial expression recognition and how we measure them. Specifically, this thesis was the first to uncover that emotional concordance and expressive suppression can be significant predictors of facial expression recognition ability, and that our degree of emotional concordance decreases in older adulthood. Additionally, this thesis developed a novel tool for inducing and measuring the subjective experience of emotion in a sample of children. Although there were some limitations that challenged the studies in this project, the findings of each study contribute uniquely to the literature around emotion. Importantly, this research provides insight into the relationships between our emotion processes in adults, and older adults, and equips future researchers with the tools to extend these questions into research with children.

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Appendices

Appendix A: Ethics Approval

Dear Applicant,

Principal Investigator: Dr Megan Willis
Co-Investigator: Dr Francesco Foroni
Student Researcher: Rachael Watson (Doctoral)
Ethics Register Number: 2018-37H
Project Title: The Contribution of Facial Expressivity and Subjective Emotional Experience to Facial Expression Recognition.
Date Approved: 01/05/2018
Ethics Clearance End Date: 30/06/2021

This is to certify that the above application has been reviewed by the Australian Catholic University Human Research Ethics Committee (ACU HREC). The application has been approved for the period given above.

Researchers are responsible for ensuring that all conditions of approval are adhered to, that they seek prior approval for any modifications and that they notify the HREC of any incidents or unexpected issues impacting on participants that arise in the course of their research. Researchers are also responsible for ensuring that they adhere to the requirements of the National Statement on Ethical Conduct in Human Research, the Australian Code for the Responsible Conduct of Research and the University's Code of Conduct.

Any queries relating to this application should be directed to the Ethics Secretariat (res.ethics@acu.edu.au). It is helpful if quote your ethics approval number in all communications with us.

If you require a formal approval certificate in addition to this email, please respond via reply email and one will be issued.

We wish you every success with your research.

Kind regards,

Kylie Pashley
on behalf of ACU HREC Chair, Assoc Prof. Michael Baker

Senior Research Ethics Officer | Office of the Deputy Vice Chancellor (Research) Australian Catholic University
T: +61 2 9739 2646 E: res.ethics@acu.edu.au

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Appendix B: Bivariate Correlations for Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity, Emotional Concordance, Suppression and Reappraisal for Younger Adults from Chapter 4

B.1 Bivariate Correlations at an Overall and Negative Valence Level

Table B.1.1

Bivariate Correlations for Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity, Emotional Concordance, Suppression and Reappraisal for Younger Adults for Overall and Negative Emotions.

	1.	2.	3.	4.	5.	6.
Overall Emotion						
1. FER	-	-.299	-.397**	.084	-.048	.119
2. SEE		-	.401**	-.078	.008	.158
3. FE			-	-.011	.080	-.227
4. EC				-	-.041	-.349*
5. ER-S					-	-.153
6. ER-R						-
Negative Emotions						
1. FER	-	-.254	-.437**	-.079	.234	-.036
2. SEE		-	.380*	-.083	-.013	-.132
3. FE			-	.168	-.464**	-.115
4. EC				-	-.195	.049
5. ER-S					-	-.016
6. ER-R						-

B.2 Bivariate Correlations at a Discrete Emotion Level

Table B.2.1

Bivariate Correlations for Facial Expression Recognition, Subjective Emotional Experience, Facial Expressivity, Emotional Concordance, Suppression and Reappraisal for Younger Adults for Discrete Emotions

Variable	1.	2.	3.	4.	5.	6.
Happiness						
7. FER	-	-.002	.361*	.485**	-.113	.192
8. SEE		-	.395**	.184	-.04	.144
9. FE			-	.617**	-.501**	.181
10. EC				-	-.376*	.199
11. ER-S					-	-.074
12. ER-R						-
Anger						
7. FER	-	-.010	-.220	-.192	.287	.011
8. SEE		-	.055	-.007	-.197	-.18
9. FE			-	.628**	-.392*	-.065
10. EC				-	-.209	.052
11. ER-S					-	-.016
12. ER-R						-
Disgust						
7. FER	-	.036	-.112	-.084	.156	-.048
8. SEE		-	.222	.325*	-.018	-.272
9. FE			-	.404**	-.397**	-.026
10. EC				-	-.117	-.074
11. ER-S					-	-.016
12. ER-R						-
Fear						
7. FER	-	.011	-.321*	.158	.100	.069
8. SEE		-	.273	-.284	-.116	-.143
9. FE			-	.144	-.020	.154

