SENSITIVITY TO EMOTION SPECIFIED IN FACIAL EXPRESSIONS AND THE IMPACT OF AGING AND ALZHEIMER'S DISEASE

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ABSTRACT

This thesis describes a program of research that investigated the sensitivity of healthy young adults, healthy older adults and individuals with Alzheimer's disease (AD) to happiness, sadness and fear emotion specified in facial expressions. In particular, the research investigated the sensitivity of these individuals to the distinctions between spontaneous expressions of emotional experience (genuine expressions) and deliberate, simulated expressions of emotional experience (posed expressions). The specific focus was to examine whether aging and/or AD effects sensitivity to the target emotions. Emotion-categorization and priming tasks were completed by all participants. The tasks employed an original set of ecologically valid facial displays generated specifically for the present research. The categorization task (Experiments 1a, 2a, 3a, 4a) required participants to judge whether targets were, or were not showing and feeling each target emotion. The results showed that all 3 groups identified a genuine expression as both showing and feeling the target emotion whilst a posed expression was identified more frequently as showing than feeling the emotion. Signal detection analysis demonstrated that all 3 groups were sensitive to the expression of emotion, reliably differentiating expressions of experienced emotion (genuine expression) from expressions unrelated to emotional experience (posed and neutral expressions). In addition, both healthy young and older adults could reliably differentiate between posed and genuine expressions of happiness and sadness, whereas, individuals with AD could not. Sensitivity to emotion specified in facial expressions was found to be emotion specific and to be independent of both the level of general cognitive functioning and of specific cognitive functions. The priming task (Experiments 1b, 2b, 3b,4b) employed the facial expressions as primes in a word valence task in order to investigate spontaneous attention to facial expression. Healthy young adults only showed an emotion-congruency priming effect for genuine expressions. Healthy older adults and individuals with AD showed no priming effects. Results are discussed in terms of the understanding of the recognition of emotional states in others and the impact of aging and AD on the recognition of emotional states. Consideration is given to how these findings might influence the care and management of individuals with AD.

CHAPTER 1

General Overview

Accurately perceiving the affective state of an interaction partner is a fundamental aspect of social functioning. Knowing the affective state of a partner allows individuals to act in adaptive ways and allows them to maximise potentials and minimise risks in the environment. It also allows for smooth communication and enhances the quality of social relationships, which is an important aspect of quality of life. Facial expressions provide a valuable source of information regarding the affective state of interaction partners, they are accessible, readily identified and confusion is rare among normally functioning adults. Facial expressions however are not always reliable, as individuals can and often do fake, mask, or suppress their facial expressions during the course of everyday activity. It is important for successful social interaction to be able to accurately perceive the veracity of information and be able to distinguish between facial expressions that specify the experiencing of a specific emotional state and facial expressions that are simply simulations of such expressions. Previous research has shown healthy young adults to indeed be sensitive to the differences between facial expressions specifying happiness and simulated or posed expressions of happiness.

The present thesis builds on this past research by considering sensitivity to facial expressions of sadness and fear, in addition to happiness amongst healthy young adults, healthy older adults and adults with Alzheimer’s disease (AD). Previous research examining facial expression recognition among older adults and individuals with AD has found deficits. These deficits either have been attributed to the cognitive decline that accompanies normal aging and AD or have been found to be independent of cognitive decline and therefore a specific deficit. That is, it has been argued that expression recognition is both a distinct skill and a skill dependant on several aspects of general cognitive functioning. The relationship between expression recognition and cognition is unclear. Accordingly, the present research considered the relationship between perceiver sensitivity to affective state and various cognitive functions. A brief overview of the structure of the thesis and contents of each chapter is given below.

Chapter 1 provides an overview of the key areas of interest in the thesis. First, the functional approach to the study of emotions and the recognition of facial expressions of emotion will be considered. Within this section, the differences between posed and genuine expressions of emotion will be highlighted, in terms of function, ontology and physiognomy. Second, a review of the facial expression recognition literature pertaining to older adults and individuals with AD is presented. Following this the neurological and cognitive explanations for poorer performance are considered with an emphasis on identifying the neural basis for facial expression recognition and whether these are linked to the neurological changes that occur as a consequence of healthy aging and AD. Changes in cognitive function due to aging and AD are also discussed with an emphasis on the relationship between facial expression recognition and cognitive functioning.

One of the limitations of much of the research that will be reviewed in this chapter is a lack of ecological validity in the facial displays employed in the research, with most studies relying solely on posed facial expressions of emotion. To fully understand the ability of individuals to correctly identify the affective state of interaction partners, rather than simply their facial expressions, it is vital for research to employ valid facial expressions that mirror those seen in the relevant referent situations. Accordingly, the first stage of the reported research involved the generation of suitable facial displays. Chapter 2 presents an account of how facial displays of posed, genuine and neutral expressions were generated. In addition, the neuropsychological tests used to measure cognitive functions and behavior of participants in the reported research is also introduced in Chapter 2.

Chapters 3, 4 and 5 each report the findings from two experiments – an emotion categorization task and an emotion-priming task. These were designed to assess perceiver sensitivity to the affective state of others and the ability of perceivers to differentiate between genuine and posed expressions of emotion. Chapter 3 reports the findings for healthy young adults, Chapter 4 for healthy older adults and Chapter 5 for AD patients. Chapter 6 compares the findings from the three participant groups, reporting both group and case-matched analyses.

Chapter 7 provides a discussion of the reported findings within the context of previous research. The implications of the reported findings are considered in terms of the understanding of the recognition of emotional states in others and the impact of aging and AD on the recognition of emotional states. Further consideration is given to the implications of these findings for the care and management of individuals with AD. Directions for future research are also considered.

The Social Function of Emotion

There is potentially a large range of emotions, however, theorists of emotion have largely agreed to the adaptive benefit of sets of discrete primary emotions. Ekman (1973) suggests there are seven primary emotions common to the adaptive function of all human beings: sadness, anger, fear, surprise, disgust, contempt, and happiness[1]. These emotions form the basis of much that we consider integral to the human condition. Emotions are biologically based patterns of experience, physiology, communication and ultimately perception and action. Emotions are arguably best defined in terms of their function, namely the basis to inform and prepare an individual to relate adaptively to their environment. They are the solutions to problems and promote adaptive modes of behavior (Johnston, 2003; Keltner & Haidt, 2001). Emotion provides the impetus to seek opportunity (Gueguen & De Gail, 2003; Owren & Bachorowski, 2001) and to identify risk (Dimberg & Oehman, 1996; Green, Williams, & Davidson, 2003), functioning, therefore, to help individuals respond to the world around them (Levenson, 1999).

The environment in which individuals exist, the world around them, is largely social in nature. Many of the opportunities and risks in the environment are experienced in a social context or are the result of the social context. Beyond the intrapersonal function of informing and preparing the individual to adapt to their environment, emotions have

[1] Interest, shame/shyness, distress (Izard & Bartlett, 1972; Tomkins, 1962) and guilt (Izard & Bartlett, 1972) are also suggested as primary emotions. Panksepp (1982) suggests there are fewer, namely, fear, rage, panic, and expectancy.

important interpersonal functions (Keltner & Haidt, 1999, 2001). Given human behavior is often governed by how individuals perceive others are feeling, emotions serve an important social and interpersonal function by enabling the individual to behave adaptively in social interactions.

A social functional account of emotion contends that emotions serve three main functions. First, they provide information about the affective state of others, their intentions (Fridlund, 1992), likely future behavior and the nature of their relationships with each other (Keltner & Gross, 1999). They also provide information about the environment. Children have been shown to rely on parental facial expressions to assess situations that are ambiguous to them (Klinnert, 1984). For example, a child moved closer to his/her mother when she portrayed a fear expression than when she did not portray emotion. Second, emotions evoke complementary emotions and a contagion effect in others, as evidenced by complementary fearful reactions to angry faces (Dimberg & Oehman, 1996) and a tendency to experience emotions similar to those expressed by others in order to promote shared experience (Hatfield, Cacioppo, & Rapson, 1992), and hence, interpersonal rapport. Third, emotions serve as incentives or deterrents for other peoples' behavior, as evidenced by the strength of emotional rewards and punishments in learning and shaping behavior (Bear, Manning, & Izard, 2003; Weinberg, Tronick, Cohn, & Olson, 1999). For example, emotions are attached to commercial messages in the advertising industry to promote better memory for the product (Baird, Wahlers, & Cooper, 2007) or are employed in road safety campaigns to shape more responsible behavior (Lewis, Watson, White, & Tay, 2007).

On a larger scale, the social function of emotions can help define group boundaries, help establish roles within the group and help negotiate problems. Sharing fear and anger toward non-group members has been shown to enhance group solidarity (Frijda & Mesquita, 1994). Likewise, the display of embarrassment can confer a low status on a member of a group (Keltner, Young, Heerey, Oemig, & Monarch, 1998). It has been suggested that children are helped to learn the norms and values of their culture by interpreting the facial expressions of their parents (Bretherton, Fritz, Zahn-Waxler, & Ridgeway, 1986).

The functional utility of emotion as a guide to adaptive social behavior is predicated on the notion that emotion brings about positive consequences, for instance, that the display of sadness will evoke sympathy, help and closer social proximity. Similarly, during an interaction the display of happiness will promote future interactions and closer bonds. These examples demonstrate a functional role for emotion in the social context, the utility of which is dependant on both the expression and accurate recognition of emotion.

Facial Expressions

Emotions have expressive, observable components that allow perceivers to know about the emotional state of another. Information about affective state can be communicated through several channels, for instance, postural cues which convey emotion in the way an individual walks or holds their bodies (Atkinson, Tunstall, & Dittrich, 2007; Dittrich, Troscianko, Lea, & Morgan, 1996) and prosodic cues that convey emotion in the intonation, speed and pitch of the voice (McNeely & Parlow, 2001). More time is spent looking at the face, however, than any other object or part of the body (e.g., Haxby, Hoffman, & Gobbini, 2002). The dynamic and highly visible nature of the face permits arguably the most accessible and efficient communication of emotion via facial expressions (Buck, 1994; Ekman & Rosenberg, 2005; Frijda & Mesquita, 1994).

Facial expressions are ubiquitous symbols, signals and symptoms of emotional experience and communication. It has been suggested that the communicative impact of the face is so powerful that it is difficult to separate the message from the medium. That is, there is a tendency to describe facial action, or muscle contraction, in terms of the emotion portrayed rather than in anatomical terms (Rinn, 1984). Thus, a face may be described as happy or sad rather than describe the specific movements of the face.

Darwin (1872/1998) was among the first to hypothesize that facial expressions represent innate and automatic behavior patterns that have links with human emotions and result from natural selection. Selection pressures shaped facial musculature over millions of years of mammalian evolution and in concert promoted changes in brain development. Furthermore, it is argued that facial expressions of emotion evolved because their adaptive value for social communication promoted survival. For instance, detecting that an expression specifies fear permits an individual to evade danger or protect another person from danger. The need to exploit social knowledge and understand fellow human beings influenced development and the behavioral capacity that set apart the human species from other primates. Darwin concluded, therefore, that facial expressions of emotion were biologically linked to emotional state, but had acquired a social communication function.