10. EC				-	.221	.136
11. ER-S					-	-.016
12. ER-R						-
Sadness						
7. FER	-	.078	-.075	.042	.08	-.169
8. SEE		-	.251	.259	-.043	-.193
9. FE			-	.464**	-.375*	-.367*
10. EC				-	-.431**	-.069
11. ER-S					-	-.016
12. ER-R						-

Appendix C: Conceptual Knowledge Vignettes and Original Sources

Vignette	Target Emotion	Adapted source
Anna built a large tower out of blocks. Then a boy came and kicked the tower over. Anna yelled at the boy and hit him.	Angry	Nelson et al. (2013)
Jack's little brother broke his favourite toy on purpose.	Angry	Ribordy et al. (1988)
Alice let her best friend use her new ball. Her friend wasn't careful and lost the ball and would not give Alice another one.	Angry	Stewart and Singh (1995)
David's friend gave him a present for helping him with his homework. Later, David's friend changed his mind and took the present back.	Angry	Ribordy et al. (1988)
Zoe made her mum a necklace for her birthday and told her little brother not to touch it, but her brother ignored her and broke the necklace.	Angry	Ribordy et al. (1988)
Max invited his best friend over to play. After spending the day playing, Max's friend made a nasty comment about Max's sister.	Angry	Coats and Blanchard-Fields (2008)
Mia was waiting in line at the canteen when someone deliberately pushed in front of her.	Angry	Widen and Russell (2010)
Ben's friend stole his favourite toy and wouldn't give it back to him.	Angry	Harris et al. (1986)
Emily was playing with her brother when he hit her. Emily's mum then yelled at her for fighting with her brother.	Angry	Widen and Russell (2011)
James was trying to tell his mum an exciting story and his little brother kept interrupting.	Angry	Ribordy et al. (1988)

Anna took a big bite of an apple. She then saw that there was a worm in the apple and spat it out as fast as she could.	Disgusted	Nelson et al. (2013)
Jack was sitting in the backseat of his parent's car when his sister vomited all over him.	Disgusted	Camras and Allison (1985)
Alice was sitting on a bus next to someone who hadn't bathed, showered or changed their clothes for a week and they smelled.	Disgusted	Camras and Allison (1985)
David was walking along the street when he slipped over a pile of vomit.	Disgusted	Willis et al. (2017)
Zoe went to a movie with a friend. In the movie, people were eating bugs and worms.	Disgusted	Ribordy et al. (1988)
Max was playing in the park when he tripped and fell over and his hands landed in dog poo.	Disgusted	Ribordy et al. (1988)
Mia was playing with her older brother when he came and farted on her.	Disgusted	Willis et al. (2017)
Ben was having dinner at an Italian restaurant with his family when he noticed a cockroach in his pasta.	Disgusted	Willis et al. (2017)
Emily took a block of cheese out of the fridge and was about to eat some of it when she noticed it was green and mouldy.	Disgusted	Willis et al. (2017)
James bit into an apricot to see how it tasted and discovered it was full of crawling insects.	Disgusted	Stewart and Singh (1995)
Anna was walking alone in the bushes. It was becoming dark when she realised she was lost and didn't know where she was.	Afraid	Willis et al. (2017)
Jack was walking down the street when a big dog started growling and chasing him. Jack screamed and ran away as fast as he could.	Afraid	Widen and Russell (2010)
Alice was driving when she saw a car swerve into her lane and thought she was about to have a car crash.	Afraid	Van Oyen Witvliet and Vrana (1995)