An important debate about facial expressions centers on the definition of whether the displays of the basic emotions are a symptom of emotion and therefore a ‘readout’ that serves to express the affective state of an individual or whether they are primarily a means to communicate socially. The ‘emotion expression view’ (Buck, 1994) posits that facial displays are clearly revealed in solitude and although social functions are the basis for the evolution of displays, social interaction is not necessary to elicit facial expressions. The ‘behavioral ecology view’ (Fridlund, 1992; Frijda & Mesquita, 1994), in contrast, criticizes the stance that emotion should be regarded as the major determinant of facial displays and suggests that displays are social tools that serve social motives based on the intentions toward a given social environment.

Several studies have shown these two functions are not mutually exclusively and suggest the primary role of social communication is not inconsistent with the presence of underlying affective state and vice-versa (Johnston, 2003; Keltner & Haidt, 2001; Norris, Chen, Zhu, Small, & Cacioppo, 2004). Facial displays therefore serve two broad functions: They are an expression of emotional state as well as a means to communicate knowledge about the social context, and accordingly both roles are crucial to successful social functioning.

Successful social functioning is also dependant on establishing the veracity of facial expressions. Individuals can, and often do, mask, fake and suppress their facial expressions for a variety of reasons and in many aspects of everyday life. This is because it is not always adaptive to engage in behavior that openly announces one's affective state to others. For example, an individual may mask a sad expression when they deem such an expression might confer vulnerability to others that is not advantageous, or they might fake a smile to encourage convenient closer social proximity. The following section considers the differences between posed and genuine facial expressions, and in particular, how these expressions relate to affective state.

Posed and Genuine Facial Expressions

As has been discussed, emotions help an individual function in an adaptive way to the contingencies of his/her environment. The most accessible example of the expressive component of emotion, the facial expression, provides a social perceiver with the opportunity to acquire knowledge about the emotional state of others. Because individuals can partially decouple their facial expressions from how they feel (Ekman, Friesen, & O'Sullivan, 1988), they can utilize facial displays for a variety of reasons other than to signal their emotional experience. For example, individuals smile as part of cursory social etiquette regardless of whether they are happy or not. Individuals also smile to disguise other feelings (Gosselin, Warren, & Diotte, 2002), to communicate friendliness and likeability (Hecht & LaFrance, 1998), and to convey trustworthiness (Ekman & Friesen, 1982; Hecht & LaFrance, 1998; Provine, 1997). Similarly, individuals can look sad because they feel sad or because they wish to communicate that they understand that sadness is the appropriate or desired response. They may even feign a sad expression to ‘lure’ sympathy or forgiveness. Parents have been shown to use fake facial expressions as a means to facilitate children’s learning (Gerull & Rapee, 2002), by conveying a seemingly stronger message because it is accompanied by the concept of emotion. Similarly, children have been shown to control their facial expressions, hence, attempting to decouple the expression from their experience, from as young as four years old (Davis, 1995).

In a variety of different ways, posed expressions may be employed to gain advantage over interaction partners or to facilitate a particular goal. Both posed and genuine expressions are therefore important, during social interaction. However, they provide different information to the perceiver, and are consequently meaningfully different in terms of social significance. Not only is the difference important, but the sensitivity of the perceiver to the different expressions is also an important skill that has likely developed in a type of ‘arms race’. In other words, the adaptive advantage of producing disingenuous expressions is mirrored by the adaptive advantage of developing sensitivity to the veracity of the emotion specified in the facial expressions. The bases of the difference between posed and genuine expressions are ontological and physiognomic; hence, the following section will consider these two types of expressions, highlighting the ontological distinction (Buck, 1984) and also the subtle differences in their physical manifestation (Ekman, Hager, & Friesen, 1981).

Differences between Posed and Genuine Expressions

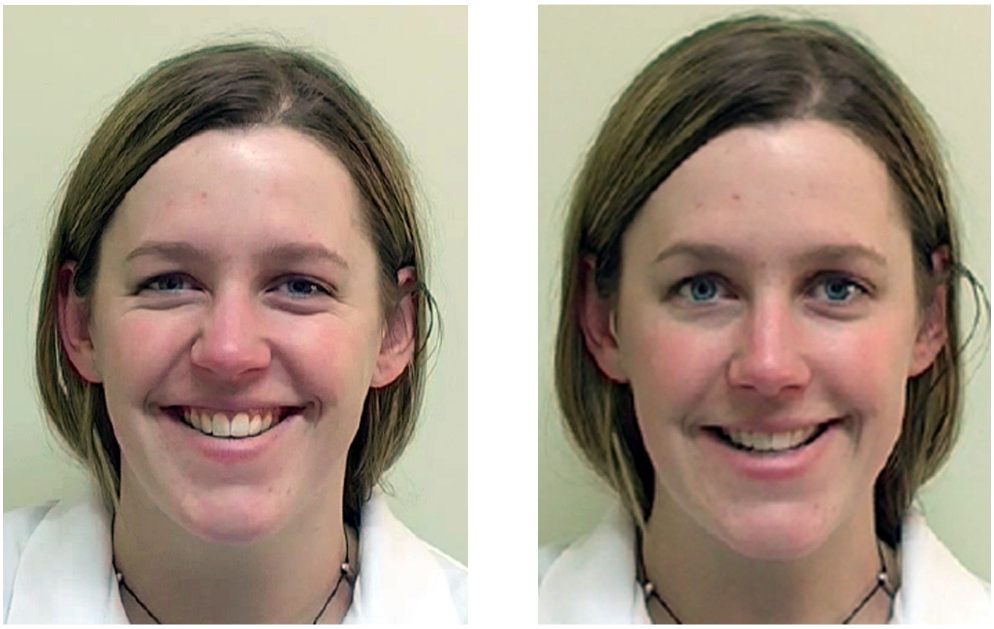
Physiognomic Differences

There are physiognomic differences between posed and genuine expressions that result from and reflect the different ontological bases of these two types of expressions. The vast majority of research investigating the physiognomic differences between posed and a genuine expression has focused on expressions of happiness, that is, smiles. Consequently, when considering the physiognomic differences between posed and genuine expressions here, more detail can be provided with regard to happy expressions.

Happy expressions

Ekman and Freisen (1982) suggested that there are five potential markers that distinguish posed from genuine smiles. These are the Duchenne marker; the symmetry of zygomatic major contraction; the smoothness of contraction; the duration of expression; and the degree of synchrony of action. The Duchenne marker, in particular will be considered in the following section because this marker is the most relevant to the facial displays that have been employed in the present research.

Duchenne de Boulogne (Ekman, Davidson, & Friesen, 1990) was a French neurologist and anatomist who was the first to report differences between spontaneous smiles expressing positive emotion and intentional posed smiles. Duchenne noted that deliberate contraction of the zygomatic major muscle, which extends from the top of the cheekbone to the upper lip and pulls the corners of the mouth obliquely upward and is the prototypical smile configuration of the mouth, did not give an impression of happiness. In comparison, the facial expression that resulted from his subject hearing a joke involved, in addition to zygomatic contraction, contraction of the orbicularis oculi muscle. This muscle pulls the skin surrounding the eyes toward the eyeball causing wrinkles or crow's feet, and did give the impression of happiness. Duchenne concluded that contraction of the orbicularis oculi (later termed the Duchenne marker) was a reliable marker to distinguish genuine/involuntary (Duchenne smiles) from posed/voluntary smiles. Figure 1 shows an example of a genuine smile that involves contraction of the orbicularis oculi and zygomatic major muscles as well as a posed smile that only involves contraction of the zygomatic major muscle.



A B

Figure 1. A Genuine (A) and Posed (B) Smile

The conclusion that some muscles in the face can be voluntarily controlled while others cannot was supported by later evidence showing that there are neurological differences in brain activation associated with voluntary and involuntary facial movement (Rinn, 1984). Genuine expressions involve older sub-cortical neural pathways (Damasio, 1994), specifically the anterior cingulate region, limbic region and basal ganglia. Innervations of the facial muscles occur via the extra-pyradimal motor system (Gazzaniga, Ivry, & Mangun, 2002). In contrast, posed expressions originate from the left hemisphere motor cortex and they are innervated via the pyradimal tract (Gazzaniga & Smylie, 1990).

Distinctions of these neural pathways can be observed in stroke patients. Those who have experienced damage to the motor cortex, where voluntary expressions originate, show asymmetrical voluntary facial movements but the symmetry of involuntary expressions remains intact. Those with damage to older subcortical areas like the anterior cingulate, where involuntary expressions originate, show asymmetry during involuntary facial expressions but not during voluntary contraction of muscles (Damasio, 1994). Indeed, before the advent of neural imaging, facial movement had long been used to help diagnose brain injury (DeJong, 1979). Ekman, Roper and Hager (1980) also provide support for the claim that the Duchenne marker (genuine smile) is not under volitional control by demonstrating that only approximately 20% of individuals can voluntarily contract the key lateral portion of the orbicularis oculi muscle.

In addition to the Duchenne marker, posed and genuine smiles differ with regard to symmetry, with the latter being more symmetrical than the former (Ekman et al., 1981;

Gazzaniga & Smylie, 1990; Rinn, 1984). Likewise genuine smiles are smoother and involve a more regular contraction of muscles throughout the expression than do posed smiles, which likely appear irregular in comparison (Ekman & Friesen, 1982). Research has reported that posed smiles have more pauses and changes in intensity than genuine smiles (Hess & Kleck, 1990) and genuine smiles are more consistent in the duration of the different phases of the expression (Frank, Ekman, & Friesen, 1993). The overall duration of smiles has also been suggested as a marker. Genuine smiles are more consistent, typically lasting between 0.5 and 4 seconds, than posed smiles, the duration of which is more erratic (Ekman & Friesen, 1982).

There is no evidence to suggest these differences in symmetry, smoothness and consistency would be limited to expressions of happiness, rather smiles are expressions that are more accessible and therefore have been the expression of choice to demonstrate such differences. Future research is needed to confirm whether these markers have utility to distinguish posed from genuine expressions of other emotions.

Sad expressions

Unlike smiles, there is no converging evidence to suggest whether genuine expressions of sadness involve the contraction of reliable muscles that, therefore, form the basis of a physiognomic difference between posed and genuine expressions. However, contracting the frontalis and corrugator/depressor supecilii, which raise and lower the inner brow respectively and result in a straightening of the inner portion of eyebrow or an oblique angle and a triangulation of the inner upper eye lid, have been nominated as core movements of sadness in most accounts of prototypic expressions (e.g., Ekman, 2002; Gosselin, Kirouac, & Dore, 1995; Kohler et al., 2004). In at least one study that sought to establish the mean probability of occurrence of specific muscle movements in the face during felt and unfelt emotional experience, these two muscle movements were more probable in felt than unfelt displays of sadness (Gosselin et al., 1995).

Figure 2 provides an example of this muscle movement combination. More research is needed to better understand the potential of this marker. Accordingly, it cannot be included as criterion to base posed versus genuine distinctions in the present research and such a distinction will need to be made on the ontological rather than physiognomic basis. In addition, posed expressions, particularly of negative emotions, are found to be exaggerated compared to genuine expressions (Naab & Russell, 2007; Tcherkassof, Bollon, Dubois, Pansu, & Adam, 2007), that is they contain additional movements as well as more intense muscle movements. While the presence of additional facial movements can also not be included as criterion in the present study, these two potential distinctions are noteworthy and will be considered further in Chapter 2.

A B

Figure 2. A Neutral Expression (A) and a Genuine Sad Expression that Involves Contraction of the Frontalis and Corrugator supecilii (B)

Fear expressions

As with sadness, there is no reliable evidence of a specific marker differentiating genuine from posed fear expressions. Contracting the frontalis and lowering the brow as well as contracting the levator palpebrae superioris, which widens the eye aperture, appear as core units in most investigations (e.g., Ekman, 2002; Gosselin et al., 1995; Kohler et al., 2004). These movements are more probable in felt compared to unfelt experience (Gosselin et al., 1995). Figure 3 provides an example of this muscle movement combination. As noted above, there is also likely to be additional units present in the posed compared to the genuine fear expression and this marker will also be discussed further in Chapter 2.

A B

Figure 3. A Neutral Expression (A) and a Genuine Fear Expression that Involves Contraction of the Frontalis and Levator palpebrae superioris (B)

Ontological Difference

There is also a fundamental ontological difference between posed and genuine expressions. Genuine facial expressions are the display of experienced emotional states, that is, they have an ontological basis in emotional experience. Genuine expressions occur spontaneously and within the context of a congruent emotional experience. For example, athletes receiving Olympic medals displayed genuine smiles more frequently than posed smiles (Matsumoto & Willingham, 2006). Individuals with PTSD and clinical depression who experience less positive affect have been shown to display fewer genuine smiles than healthy controls (Berenbaum & Rotter, 1992). Furthermore, the frequency of genuine smiles increased as depressive symptoms decreased (Steiner, 1986). Likewise, schoolchildren display more smiles that are genuine after succeeding at a game and more posed smiles when they failed (Schneider & Unzner, 1989). In fact, most people have been shown to have difficulty voluntary inhibiting expressions of felt emotion, that is, genuine expressions (Rinn, 1984).

In contrast to genuine expressions, posed expressions, by definition, result from the purposeful communicative intent of the poser, which may range from deception to social compliance (Ekman & Rosenberg, 2005). For example, individuals displayed more posed than genuine smiles when masking negative affect (Ekman et al., 1988; Woodzicka, 2008). There is no systematic relationship between posed expressions and affective state; they are representative of not indicative of emotional experience. Posed expressions can be contrary to the actual felt emotional state of an individual or can accompany neutral state.

Facial Expression Recognition

The notion that humans have evolved adaptive responses to the affective state of others is consistent with the assumption that the behavior of the sender and receiver has co-evolved in reciprocal fashion. This leads to the conclusion that the signal should be as perceivable as it is laden with meaning. The adaptive value of facial expressions is dependant on, and can only be realised by, a preparedness and ability to detect the information that is specified in facial expressions. Many studies support the view that humans are biologically predisposed to display (Dimberg, Thunberg, & Grunedal, 2002) and to recognise facial expressions of emotion (Bargh & Ferguson, 2000; Batty & Taylor, 2003) as evidenced, for instance, by the ease with which individuals can learn to fear and avoid angry faces (Dimberg & Oehman, 1996).

The recognition of facial expressions has long been of interest to researchers. The literature reports as many as 1700 empirical studies that have investigated whether, how and when individuals recognise emotion in the face of another person. Before the 1960s, it was thought that facial expressions were learnt, culturally specific displays. Ekman and Friesen (1971) subsequently provided convincing evidence for the universality of the basic expressions of happiness, sadness, fear, anger, disgust and surprise. That is, there are clear commonalities when normally functioning adults from different cultures are asked to pose or to recognise the basic expressions. Universality means that emotions share functionality across individuals and situations and it is the functional specificity that is implied rather than any consistency among the antecedent events. In other words, the type of experience that gives rise to the emotional response might vary between individuals but the function the emotion serves, the way it is displayed and the ability to recognise the emotional response is very similar across individuals.

The Ekman and Friesen studies utilized a wide range of cultures, including preliterate groups and media-isolated groups from Borneo (Ekman, Sorenson, & Friesen, 1969) and New Guinea (Bartlett, Hager, Ekman, & Sejnowski, 1999; Ekman & Friesen, 1971). The recognition rates of the basic facial expressions were shown to be greater than chance regardless of whether they were being judged by a member of the same cultural group or not. Although there was some variation between expressions and cultures, there was a universal understanding of what an expression meant and this understanding was independent of any cross-cultural learning. Subsequent studies, including a meta-analysis of 97 cross-cultural facial expression recognition studies, (Elfenbein & Ambady, 2002) have confirmed these findings.

Most subsequent studies investigating emotion processing examined the recognition of these basic facial expressions (Calder et al., 2003; Phillips, Drevets, Rauch, & Lane, 2003a; Surguladze et al., 2004), since prototypical expressions are readily identifiable and marked confusion is rare amongst normally functioning adults. When poor performance on such tasks is identified, it is found to be associated with poor social skills in general and poor social adjustment (Boice, 1983; Leppanen & Hietanen, 2001). Similarly, disruption in emotion perception, in particular, deficits in facial expression recognition has been found to play a role in a variety of clinical disorders and such disruptions are also associated with low levels of social functioning. For example, a deficit in the recognition of facial expressions is associated with functional impairment in social interaction skills in autism (Boraston, Blakemore, Chilvers, & Skuse, 2007). Some research has found that the adverse effect that inaccurate social perception has on social functioning is independent of cognitive deficits (Kohler, Bilker, Hagendoorn, Gur, & Gur, 2000) or at least mediates between cognitive and social functioning (Addington, Saeedi, & Addington, 2006). There are a number of groups that suffer from social impairments and many studies have investigated the recognition of facial expressions by these groups. Two such groups that have been shown to experience difficulty in particular aspects of social functioning are older adults and individuals with AD. A summary follows of previous findings regarding the effects of aging and Alzheimer's disease (AD) on the recognition of facial expressions.

Aging and Facial Expression Recognition

Adult aging refers to a multidimensional process of physical, psychological, and social change. The number of people aged 65 or older has doubled since 1970. In New Zealand 2006, ten percent of the population was aged 68 years or older and the oldest ten percent of the population will be 74 years or older by the year 2026 (Statistics New Zealand, 2006). Many individuals can expect to spend a quarter of their lives over the age of 65 years. Consequently, it is not surprising that considerable research interest has focused on understanding more about the effect of aging on crucial mechanisms that support health and the quality of life. Difficulties in emotion recognition are associated with interpersonal problems, reduced quality of life and the development of psychopathology (Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006), all of which have negative implications for well-being, particularly for older adults (Seeman, Lusignolo, Albert, & Berkman, 2001).

Studies were considered for review when older adults were compared to younger adults, the mean age for older adults exceeded 65 years, and the mean age for younger adults was less than 35 years. Only studies in English were included and Table 1 presents a summary of the twelve studies that met this inclusion criteria. As can be seen in Table 1, all studies employed an identification task to assess facial expression recognition, which required the participant to label an expression from a forced-choice list of options. Six basic expressions (happy, sad, fear, anger, disgust and neutral) were assessed by all but one study which confined investigation to happiness, sadness, anger and fear (Sullivan & Ruffman, 2004a). The following is a summary of results from the identification of facial expression tasks.

Older adults were found to have selective deficits in the recognition of several negative facial expressions. There were significantly fewer correct identifications of sadness made by older adults compared to young adults. The recognition of sadness was found to be impaired in almost three quarters of studies (Calder et al., 2003; Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006; MacPherson, Phillips, & Della Sala, 2006; L. H. Phillips, R. D. MacLean, & R. Allen, 2002a; Sullivan & Ruffman, 2004a; Suzuki, Hoshino, Shigemasu, & Kawamura, 2007; Wong, Cronin-Golomb, & Neargarder, 2005). Similarly, older adults had difficulty identifying anger, with impairment found in just over half of the studies (Calder et al., 2003; Isaacowitz et al., 2007; Phillips et al., 2002a; Sullivan & Ruffman, 2004a; Sullivan, Ruffman, & Hutton, 2007; Suzuki et al., 2007; Wong et al., 2005). Fear posed difficulty in approximately one third of studies (Calder et al., 2003; Isaacowitz et al., 2007; Keightley et al., 2006; Wong et al., 2005). In contrast, the recognition of happiness and disgust were largely spared in older age and there is some evidence of an age-related improvement in disgust, with a third of studies finding that disgust was identified better by older adults compared to younger adults (Calder et al., 2003; Suzuki et al., 2007; Wong et al., 2005).

Table 1. Summary of Research on the Recognition of Facial Expressions in Older Adults (OA)

Author	Young adults (YA)		Older adults (OA)		Stimuli	Tasks	Results
	N (M/F)	Age	N (M/F)	Age			
Phillips et al. (2002)	30 (11/19)	29.9	30 (15/15)	69.2	E&F	Identification Which label best describes face Printed list	Anger and Sadness - OA < YA
MacPherson et al. (2002)	30 (15/15)	28.8	30 (15/15)	69.9	M&E	Identification Choose label that best describes emotion Printed list	Sadness - OA < YA
Calder et al. (2003), expt 1	24 (12/12)	25.0	24 (12/12)	65.1	E&F	Identification Select label that best describes emotion Printed list	Fear and Sadness – OA < YA Disgust – OA > YA
Calder et al. (2003), expt 2a	73 (37/36)	24.3	58 (26/32)	65.2	E&F	Identification Select label that best describes emotion Printed list	Anger – OA < YA Disgust – OA > YA
Calder et al. (2003), expt 2b	28 (14/14)	23.9	23 (11/12)	66.5	E&F	Identification Select label that best describes emotion Printed list Morphed continua expressions.	Analysed with expt. 2a
Sullivan & Ruffman (2004)	31	26.0	30	72.0	E&F	Identification Anger, sad, happy, fear	Anger and Sadness – OA < YA
Wong et al. (2005)	20	19.2	20	69.5	E&F	Identification Identify facial expression being displayed by pressing label that best describes emotion. Printed list	Anger, Fear and Sadness – OA < YA Disgust – OA > YA
Keightley et al. (2006)	30 (15/15)	25.7	30 (15/15)	72.5	M&E	Identification Choose label that best matched the facial emotion expression Printed list	Fear and Sadness - OA < YA

Table 1. *Continued*

Author	Young adults (YA) N (M/F)	Young adults (YA) Age	Older adults (OA) N (M/F)	Older adults (OA) Age	Stimuli	Tasks	Results
MacPherson et al. (2006)	29	29.0	29	69.8	M&E	Identification Matching Sad, angry, contempt	Sad – OA < YA
Isaacowitz et al. (2007)	189	27.1	78	71.0	E&F	Identification Name emotion target person experiencing Verbal list	Anger and Fear – OA < YO
Sullivan et al. (2007)	27	23.0	27	73.0	E&F	Identification Describe how person is feeling Printed list	Anger – OA < YA
Suzuki et al. (2007)	34 (17/17)	20.6	34 (17/17)	69.7	M&E	Identification Identify one basic emotion that best described expression	Sadness – OA < YA Disgust – OA > YA

Note. Abbreviations: E&F = Ekman and Freisen; M&E = Matsumoto and Ekman.