David broke his mum's favourite vase and knew he was going to get into trouble when his mum came home from work.	Afraid	Willis et al. (2017)
Zoe was playing in her bedroom one night when she heard a noise outside her window	Afraid	Widen and Russell (2010)
Max was playing in his sandpit when he saw a big black spider crawling on his leg.	Afraid	Kayyal and Widen (2013)
Ben was swimming at the beach when he saw a shark swimming towards him.	Afraid	Willis et al. (2017)
Emily was playing in her bedroom when she heard a very loud clap of thunder	Afraid	Nelson et al. (2013)
James was bushwalking when he noticed he had trodden on something. He looked down and realised he had just stepped on a snake.	Afraid	Willis et al. (2017)
Mia woke up in the middle of the night after dreaming that there was a monster under her bed	Afraid	Nelson et al. (2013)
Anna had a big party for her birthday. All her friends came and gave her presents.	Happy	Nelson et al. (2013)
Jack helped his Mum with the chores and was allowed to stay up late watching television.	Happy	Harris et al. (1986)
Alice spent a long time working on a school assignment and really wanted to do well. When the assignment was handed back, she found out that she got full marks.	Happy	Van Oyen Witvliet and Vrana (1995)
David got a new set of Lego for Christmas that he wanted.	Happy	Stewart and Singh (1995)
Zoe painted a picture for her mum at school. When she showed her mum, she told her she really liked it.	Happy	Ribordy et al. (1988)
Max was helping his dad fix his bicycle. When they had fixed it, his dad told Max he'd done a great job.	Happy	Nelson et al. (2013)
Mia had been begging her mum for a kitten for months. One afternoon she came home from school and found her mum holding a brand new kitten.	Happy	Stewart and Singh (1995)