Alzheimer's disease (AD) and Facial Expression Recognition

Alzheimer's disease (AD) is a progressive neurodegenerative disorder that is characterised by deterioration of intellectual functioning and change in personality. AD is the most common type of dementia and emerged as a distinct disease in the mid-20th century, although German physician Alois Alzheimer first described it in 1906. AD has a gradual course that typically involves ten years from diagnosis to death (Grossman, Bergmann, & Parker, 2006). It is estimated that over 26.6 million people live with AD worldwide (Brookmeyer, Johnson, Ziegler-Graham, & Arrighi, 2007). In New Zealand, the disease effects 17-21 thousand individuals (Alzheimer's New Zealand, 2005) and this number is expected to quadruple by 2050 as the population ages (Brookmeyer et al., 2007). Approximately 2-3% of individuals aged 65 years have AD and the prevalence rate doubles every five years for those aged 70-85 years (Hodges, 2006). The specific focus of the present research is late-onset sporadic AD, which is characterised by the presentation of symptoms after the age of 60 years. The dominant theory of pathology in AD is the amyloid cascade hypothesis (Grossman et al., 2006), which in brief, postulates that plaques are derived from an excess of amyloid ß peptides (Aß). This results in a toxic cascade of secondary protective responses, like free radical formation and inflammatory response, which contribute to the death of neurons.

For the diagnosis of AD, the initial dysfunction necessarily requires impaired memory, but varying impairments in visuospatial abilities, language skills, complex attention and mental speed are common changes that support its clinical delineation and trajectory (Calder et al., 2003; Keightley et al., 2006; MacPherson et al., 2006). A clinical diagnosis is obtained to determine the presence of AD, which can only be confirmed at autopsy. Diagnosis is made in the presence of an insidious onset and progressive cognitive decline that involves two or more areas of cognition, including episodic memory (Hodges, 2006). In addition, there is a breakdown of social function or activities of daily living.

AD is often associated with problems in social functioning and the ability to recognise the affective state of others is an important aspect of social functioning. These problems are associated with the increase in caregiver burden (Holt et al., 2005; Reinders et al., 2006), and are a major factor in decreased quality of life (Chiu, Chen, Yip, Hua, & Tang, 2006). The degradation of social skills and social comprehension also effects the management of behavioral problems. The behavioral and psychiatric symptoms of dementia (BPSD) are reported to occur in approximately 90% of dementia patients (Buhr & White, 2006) and are the most important factor for caregivers considering institutionalisation (Tariot, Mack, Patterson, Edland, & et al., 1995). Poor social functioning contributes to the anxiety and phobic behaviors found to be problematic in AD (Steele, Rovner, Chase, & Folstein, 1990), as well as the agitation and aggressive behaviors often associated with the management of those with AD (Chiu et al., 2006). The majority of research interest has focused on the cognitive and psychiatric profiles associated with AD. Given the prevalence of social problems and how these problems negatively influences the quality of life of patients and carers it is necessary to also examine how AD influences social functioning.

As a means to better understand social functioning, several studies have focused on emotional processing and investigated whether individuals with AD demonstrate impaired ability to recognise facial expressions. Studies were considered for review when individuals diagnosed with AD were compared to age matched healthy participants to control for the known effects of healthy aging and the experimental paradigm involved the presentation of photographs of facial expressions[2]. Only studies in English were considered. Table 2 presents a summary of the eleven studies that met these criteria. As can be seen, unlike the healthy older adult research, the AD research is more heterogeneous with a variety of experimental tasks and stimuli employed. This places additional constraints on being able to make clear comparisons across experiments. What follows is a summary of results pertaining to the application of respective identification, discrimination and matching tasks.

Identification Tasks

Identification tasks required the participant to label each expression individually from a forced-choice list of options. Each of the eleven studies investigated the ability of AD patients to identify expressions. No significant difference in performance was found between AD and healthy controls (HC) in five studies (Bucks & Radford, 2004; Burnham & Hogervorst, 2004; Fernandez-Duque & Black, 2005; Lavenu, Pasquier, Lebert, Petit, & Van der Linden, 1999; Ogrocki, Hills, & Strauss, 2000). Of the six studies that did find

[2] Studies that included cartoon stimuli representing facial expressions were excluded due to the lack of ecological validity.

that AD patients performed significantly worse than the HC group, only two attribute this impaired performance to a specific emotion processing deficit (Allender & Kaszniak, 1989; Hargrave, Maddock, & Stone, 2002). The remaining four studies either attribute poor performance to abstract reasoning deficits (Koff, Zaitchik, Montepare, & Albert, 1999), general cognitive decline (Kohler et al., 2005), verbal deficits (Roudier et al., 1998), or difficulty with verbal memory (Albert, Cohen, & Koff, 1991).

Discrimination Tasks

Discrimination tasks required the participant to look at pairs of photographs and indicate whether the expressions shown were the same or different. Emotion processing was assessed by discrimination tasks in five studies; three of which found no impaired performance of AD compared to healthy controls (Bucks & Radford, 2004; Fernandez-Duque & Black, 2005; Roudier et al., 1998). Two found that AD participants performed significantly worse than healthy controls (Albert et al., 1991; Hargrave et al., 2002), but only the latter concluded this deficit was due to a specific emotion processing impairment. The poorer emotion discrimination performance was accounted for by the identity control task in the remaining study (Albert et al., 1991).

Matching and Selecting Tasks

Matching and selecting tasks required the participant to match a target expression to one of several alternative expressions and select a target expression from several alternatives, respectively. Five selection and/or matching tasks were performed in four studies. As with the discrimination task, the poor performance in matching and selecting was accounted for by a naming task in one study (Albert et al., 1991) and was concluded as reflecting visuospatial dysfunction in another (Burnham & Hogervorst, 2004). AD participants did not have any difficulty with the matching task in the Bucks and Radford (2004) study but did show impairment in the selection task. The authors concluded that the more difficult selection procedure of scanning and identifying the emotion present in five alternative expressions might have resulted in the poor performance, particularly as this was the only task in their study to show deficits compared to healthy controls. AD patients in the final study (Hargrave et al., 2002) did not have the same difficulty with the matching task as they had with both the identification and discrimination tasks.

Ability with Specific Expressions

All of the reviewed studies used expressions depicting several of the basic emotions as task stimuli in their respective emotion processing tasks. Only six studies, however, considered the performance of groups on specific emotions separately (Bucks & Radford, 2004; Burnham & Hogervorst, 2004; Fernandez-Duque & Black, 2005; Hargrave et al., 2002; Kohler et al., 2005; Lavenu et al., 1999). Of these, only one established the relative performance score between emotions and found a deficit with regard to sad expressions relative to the other misidentified expressions of surprise and disgust (Hargrave et al., 2002). As discussed earlier, sad facial expressions are often problematic for healthy elderly, therefore, a potential deficit over and above a vulnerable baseline is worthy of particular attention. Fear and contempt also proved problematic (Lavenu et al., 1999).

In summary, two studies identified consistent problems and found AD participants were impaired relative to age-matched controls in all three tasks (Albert et al., 1991; Hargrave et al., 2002), although only the later study concluded this was due to a specific emotion processing deficit. The same conclusion was reached by another study (Allender & Kaszniak, 1989), although they only assessed skills using an identification task. The only other study (Koff et al., 1999) to use only an identification tasks and report poor performance concluded this was secondary to cognitive deficits. Three studies consistently found AD participants were not impaired as evidenced by performances similar to healthy controls in all tasks (Fernandez-Duque & Black, 2005; Lavenu et al., 1999) or on the only task (Ogrocki et al., 2000). The remaining three studies produced inconsistent findings across tasks. One demonstrated that individuals with AD had difficulty with facial expression identification but not with the discrimination of expressions (Roudier et al., 1998). Another that there was no difficulty with identification but matching was problematic (Burnham & Hogervorst, 2004), and the last found the ability to process facial expressions was preserved except when assessed using a selection task (Bucks & Radford, 2004).

It is difficult to conclude whether AD patients do demonstrate poorer performance in facial expression recognition. Just over a half of recognition tasks were performed poorly compared to healthy aged matched controls and a third of tasks continuing to show group differences independent of face processing or specific cognitive abilities. The information relating to deficits in specific emotions could only be garnered from a few studies and no consistent impairment was found, although it is noteworthy that sad expressions were problematic for AD participants relative to the difficulty they had even with other problematic expressions.

Table 2. Summary of Recognition of Facial Expressions in Alzheimer's disease (AD)

Author	Healthy older adults (HOA)			Alzheimer's disease (AD)			Stimuli	Tasks	Results
	N (M/F)	Age	MMSE	N (M/F)	Age	MMSE			
Allender & Kaszniak (1989)	13	68.1	137.5 [a]	13	66.3	107.6 [a]	Izard photos	Identification Verbal/point response Printed list of 9 options	Identification AD<HC Specific emotion processing deficit in AD
Albert et al. (1991)	19 (6/13)	87.5		19 (4/15)	89.6	101 [a]	E&F	Identification Verbal response/verbal list Selection Point response Printed list of 4 options Discrimination Verbal response to pairs of same or different people	All tasks AD<HC Discrimination accounted for by control task Selection accounted for by BNT Identification accounted for by verbal memory (not BNT) No deficit independent of cognitive deficits
Roudier et al. (1998)	14 (1/13)	81.1	26.1	31 (2/29)	80.5	16.2	E&F	Identification Verbal response from verbal list and point response from 4 photos of same person with different expressions Discrimination Verbal response from pairs of same and then different people	Identification AD<HC Discrimination AD=HC Facial discrimination and emotion discrimination are distinct Argued deficit due to verbal deficit
Koff et al. (1999)	19 (4/15)	88.9		23 (4/19)	90.2	20.3	Video vignette	Identification Verbal response from verbal list	Identification AD<HC Accounted for by abstract reasoning Difficulties secondary to cognitive deficits
Lavenu et al. (1999)	12 (6/6)	65.7	29.5	20 (4/16)	70.7	22.9	E&F	Identification Point response List of 7 options Detection Point to neutral or expressive photo of same person	Both tasks AD=HC Fear & contempt AD < HC
Ogrocki et al. (2000)	15 (5/10)	72.7	29.2	17 (7/10)	73.9	21.8	E&F	Identification Verbal response to 2 options	Identification AD=HC

Table 2. *Continued*

Author	Healthy older adults (HOA)			Alzheimer's disease (AD)			Stimuli	Tasks	Results
	N (M/F)	Age	MMSE	N (M/F)	Age	MMSE			
Hargrave et al. (2002)	14 (4/10)	68.0	29.1	22 (12/10)	74.0	18.5	M&E	Identification Verbal/point response Printed list of 7 options Matching Verbal/point response View of 6 options Discrimination Verbal response to pairs of different people	All tasks AD<HC Deficit in emotion processing independent of deficit in face processing Selective identification deficit for sad
Burnham & Hogervorst (2004)	13 (10/3)	73.0	29	13 (8/5)	76	21	E&F	Identification Point/verbal response Printed list of 6 options Matching Point/verbal response View of 4 options	Identification AD=HC Matching fear, sad & happy AD<HC Argued deficit likely due to visuospatial dysfunction
Bucks & Radford (2004)	12 (5/7)	74.4	28	12 (4/8)	75.5	18.8	FAB	Identification Verbal response Verbal list options Selection Point response Verbal options Matching Point response from verbal instructions Discrimination Verbal response to pairs of different people	Selection AD<HC Other tasks AD=HC Argued ability preserved relative to general cognitive decline Argued poor selection performance due to increased cognitive load in this more difficult task
Fernandez-Duque & Black (2005)	10 (4/6)	65.1	29	9 (5/4)	70.1	24.8	E&F	Identification Point response to 1 of 7 print options Discrimination Verbal response to pairs of different people	Both tasks AD=HC No impairment in AD found overall or for any specific expression

Table 2. *Continued*

Author	Healthy older adults (HOA)			Alzheimer's disease (AD)			Stimuli	Tasks	Results
	N (M/F)	Age	MMSE	N (M/F)	Age	MMSE			
Kohler et al. (2005)	22 (9/13)	69.4	29.5	20 (11/9)	75.9	2.7	Genuine	Identification Identify intensity Differentiate intensity No information regarding procedure	Identification AD<HC Accounted for by general cognition. Impaired at recognising both happy and sad when an intensity judgment was added to the task Impaired at sad intensity differentiation

Note. Abbreviations: E&F = Ekman and Freisen; M&E = Matsumoto and Ekman.
[a] Dementia rating scale.

Explanations for the Impairments Found in Previous Research

Older adults have demonstrated difficulties in the recognition of at least some of the basic expressions in previous research and individuals with AD have often demonstrated deficits. Two possible explanations for the impairments are discussed in the following section. The first explanation focuses on the neurological changes that occur with aging and are central to the pathology of AD. The second focuses on cognitive functions given several previous studies have attributed poorer performance in facial expression recognition tasks to cognitive decline.

Neurological Explanation

Impaired facial expression recognition may well result from pathology affecting neural substrates critical to emotion processing. For example, individuals with amygdala damage have difficulty recognising basic expressions (Adolphs, 2007), as do people with frontal damage (Adolphs, 2002a; Ridout et al., 2007). Conversely, deficits in facial expression recognition are associated with less activity in these brain regions (Benuzzi et al., 2004; Loughead, Gur, Elliott, & Gur, 2008; Murphy, Nimmo-Smith, & Lawrence, 2003; Salloum et al., 2007). There is evidence that the age differences in identifying facial expressions are related to the changes in neural systems due to aging (Calder et al., 2003; Isaacowitz et al., 2007; Ruffman, Henry, Livingstone, & Phillips, 2008; Sullivan & Ruffman, 2004b; Suzuki et al., 2007). Similarly the effect of AD has been associated with neuropathology (Rosen et al., 2005). Accordingly the neural substrates known to support the recognition of facial expressions are summarised below, followed by a summary of the neurological changes that occur due to aging and AD.

The Neural Basis of Facial Expression Recognition

A large range of brain structures have been shown to be involved in the recognition of facial expressions of emotion (Adolphs, Tranel, & Damasio, 2003; Benuzzi et al., 2004; Biseul et al., 2005; Phillips, Drevets, Rauch, & Lane, 2003b), however, the frontal and temporal regions are the most important. Within these regions, key components are the amygdala (Adolphs, 2002b; Phillips et al., 2003a), orbitofrontal cortex and ventral striatum (Britton, Taylor, Sudheimer, & Liberzon, 2006; Norris et al., 2004; Simon, Craig, Miltner, & Rainville, 2006; Vuilleumier & Pourtois, 2007; Winston, O'Doherty, & Dolan, 2003). Previous research has shown these areas are critical for maintaining general vigilance of affective information (Eimer & Holmes, 2007; Haxby et al., 2002) and, therefore, respond to all facial expressions of emotion.

The medial prefrontal cortex (Habel et al., 2007; Haxby et al., 2002; Vuilleumier & Pourtois, 2007; Winston et al., 2003) and fusiform cortex (Phan, Wager, Taylor, & Liberzon, 2002b), which are commonly activated in response to facial expressions and also not found to be specific to a particular emotion, are likewise implicated in the role of general response to socially relevant information. In addition, the dorsolateral prefrontal cortex (Sprengelmeyer & Jentzsch, 2006), superior temporal sulcus (Winston et al., 2003), anterior cingulate (Burgdorf & Panksepp, 2006; Leppanen & Nelson, 2006; Sprengelmeyer & Jentzsch, 2006) and insula (Britton, Taylor et al., 2006; Phan et al., 2002b; Phillips et al., 2003a) are consistently implicated in emotional information processing.

The recognition of specific expressions of emotion has been associated with certain brain regions, and although the evidence to suggest which brain areas subserve which emotion is tentative, there is sufficient agreement that at least partially dissociable neural pathways are involved with the recognition of specific emotions (Adolphs et al., 2003; Blair, Morris, Frith, Perrett, & Dolan, 1999). Only happy, sad and fear expressions are considered below given their relevance to the present set of studies.

Happy

Basal ganglia activation has been shown in response to happy facial expressions (Phan, Wager, Taylor, & Liberzon, 2002a), although not specifically, which is consistent with the rich innervations of dopaminergic neurons that respond to positive affect. Kesler-West et al. (2001) also found significant activation in the medial frontal - cingulate sulcus region which did not show activation in response to other emotions.

Sad

The anterior cingulate (Phillips et al., 2003a), subcallosal cingulate (Phan et al., 2002a), ventromedial prefrontal cortex (Britton, Taylor et al., 2006) and temporopolar area (Blair et al., 1999; Lee et al., 2002) have been associated with sadness. Other research has found no specific activation associated with the recognition of sad facial expressions (Kesler-West et al., 2001).

Fear

The amygdala is often linked with the recognition of fearful facial expressions (Adolphs & Tranel, 2003; Loughead et al., 2008; Ohrmann et al., 2007; Phan et al., 2002b; Williams et al., 2005), although there has been some research that found amygdala activity was detected in response to anger expressions but not fear (Britton, Taylor et al., 2006). Furthermore, amygdala activity has been found in response to all types of expressions and was not selective for any particular expression (Fitzgerald, Angstadt, Jelsone, Nathan, & Phan, 2006). This inconsistency may be explained by the finding that a sustained cortico-amygdala response differentiated the response to threat-related information (fear expressions) from the amygdala activation to other facial expressions or novel stimuli (Williams et al., 2004). Similarly a subcortical thalamic-hippocampal-amygdala response is involved in the rapid detection of fear expressions (Reinders et al., 2006). The recognition of fear expressions has also been shown to involve hippocampus activity (Britton, Phan et al., 2006) and a critical role for the somatosensory cortex has been suggested (Pourtois et al., 2004).

Age-related Neurological Changes

Aging is associated with a wide variety of changes in the structure and function of the brain (Keller, 2006; Peters, 2006; Tisserand & Jolles, 2003). The idea that age-related decline is associated with brain shrinkage has been widely accepted (Raz & Rodrigue, 2006) and it has therefore been generally accepted that as an individual ages, their brain ages and these structural changes in the brain may underlie cognitive decline. There is little evidence for pervasive volume loss during healthy aging; rather loss appears to be much more limited and restricted to specific brain areas (Raz & Rodrigue, 2006).

The prefrontal cortex (PFC) is particularly vulnerable (Raz, Williamson, Gunning-Dixon, Head, & Acker, 2000; Tisserand & Jolles, 2003). Raz and Rorique (2006) state the trend to emerge from both in vivo volumetry and voxel-based morphometry (VBM) studies is that the prefrontal cortices are more significantly affected by aging than the temporal regions, which show moderate neuronal loss, with smaller differences still in parietal and occipital cortices. The volume and density of the hippocampus, amygdala, cerebellum and neostriatum are reported to show a moderate negative association with age (Raz & Rodrigue, 2006). VBM studies also show age-related atrophy of the anterior cingulate cortex and striate cortex (Raz & Rodrigue, 2006; Tisserand et al., 2002). In summary, many of the brain regions effected by aging are also important for facial expression recognition. For example, the frontal region, anterior cingulate (Boccardi et al., 2003; Rosen et al., 2005), amygdala and hippocampus and/or amygdala-hippocampal junction (Adolphs, 2002a; Adolphs & Spezio, 2006; Blair et al., 1999; Vuilleumier & Pourtois, 2007).

Neurological Changes in AD

Individuals with AD experience far more pervasive structural and morphological changes in the brain than that shown with normal aging. Early pathology is known to preferentially affect the medial temporal lobe structures; in particular, characteristic neurofibrillary tangles are found in the entorhinal cortex, hippocampus and amygdala (Hodges, 2006). The atrophy rate of medial temporal structures separated healthy elderly from those who developed cognitive impairment with 91% specificity and 85% sensitivity (Wenk, 2003). The posterior cingulate region also shows extensive hypometabolism in AD (Hodges, 2006). Beyond the early stages of the disease, characteristic pathology occurs in many areas of the brain including the frontal regions. As was shown with respect to healthy aging, individuals with AD experience damage to regions that are known to support the recognition of facial expressions, in particular, the crucial temporal lobe region is effected in the early stages of the disease.

Cognitive Decline Explanation

The neurological changes in aging and AD are also linked to poorer cognitive functions. The age-related changes in cognitive functions and the impact of AD on cognitive functioning are also discussed given general cognitive decline is often argued to account for difficulty with facial expression recognition.

Age-related Cognitive Changes

Age effects fluid abilities (i.e., speed and problem solving) more than crystallised abilities (i.e., knowledge and expertise), as such, age differences in performance tend to increase with more difficult cognitive tasks. General cognitive resources, in particular, processing speed and working memory, are especially vulnerable and are crucial factors in the decline of the other cognitive functions (Salthouse, 2005). These cognitive resources are often involved in the completion of facial expression recognition tasks.

Many of the age-related neurological changes in the brain summarized above are also associated with cognitive performance[3] (Gunning-Dixon et al., 2003; Gunning-Dixon & Raz, 2000, 2003; Gunstad et al., 2006; Peters, 2006; Zimmerman et al., 2006) as well as facial expression perception. In particular, the decline in metabolism in the medial network, including the anterior cingulate and medial prefrontal cortex, is correlated with a decline in cognitive functioning (Pardo et al., 2007).

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[3] Raz and Rodrique (2006) suggest many of the associations are modest, however, and findings are often inconsistent.