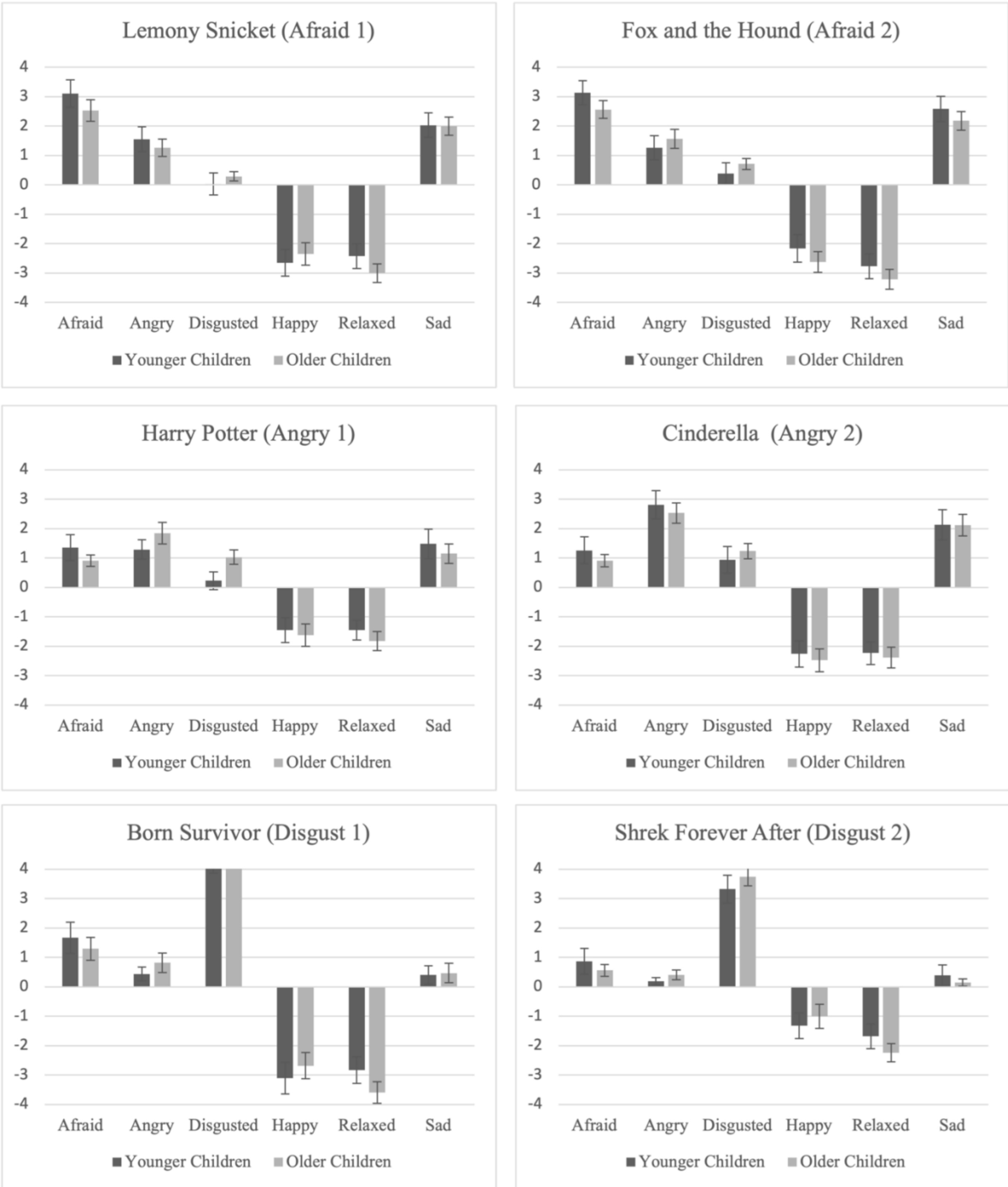
Ben had been training for his annual swimming carnival over the summer. He won all of the races he swam in at the carnival.	Happy	Van Oyen Witvliet and Vrana (1995)
Emily's mum is making her favourite meal for dinner tonight.	Happy	Stewart and Singh (1995)
James asked his mum if his friends could come over to play and she said yes.	Happy	Ekman and Friesen (1971)
Anna was walking her dog around the neighbourhood one afternoon and saw lots of cars driving past.	Neutral	Willis et al. (2017)
Jack let his best friend play with his new toy. His friend gave it back when he had finished playing with it.	Neutral	Willis et al. (2017)
Alice was sitting in the backseat of her parent's car. She was looking out the window and counting all the buses that drove past.	Neutral	Camras and Allison (1985)
David was sitting on the bus on the way to work. He was sitting next to someone who was listening to music and playing games on their phone.	Neutral	Camras and Allison (1985)
Zoe was walking home from school and looking at all the different houses on the street.	Neutral	Willis et al. (2017)
Max was bushwalking when he noticed he had trodden on something. He looked down and realised he had just stepped on a tree branch.	Neutral	Willis et al. (2017)
Mia helped her mum with the chores and then had a shower before going to bed.	Neutral	Harris et al. (1986)
Ben spent a long time working on a school assignment and was waiting to receive his results.	Neutral	Van Oyen Witvliet and Vrana (1995)
Emily was waiting in the line of the canteen to buy her lunch.	Neutral	Widen and Russell (2010)
James came home from school and sat down at his desk to do his homework before dinner.	Neutral	Willis et al. (2017)