Difficulties with emotion processing and facial expression recognition have often been explained by task difficulty and deficits in general cognitive functioning in various populations, for example, schizophrenia (Russell, Green, Simpson, & Coltheart, 2008), ADHD (Yuill & Lyon, 2007) and also in AD (e.g., Albert et al., 1991). Many other studies, however, have concluded that difficulties in the ability to recognize facial expressions are independent of cognitive functioning (Hargrave et al., 2002; Johnston, Katsikitis, & Carr, 2001; Marsh & Blair, 2008) and reflect a specific emotion processing impairment.

Cognitive Changes in AD

The distinct neuropathology associated with AD results in the decline of cognitive functioning. Deficits in anterograde episodic memory are the most common initial symptom of AD (Hodges, 2006) and reflect characteristic pathology in the medial temporal lobe (Braak & Braak, 1995; Hodges, 2006).[4] Deficits in semantic memory are also common (Hodges & Patterson, 1995), as are deficits in attention and executive functions (Hodges, 2006), which reflect frontal lobe involvement. Visuospatial and perceptual impairments are usually evident at a later stage of the disease process.

Individuals with AD perform poorly on most measures of cognitive functions. As discussed earlier, with respect to healthy older adults, difficulties with facial expression recognition have been explained by general cognitive decline, but have also been found independent of cognitive functions and, therefore, a distinct emotional impairment. Individuals with AD experience damage to brain areas that are involved in facial expression recognition and support a variety of cognitive functions. Whether these functions are both compromised in

[4] In particular the transentorhinal cortex and then the hippocampal formation (Braak & Braak, 1995; Hodges, 2006)

AD or whether impairments in facial expression recognition are an artefact of cognitive decline and reflect task difficulty is not well established. The relationship between poorer cognitive and emotional functioning remains unclear and so will be investigated more fully in the present research.

Limitations in Previous Research

This section discusses three particular limitations with the previous research investigating the effects of aging, and in particular AD, on the recognition of facial expressions of emotion as these are relevant to the present research. First, it may be that two separate questions were being asked when investigating the recognition of facial expressions of emotion: 1) Can participants recognise facial expressions? 2) Can participants recognise emotion as specified by facial expressions? As discussed earlier, facial expressions are not always a reliable indication of emotion because an individual can produce posed displays that are decoupled from affective state. If the aim of an investigation is to answer a question relating to whether participants have, or preserve, the ability to detect the affective state of another person via their facial expression, then the expressions from which they are asked to make judgments should contain information relevant to how the target feels.

The terms ‘emotion’ and ‘expression’ are often used as if synonymous, not only in general discussion but also in various procedures. In several studies (Albert et al., 1991; Bucks & Radford, 2004; Isaacowitz et al., 2007; Ogrocki et al., 2000) the participant was asked how the target person was feeling and given acted displays where the relevant information was simply not present. The participant can answer what this person was showing or what emotion is being represented, but they are unable to answer how the person is feeling when the facial expression provided has been decoupled from the affective state. This distinction may be especially relevant for clinical populations, where there is a potential for 'hypersensitivity' to emotion or there is a tendency to rely on a more literal understanding of the instructions. For example, Davis and Gibson (2000) reported that individuals with paranoid schizophrenia demonstrated deficits in the recognition of affect when negative posed expressions were presented that were not evident when asked to recognise genuine expressions of these emotions. In addition to imposing potential confusion in the judgement process, such a reliance on posed displays may also dilute the area of investigation into a means to examine the recognition of facial expressions rather than an attempt to examine the perception of affective state.

Several studies have shown that young adult perceivers are sensitive to the differences between genuine and posed smiles, both when making judgments about the type of smile (Frank, Ekman & Friesen, 1993) or when judging the affective state of targets (Hess, Kappas, McHugo, Kleck, & et al., 1989; Miles, 2005; Miles & Johnston, 2007). Individuals have also reported higher levels of enjoyment and pleasure when viewing genuine compared to posed smiles (Surakka & Hietanen, 1998). In addition, individuals exhibit different mimicry to posed and genuine smiles. Specifically they mimic genuine smiles by smiling genuinely and mimic posed smiles by posing a smile (Lundqvist & Dimberg, 1995). People have even been found to favour T-shirts when worn by people smiling genuinely than when worn by people with posed smiles (Peace, Miles, & Johnston, 2006). It does not appear that any research has investigated whether individuals are also sensitive to negative emotion specified in facial expressions, and furthermore, whether these fundamental skills are compromised in other populations such as older adults and individuals with AD.

Second, the majority of research investigating recognition of facial expressions of emotion has employed one or more of the three main types of experimental tasks. Often these tasks require skills that place a cognitively vulnerable participant under a substantial working load. Different procedures engage the participant in different ways and require different cognitive skills. For instance, the participant must access semantically meaningful information about each of the alternative response options and apply this to a single exemplar in emotion identification tasks. When only verbal response options are provided, the participant must also remember each option. In contrast, discrimination tasks require the assessment of two stimuli but can be completed by visuoperceptual comparisons that may have little to do with access or understanding of emotional information and more to do with configurations of visual stimuli. Emotion matching tasks, in further contrast, require the participant to scan several photographs and retain defining information about each so a match to the target can be made. Visuoperceptual information devoid of emotional content can also be used to complete this task. In addition, whilst these procedures require a variety of cognitive skills that arguably overshadow or even interfere with emotion recognition they also suffer from poor face validity in respect to the referent situation of an actual social interaction.

Third, many of the studies reviewed reported ceiling or near ceiling effects for the recognition of happy expressions. Data is often excluded from analysis in recognition and imaging studies, for example, because of the ceiling effect. Rosen et al. (2006) suggested that more subtle positive expressions may have better demonstrated potential associations when they investigated the association between happiness recognition accuracy and tissue loss. Rather than manipulate task difficulty through the complexity of the facial displays (e.g., morphing, obscuring), the present research argues that subtly can be achieved by considering the nature of the judgments that are required within the complexity of real-life facial displays.

A task which assesses sensitivity to posed versus genuine expressions (Miles, 2005) would suffice as a more subtle task. This task requires a participant to detect affect via the face from not only neutral expressions but also posed expressions that closely simulate positive affect. Therefore, this task assesses the subtle yet functionally critical skill of detecting actual emotion in facial expressions.

The Present Research

The present research aimed to address the three particular limitations in the current literature by employing ecologically valid facial displays that provide the perceiver with information relevant to the affective state of another person. The displays were employed in tasks that minimized the use of cognitive skills such as memory, language and visuospatial discriminations. The categorization task required the participant to make judgments about the target emotion of individually presented facial expressions and the priming task required he/she identify the valence of unambiguous words preceded by facial expression primes. These two tasks involved subtle judgements, while still maintaining the meaningful discriminations that are required during exposure to the variety of everyday facial expressions.

Having addressed these limitations, the present research investigated whether healthy young adults, older adults and individuals with AD were sensitive to affective state specified in facial expressions and how the groups compared. Specifically the reported research looked at whether these groups could differentiate between expressions that specified emotion (genuine expressions) from expressions that did not (posed and neutral expressions).

The focus of the present research was to investigate affect specified in faces rather than simply facial expressions. The tasks employed emphasise emotional rather than cognitive skills. However, given the inconsistency in the AD literature in particular, the present research also looked at whether sensitivity to emotion was associated with the general cognitive decline associated with aging and central to the presentation of AD, or whether it was a distinct skill independent of cognitive functioning. These two functions are known to decline with both advanced age and AD and both are linked to underlying neurological changes in older age and AD. To better understand the relationship between these two functions the present research assessed a variety of cognitive functions across the major domains. A comprehensive evaluation of each domain was not warranted, given the specific focus of the present research, rather a multi-test score relating to each broad domain was sought. Specifically, a measure of episodic memory (events), semantic memory (facts and knowledge) and working memory (temporary storage and manipulation of information), as well as general executive function (planning, flexibility, monitoring), attention (orientation and concentration) and visuoperception skills (accuracy with visual information) [5] was sought, as detailed in Chapter 2.

The present study predicted that healthy young adults would be sensitive to each of the target emotions of happiness, sadness and fear as specified in facial expressions and would be able to differentiate between posed and genuine expressions of these emotions. Given the problems identified by previous research, it was expected that healthy older adults would have difficulty and would not be sensitive to sadness and fear but would maintain sensitivity to happiness and be able to differentiate between posed and genuine smiles. In addition, it was predicted that individuals with AD would show more profound deficits reflecting the

[5] Each of the descriptions in brackets are incomplete and do not acknowledge the broad and interactive function of systems.

more pervasive neurological changes associated with the disease, would not demonstrate sensitivity to the target emotions, and would not be able to differentiate between posed and genuine expressions.

CHAPTER 2

Generation and Selection of Research Materials

The present chapter outlines the research materials that have been generated and selected for use in the following programme of research. In order to test whether individuals were sensitive to emotion, participants needed to be provided with facial displays that contained the relevant information. The first section of this chapter outlines the procedure employed to generate genuine, posed and neutral expressions of happiness, sadness and fear and the second section introduces the tests used to measure cognitive function.

Generation of Facial Displays

The majority of previous research investigating the recognition of facial expressions has employed facial expressions that have been created to comply with the criteria defined in the facial action coding system (FACS; Ekman, 2002). The FACS is a widely used anatomically based method for describing and measuring facial behavior and it was developed by determining how the contraction of each facial muscle changes the appearance of the face. Forty-six action units (AUs) are used to describe all visual movement in the face. Specific combinations of FACS units that are thought to represent prototypic and major variants of expressions of emotion have been developed and these are often used as criteria to create and describe expressions for use in recognition studies and for use in studies investigating the differentiation of posed and genuine expressions. For example, expressions have been created by actors who have been trained to contract muscles that are representative of respective expressions (Gosselin, Perron, Legault, & Campanella, 2002; Gosselin, Warren, & Diotte, 2002; Williams, Senior, David, Loughland, & Gordon, 2001), or facial expressions have been computer generated based on FACS criteria (Krumhuber & Kappas, 2005). Imitated and posed expressions, generated by contracting specific muscles and pulling representative faces, may not always occur naturally however and may differ from those that occur in response to affective experience (Gosselin et al., 1995).

Other studies have attempted to generate more ecologically valid expressions by employing spontaneous expressions (e.g., LaRusso, 1978; Scherer & Ceschi, 2000), in particular by videotaping individuals in semi-naturalistic social settings (Motley & Camden, 1988). Unfortunately this method involves a variety of extraneous factors, such as the potential for the expression of more complex compound emotions than those of interest and the limited control over eye gaze and lighting etc. Importantly, posed displays could not be generated within the same procedure in a naturalistic setting.

The present research will adopt an alternative approach reported by Miles (2005; Miles & Johnston, 2007) who showed that ecologically valid displays could be generated in the laboratory. Miles reported that genuine smiles were generated from everyday reference situations by individuals who importantly also reported a corresponding experience of positive affect, while posed smiles and neutral expressions were generated in the absence of positive affect. To this end, facial displays were generated specifically for the present research adopting a similar procedure to Miles, which was adapted to allow for the generation of a variety of emotional expressions.

Method

Participants

The participants were 17 female students recruited from the University of Canterbury, who ranged in age from 19 to 34 years (*M* = 24.8 years, *SD* = 4.2). None of the participants wore glasses or had any distinguishing features such as facial birthmarks or prominent scars. Participants received a $10 shopping voucher in return for their time.

Apparatus

Stimulus materials were presented via a 15 inch computer monitor using Microsoft® PowerPoint software. The participant sat in front of a neutral wall approximately 60cm from the computer monitor. The session was recorded using a Canon XM2 3CCD digital video camera and recordings were captured and converted to computer files using Adobe Premier® Software. The recordings were captured in PAL format at 25 frames per second.

Materials

Each participant was shown a series of static pictures from the International Affective Pictures System (IAPS; Lang, Bradley, & Cuthbert, 2001). The IAPS is a database of over 700 pictures with normed ratings of pleasure, arousal and dominance for each photograph for both male and female viewers. A selection of 15 pictures was chosen, each of which had an arousal ratings above the mid-point of the arousal scale for female viewers (i.e., ratings > 4.5 on a 9-point scale). Since displays of happiness, sadness and fear were desired from participants, pictures were included with a large range of mean pleasure ratings for female viewers (ranging from 1.4 to 8 on a 9-point scale). Using a range of photographs also prevented participants from guessing which emotions were of interest to the researcher.

Pictures with low arousal ratings (i.e., ratings < 3.5 on a 9 point scale) were also employed to elicit expressions of neutral affect. The list of IAPS pictures used in this generation procedure can be seen in Appendix A.

Each participant also listened to sound clips from the International Affective Digitized Sounds database (IADS; Bradley & Lang, 1999). The IADS is a database of 120 emotive sounds that, like the IAPS, have normative ratings of pleasure, arousal and dominance for both male and female perceivers. A selection of eleven sounds was chosen, each of which, like the IAPS pictures, had an arousal rating above the mid-point of the arousal rating scale for female listeners (i.e., > 4.5 on a 9-point scale). A range of sounds with high arousal levels was again employed in order to elicit a variety of responses and to prevent participants anticipating the emotions of interest. Since displays of happiness, sadness and fear were desired from participants, sounds were included with a large range of mean pleasure ratings for female viewers (ranging from 1.9 to 7.9 on a 9-point scale). Appendix A also provides a list of the IADS sounds used in this procedure.

The participant was also asked to view slides that provided instructions on how to complete several tasks. During the procedure, slides instructed the participant to relax, smile for an ID photo, smile as she would for a passport photo and pretend to be sad and fearful. She was asked to pose how she thought she would have looked when experiencing previously elicited happy, sad and fearful reactions to stimuli. Each participant was asked to provide future confederate stimuli by faking sad, fearful and disgust reactions to blank slides. She was asked to imagine scenarios like playing along with a small child and ‘keeping up’ the game by feigning a sad reaction. Before listening to a high arousal-low pleasure sound, the participant was asked to imagine walking alone at night and was encouraged to concentrate on what she might be experiencing and feeling. Each participant was also asked to sing the National Anthem and was asked to stop a few seconds after the request. She was asked for permission to show her video tape to an undergraduate class who were discussing different people's facial features and told this was not true after a few seconds. Each participant also listened to a portion of one of several songs listed as the saddest songs ever written according to Rolling Stone magazine while thinking about sad events in their own personal experience.

The participant was asked to rate her reaction to each of the stimulus displays using a forced choice label option accompanied by strength of reaction analogue scales. A response booklet that was designed to accompany the presentation (see Appendix B for an example) was provided to each participant and at set intervals in the procedure, as detailed below, the participant was asked to self-report their affective reactions to stimuli. The response options were always the same and consisted of happy, sad, fear, surprise, angry, disgust and neutral labels, presented in several different orders. The participant circled the option that best described their reaction to the stimulus and if a choice other than neutral was selected, she marked the strength of her reaction on the accompanying scale. Labels of "low" and "high" at the ends of the scale and "moderate" in the centre anchored the scale.

Procedure

Participants were recruited individually to participate in a study in which they would be asked to provide some evaluations of a variety of stimuli. Each participant was told that the stimuli material would potentially be used in future research and it would, therefore, be helpful to obtain information regarding how suitable the material would be. Consequently, the participant was asked whether she would mind looking over the material and offering some simple ratings about any reaction she might have to the material she viewed. Each participant was tested individually.

An information sheet describing the task as a pilot study looking at the suitability of stimuli material for future research was provided to each participant (see Appendix C). The information sheet also outlined the basic procedure and explained that several photographs and various other stimuli would be presented. The participant was informed that she would be videotaped during the process. An initial consent form was signed by each participant indicating her willingness to take part in the pilot study.

Having answered any questions, the researcher ushered the participant to a viewing room where she was seated approximately 60cm in front of a computer screen. A video camera was mounted on a tripod behind the computer screen. A mirror was placed in a position behind and to the side of the participant to capture the reflection of stimuli presented on screen and to be within shot of the video camera. Each participant was instructed to limit body movements as much as possible so she would not inadvertently interfere with the camera/mirror configuration.

The researcher informed the participant again that her task was to simply watch the various slides and think about how each one made her feel. She was reminded she would also see task slides containing instructions that she should follow as best she could. The participant was asked to look into the camera as much as possible whilst considering the material and following the instructions displayed. The camera position was set at an angle that allowed for direct capture of the full face with only a minor shift of eye position from screen to camera required. Whilst the participant was aware she was being videotaped, she was told that this was also to investigate how viable such a method would be in terms of future research. For instance, would it be possible to capture good quality video of the future participant, the screen via the mirror, and would the mirror reflection interfere with the future participant image.

Once the participant was seated comfortably, the researcher started the Power-Point® presentation and left for an adjacent room where she could be heard but not seen. At the completion of block 1, which consisted of fifteen pictures, two sounds and five tasks (see Appendix D), the researcher instructed the participant to complete the appropriate response booklet section. This required a choice of affective label and intensity ratings where applicable to each of the stimulus displays presented thus far and the Power-Point © presentation was restarted to enable the participant to view each stimulus again while recording their initial reaction. The second block consisted of verbal instructions from the researcher in the adjacent room and task/scenario slides that were advanced on screen by the participant via the researcher's instructions. The self-report reactions to these instructions and scenario slides were elicited verbally and simply required a verbal response from the participant who was reminded to refer to their response booklet for response options. The third block (see Appendix D) started with a scenario slide and continued with the presentation of the IADS sounds and finished with task slides. At the completion of this block, the researcher asked the participant to refer to her response booklet and the sounds and slides were replayed for her to select the option that best described how each sound/task had made her feel.

At the conclusion of the procedure, each participant was debriefed and told the study was not a pilot study and the purpose was, in fact, to obtain her reactions to the experimental material. The participant was told that the videotape would be used to produce photographs of facial expressions that would be utilized in research looking at the recognition of posed and genuine facial expressions of emotion. Each participant was invited to inspect the video if she wished before being asked to give consent to the use of the video material in subsequent studies (see Appendix E for consent form). All participants consented to the use of their video-tapes.

Results

Stage 1: Self-report Evidence

Each of the seventeen response booklets was inspected for self-reported reactions to the eliciting material. To remain viable a participant had to report feeling a medium to high level of happiness, sadness or fear in response to one or more of the eliciting stimuli. The same participant should also have reported feeling neutral to at least one prompt to pose a deliberate expression of the corresponding emotion. The information from three participants did not meet the criteria at stage one. Two of these participants did not report a neutral reaction to the posed expression of sadness (1) or happiness (1) when these were the only genuine reactions elicited. Therefore the video information could not yield a genuine, posed and neutral triad of facial expressions for any of the emotions in question. One of the participants did not report any medium to high happy, sad or fear reaction.

Stage 2: Reactions Consistent with Eliciting Situation

To warrant further analysis the reactions from the remaining fourteen participants needed to be consistent with the eliciting situation. For example, a reported experience of medium happiness should follow material or a task that was consistent with positive experience. Happy reactions to IAPS pictures or IADS sounds with norms of high pleasure would be consistent and would meet the stage 2 criteria of the present study. Similarly, strong sad reactions should follow material with low pleasure ratings or tasks with face validity. For example, a reported experience of high sadness following the task slide which asked the participant to recall as vividly as possible a sad personal experience would meet the stage 2 criteria. Each of the fourteen remaining participants reported the experience of at least one emotion following a corresponding referent situation that was judged as consistent with the respective emotion.

Stage 3: Facial Movement during Reported Experience

The video tape of each participant was visually inspected for identifiable movement of facial muscles during reports of emotional experience. At this stage the information from two participants was removed from further analysis due to either a lighting problem that resulted in poor quality video (1) or to excessive movement of the participant during each incidence of emotional reaction (1). Facial movement was evident in at least one reported experience of emotion and corresponding posed expression for each of the remaining twelve participants.

After the initial three-stage inspection of the self-report and video information for each participant, as described above, expressions from twelve participants were judged to be viable for further analysis. Table 3 provides a summary of the number of displays from each participant available for coding using the FACS criteria. A still photograph was captured at the perceived apex of each of the expressions shown in Table 3 and was converted to a 640x480 bitmap file. Each photograph was standardized by applying auto levels and auto contrast in Adobe Photoshop.

Table 3. Number of Displays Available for Coding for Each Participant who met the Initial Stage 1-3 Criteria for Inclusion

Ppt#	Happy		Sad		Fear		Neutral
			Self-reported				
	Genuine	Posed	Genuine	Posed	Genuine	Posed	
1	1	2	1	2	2	3	3
2	1	3	1	2	0	0	2
3	3	2	0	0	2	1	1
4	2	3	4	4	1	4	4
5	4	3	0	0	0	0	2
6	1	2	3	4	1	4	2
7	3	2	2	3	2	3	3
8	4	3	2	4	1	4	2
9	1	3	2	2	1	2	3
10	3	2	1	1	1	1	2
110	0	0	1	1	0	0	2
12	0	0	1	1	0	0	3
total	23	25	18	24	11	22	29
#Ppt's	10	10	10	10	8	8	12

Note. Expressions have not been confirmed as genuine and posed by FACS coding.

Stage 4: Coding Facial Movement

Stage four involved the coding of facial movement to establish and verify that each expression contained action units (AU) regarded as typical for the respective emotion, according to the FACS criteria. For instance, happy expressions should involve action units that specify a smile and sad expressions should involve action units that are typical of sad faces. The FACS provides both prototypical and major variants of each of the basic emotions and research has found that recognition of emotion is largely associated with the core units for each emotion (Gosselin et al., 1995; Kohler et al., 2004; Suzuki & Naitoh, 2003).