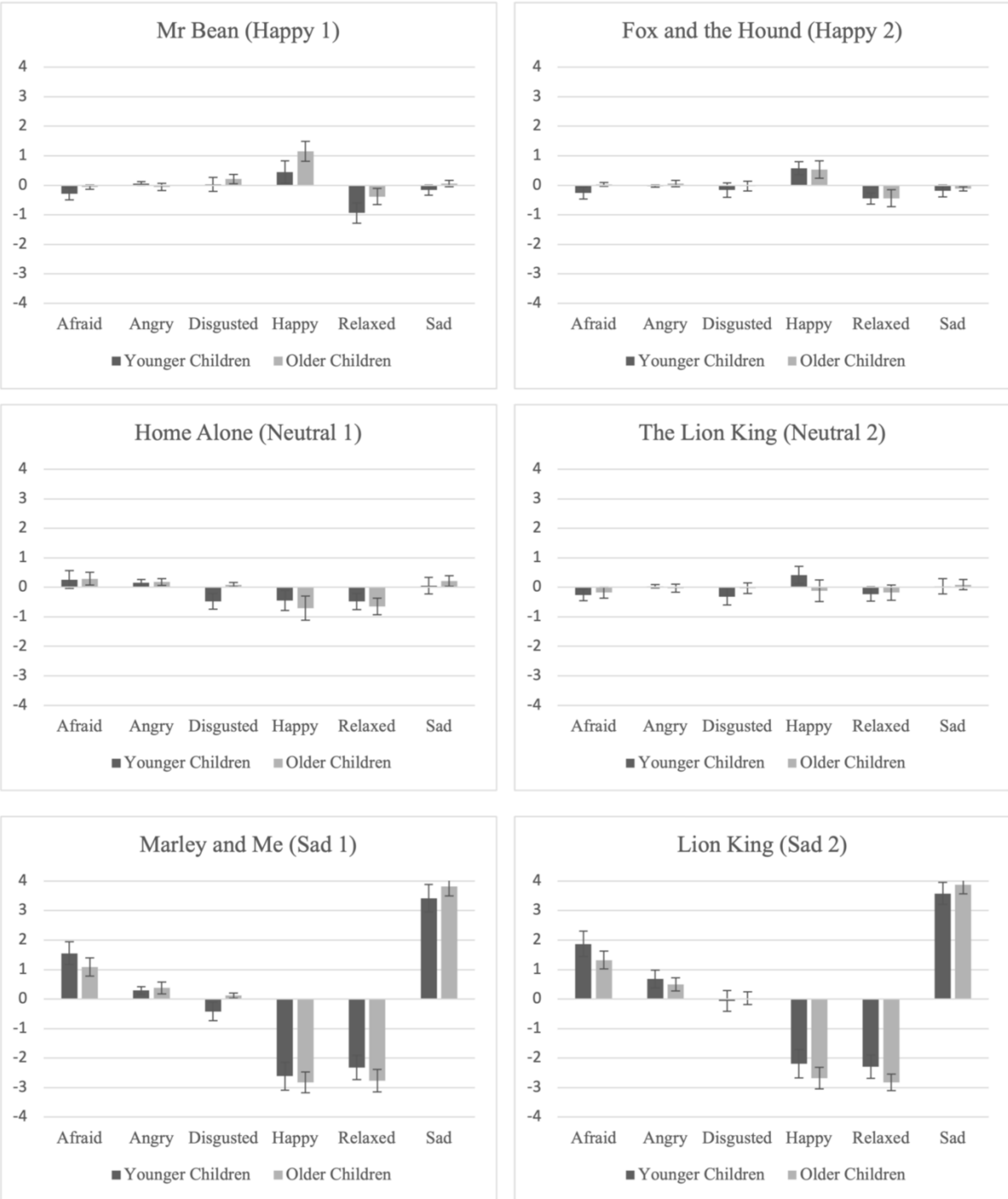
Anna found out that her best friend was moving to another country and she wouldn't be able to see her anymore.	Sad	Ribordy et al. (1988)
Jack went to feed his pet gold fish after school. When he looked in the fish tank he realised it was not swimming and had died.	Sad	Nelson et al. (2013)
Alice lost her favourite doll. She looked everywhere in the house for it but couldn't find it.	Sad	Willis et al. (2017)
David fell and broke his leg and couldn't go to the school camp with all of his friends.	Sad	Willis et al. (2017)
Zoe had been dating her boyfriend for two years when he told her he wanted to break up with her.	Sad	Willis et al. (2017)
Max was watching the news and saw that there'd been a large earthquake that had killed lots of people.	Sad	Van Oyen Witvliet and Vrana (1995)
Mia was the only one in the class who didn't get a card on Valentine's Day.	Sad	Ribordy et al. (1988)
James wanted to go to his friend's party but had a stomach bug and wasn't able to go.	Sad	Harris et al. (1986)
Ben tried out for the soccer team. He didn’t make the team but all his friends did.	Sad	Willis et al. (2017)
Emily’s grandma came to visit her from overseas. At the end of the visit, she had to say goodbye to her grandma, who she won’t be able to see again for a long time.	Sad	Stewart and Singh (1995)

Appendix D: Subjective Emotional Experience Ratings for Each Film Clip by Age Group from Chapter 6

Figure D.1

Means and Standard Deviations for Subjective Emotional Experience Ratings for Each Film Clip by Age Group

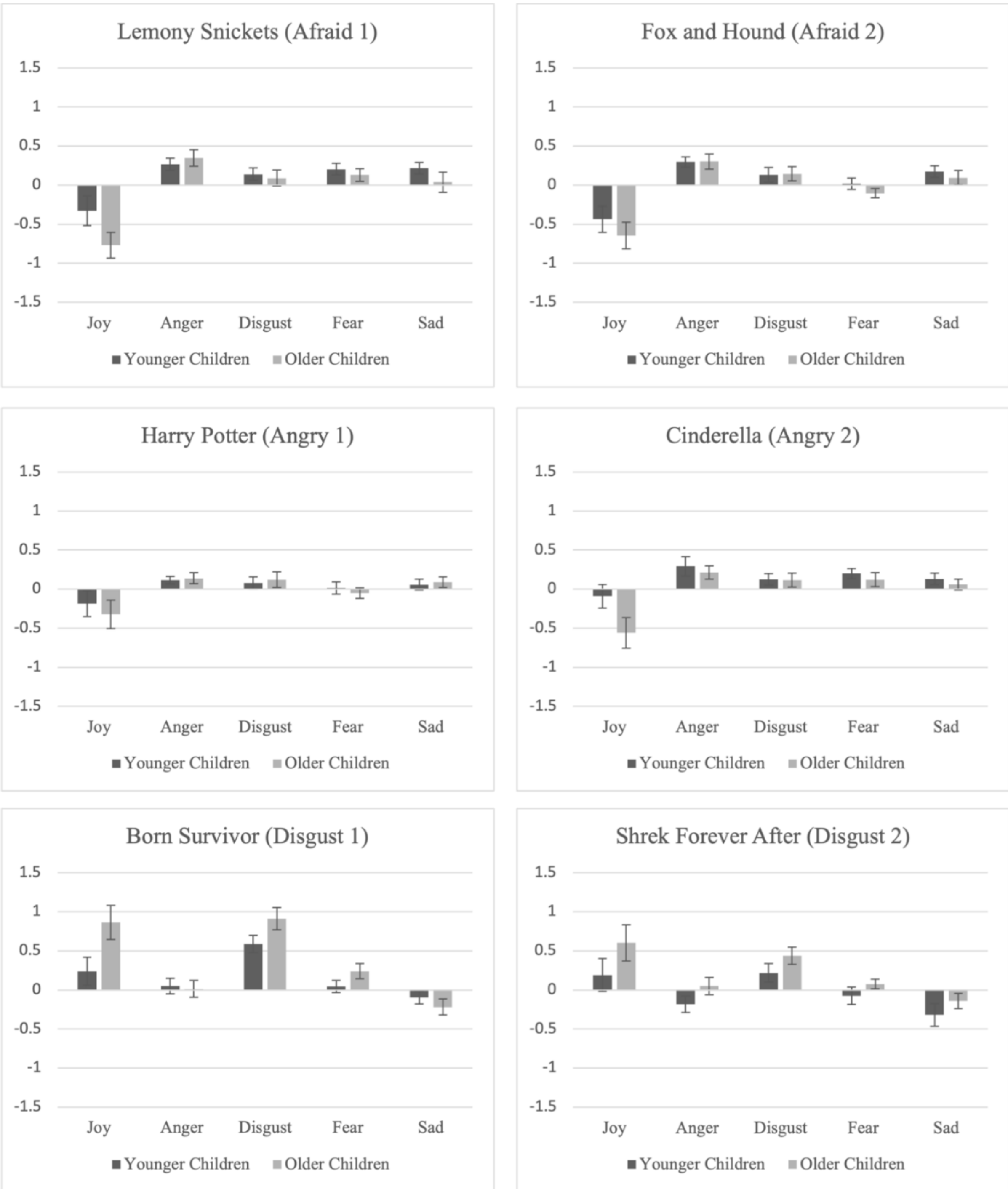


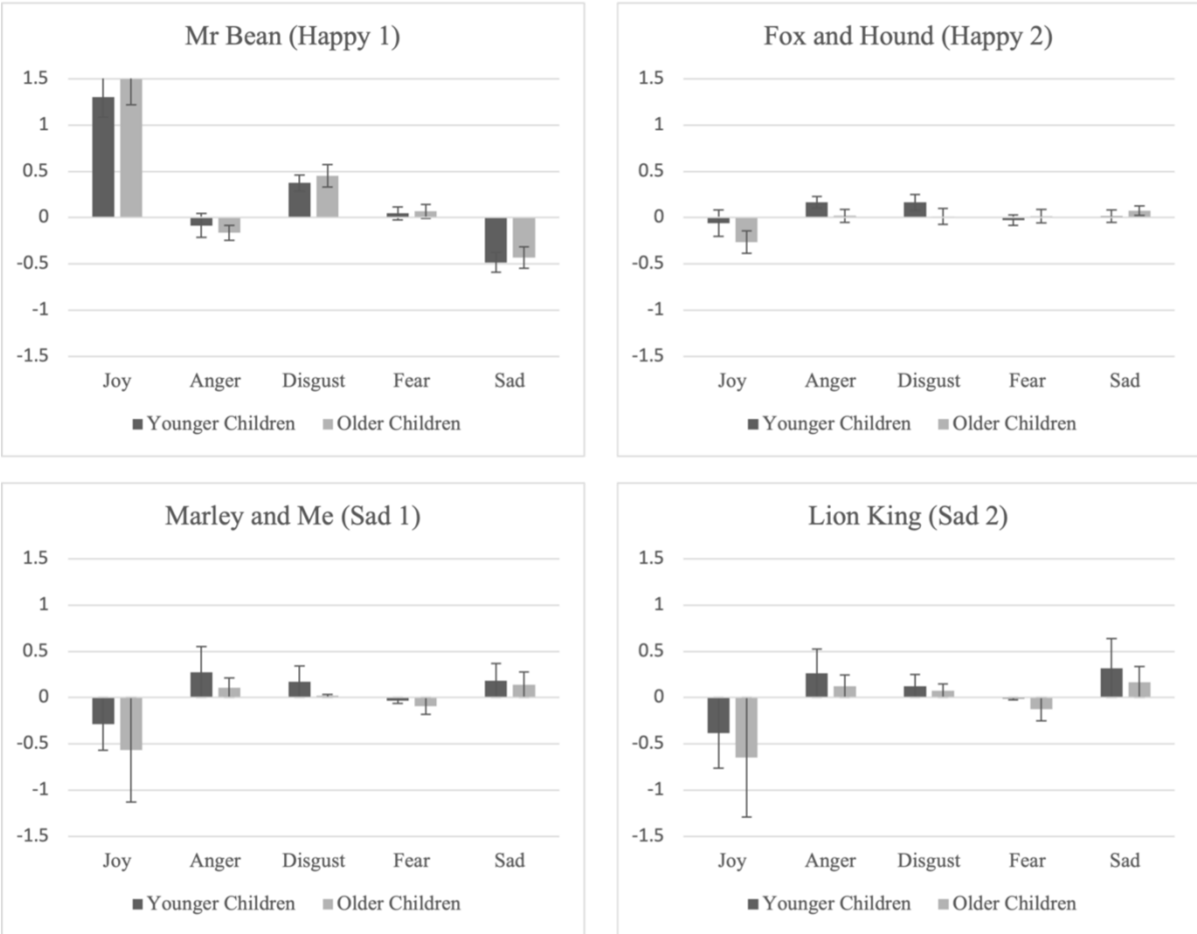

Mr Bean (Happy 1)
Fox and the Hound (Happy 2)
Home Alone (Neutral 1)
The Lion King (Neutral 2)
Marley and Me (Sad 1)
Lion King (Sad 2)
4
3
2
1
0
-1
-2
-3
-4
Afraid
Angry
Disgusted
Happy
Relaxed
Sad
Younger Children
Older Children

Appendix E: Facial Expressivity for Each Film Clip by Age Group from Chapter 6

Figure E.1

Means and Standard Deviations for Facial Expressivity for Each Film Clip by Age Group





Mr Bean (Happy 1)
Fox and Hound (Happy 2)
Marley and Me (Sad 1)
Lion King (Sad 2)
1.5
1
0.5
0
-0.5
-1
-1.5
Joy
Anger
Disgust
Fear
Sad
Younger Children
Older Children