In the present study core units for each of the target emotions (happiness, sadness, fear) were identified by means of a quasi-consensus. That is, evidence of activation of the units identified by FACS and those units found to be present during individual's portrayals of felt (Gosselin et al., 1995; Kohler et al., 2004) and unfelt emotion (Gosselin et al., 1995; Kohler et al., 2004; Suzuki & Naitoh, 2003) were sought. In addition to the core units, all action units were noted and intensity ratings were made according to FACS criteria. Ratings of core units were used to match posed and genuine expressions. Intensity ratings range from A which is indicative of trace movement to E which demonstrates maximum movement (see Ekman et al., 2002 for full description of each of the five levels of movement for each action unit). Table 4 provides a description of the relevant action units and a summary of intensity ratings.

Table 4. Description of the Relevant Action Units Discussed in Relation to Happy, Sad and Fear Expressions

Action unit		Facial muscle	Main appearance changes
AU 1	Inner Brow Raiser	Frontalis (pars medialis)	Pulls the inner portion of the eyebrow upwards and may result in an oblique shape. Often causes horizontal wrinkles in the centre of the forehead.
AU 2	Outer Brow Raiser	Frontalis (pars lateralis)	Pulls the outer portion of the eyebrow upwards and often produces an arched shape. Causes lateral portion of the eye cover to be stretched upwards. May see horizontal wrinkles in the lateral portion of forehead.
AU 4	Brow Lowerer	Corrugator supercilii Depressor supercilii	Lowers the eyebrow/inner portion of the eyebrow. Pulls the eyebrows together and may produce vertical wrinkles between brows.
AU 1+4			Pulls the medial portion of the eyebrow upwards and together. Produces and oblique shape or a dip in the centre with a pull at the corners. Produces a triangular shape to the upper eyelids.
AU 5	Upper Lid Raiser	Levator palpebrae superioris	Widens the eye aperture
AU 6	Cheek Raiser	Orbicularis oculi (pars orbitalis)	pulls the skin surrounding the eyes toward the eye ball causing wrinkles or crow's feet
AU 7	Lid Tightener	Orbicularis oculi (pars palpebralis)	Tightens eyelids and narrows eye aperture
AU 15	Lip Corner Depressor	Depressor anguli oris	Pulls the corners of the lips down
AU17	Chin Raiser	Mentalis	Pushes the chin boss upwards.
AU 20	Lip stretcher	Risorius often with platysma	Pulls the lips back laterally
AU 25	Lips part	Depressor labii inferioris	Teeth are showing and there is space between the lips
AU 26	Jaw Drop	Masseter	By relaxation rather than pulled wide open (AU 27).

Adapted from: Ekman, P., Friesen, W., & Hager, J. (2002).

Note. Intensity scores are added to each AU according to FACS manual: A = trace, B = slight, C = marked, D = sever, E = maximum.

Happy

The action units indicative of happy expressions, or more specifically smiles, are well agreed upon (Ekman et al., 1981; Frank, Ekman, & Friesen, 1988; Hess & Kleck, 1990; Williams et al., 2001). Expression of positive emotion (a genuine smile) involves AU12 and AU6. A simulated expression of happiness (a posed smile), in contrast, involves only contraction of AU12 and not AU6. Figure 4 provides an example of a neutral, posed and genuine expression. The facial action criterion set for coding happy expressions was, therefore, that all expressions contained AU12 and that genuine expressions in addition contained contraction of AU6. To minimise differences within and between participants, AU 25 and/or AU 26 were added as criteria to ensure all smiles displayed teeth.

A B C

Figure 4. Neutral (A) Expression and Posed (B) and Genuine (C) Happy Expressions

Sad

The action units indicative of sad expressions are less well defined, indeed the FACS provides three prototypes and five major variants. The action units AU1, AU4 (or combination AU1+4), AU15 and AU17 have been selected as core units because they are reported to occur more consistently across four sources (Gosselin & Kirouac, 1995; Kohler et al., 2004; Suzuki & Naitoh, 2003) than other units, although not always in combination. Accordingly, for inclusion in the present study, each posed and genuine expression had to contain at least two of the core units. Unlike for happy expressions, and as discussed in Chapter 1, no specific action unit(s) has been identified in prior literature as specifying genuine sadness or differentiating between genuine and posed expressions of sadness. No criteria were therefore set to code for veracity of the expressions. Rather, all expressions elicited, either in response to relevant referent situations or in response to experimenter instructions to pose a sad expression, were coded for activation of the core units identified above.

Figure 5 provides an example of a neutral, as well as posed and genuine sad expressions. Differentiation between genuine and posed was made on the basis of the self-report ratings of affect from the target, although it is noteworthy that at the completion of the selection process (see stage five), genuine but not posed expressions were identified as containing the AU1+4 combination and posed expressions contained activation of more action units than genuine expressions. Specifically, it was additional core units that were present in posed sad expressions. Both the AU1+4 combination and the presence of additional movements were introduced in Chapter 1 as potential markers to distinguish posed from genuine sad expressions.

A B C

Figure 5. Neutral (A) Expression and Posed (B) and Genuine (C) Sad Expressions

Fear

The core action units selected in the present study are AU4, AU5, AU7 and AU20. While AU 1 and AU2 are also consistently associated with fear across four sources (Gosselin & Kirouac, 1995; Kohler et al., 2004; Suzuki & Naitoh, 2003), both of these action units are also associated with surprise. Accordingly, these units may be contracted in the current facial displays but only in association with contraction of AU4, which is not associated with surprise. As with sadness, there are no established coding criteria to differentiate genuine from posed expressions. Accordingly, the same process was followed as for sadness. All the fear expressions had to contain contraction of at least two core action units and differentiation between posed and genuine expressions was made based on self-report evidence from the target.

Figure 6 provides an example of neutral, posed and genuine fear expressions. It is noteworthy that at the completion of the selection process (see stage five), all of the posed expressions contained activation of additional AUs in comparison to the genuine expressions. As discussed in Chapter 1, posed expressions, particularly of negative expressions, may be exaggerated and contain additional muscle movements than the genuine counterparts. In this case, all of the posed fear expressions contained AU1 and/or AU2 in association with AU4, that is, the inner and/or outer brow was raised in concert with lowering the brow. The genuine fear expressions did not involve either AU1 or AU2[6].

A B C

Figure 6. Neutral (A) Expression and Posed (B) and Genuine (C) Fear Expressions

After coding, the happy expressions from two participants were removed because there was no visible indication of AU6 (Ppt1) or AU25/26 (Ppt6) activation in the genuine facial display. Similarly, the sad expressions from participant 2 were removed because both posed sad expressions contained an additional action unit (AU2) that is not generally associated with sadness and was expressed at a moderately high intensity level. The fear expressions from participant 3 and participant 10 were not considered any further because the posed version (Ppt3) did not contain action units relevant to fear but rather surprise and additional

[6] A Cronbach's alpha of 0.96 was found between two independent coders.

action units were displayed (Ppt10) which more closely identified surprise.

Intensity has been shown to influence the recognition of facial expressions (Hess, Banse, & Kappas, 1995; Kohler, Turner, Gur, & Gur, 2004). To minimize the differences between expression types the intensity ratings were inspected for each participant to ensure there were displays of posed and genuine expressions where core units were expressed within one level of intensity. For example, the activation of AU 12 in a posed smile (AU 12B) should be matched with similar activation of AU12 in a genuine smile (AU 12B ±1 level). Action units that appeared in one type of expression but not the other could not be matched. The sad expressions from participant 1 and participant 10 were removed because the intensity ratings of core units in the posed expressions were two levels higher than in the genuine expression. Table 5 shows the number of displays retained after coding for characteristic action units and intensity using the FACS criteria.

Table 5. Number of Displays Retained after Coding

Ppt#	Happy		Sad		Fear		Neutral
	Genuine	Posed	Genuine	Posed	Genuine	Posed	
2	1	1	0	0	0	0	2
3	2	2	0	0	0	0	1
4	2	2	3	2	1	1	2
5	4	2	0	0	0	0	2
6	0	0	2	4	1	2	2
7	3	2	2	3	2	3	3
8	3	2	2	3	1	2	2
9	1	3	1	2	1	1	3
10	3	2	0	0	0	0	2
11	0	0	1	1	0	0	2
12	0	0	1	1	0	0	3
total	19	16	12	16	7	11	25
#Ppt's	8	8	7	7	6	6	12

Stage 5: Selecting Displays for the Present Research

Four facial displays of each emotion were required for the research presented in subsequent chapters. Consequently, four triads that met the selection criteria were chosen for each emotion and an attempt was made to utilize as few targets as possible to minimize the effect of target between emotions. Consequently, two targets (Ppt 4 & Ppt 7) provided displays for all three emotions, another (Ppt. 8) for both sadness and fear, and four (Ppt 12, Ppt 6, Ppt 3 & Ppt 5) provided the final sad, fear and final two happy expressions respectively. A summary of the response data for each of the selected targets can be found in Appendix F.

Measures of Cognitive Functioning

The research presented in the subsequent chapters investigated whether sensitivity to emotion, as specified in facial expressions, was related to cognitive function. The selection of tests was determined by empirical findings and the characteristics of individuals with AD. Tests were chosen that have been widely used to assess cognitive functioning in the AD population and are sensitive to AD or help supplement the clinical diagnosis and differentiate AD from other dementias such as Dementia with Lewy bodies (DLB) or fronto-temporal dementia (FTD). As discussed in Chapter 1, AD is characterised by deterioration of memory and diagnosis is supported by the decline in function of at least one other domain of cognitive function. The range of deficits that may be present secondary to memory impairments requires the administration of a wide range of tests that span the main cognitive domains to capture the scope of current cognitive functioning for each participant. Furthermore, AD is associated with deterioration of social function, impacts on daily living skills and often involves psychiatric sequelae. The following tests (see Table 6) were used to evaluate a broad range of cognitive abilities and to provide demographic and clinical information about the participants.

Table 6. Tests Used to Assess Cognitive and Behavioral Functions

		HYA1	HYA2	HOA	AD
General Screen/Background	General Health and Demographic Screen	√	√	√	√
	M.I.N.I screen (interview if appropriate)	√	√	√	
	Geriatric Depression Scale (GDS)			√	√
	Beck Depression Inventory-II (BDI-II)	√	√		
	National Adult Reading Test-II (NART-II)		√	√	√
	The Mini Mental Status Exam (SMMSE)			√	√
	Match Words with Definitions	√	√	√	√
	Edinburgh Handedness Inventory (EHI)		√	√	√
	DRS-II total score			√	√
	Alzheimer's Disease Assessment Scale – (ADAS-cog., ADAS-noncog.)			√	√
Episodic Memory	Rey-Osterrieth Complex Figure Test II&III (ROF)			√	√
	Word Recall and Recognition I&II– subtest from the Consortium to Establish a Registry for Alzheimer's disease (CERAD)			√	√
	Memory – subtest from the DRS-II			√	√
Semantic Memory	Pyramids and Palm Trees (PPT)			√	√
	Modified Boston Naming Test- subtest from the CERAD (MBNT)		√	√	√
	Conceptualisation – subtest from the DRS-II			√	√
Working Memory/Attention	Daneman and Carpenter Reading Span Test			√	√
	Digits Forward – subtest from the Wechsler Memory Scale-III (WMS-III)		√	√	√
	Digits Backward – subtest from the WMS-III		√	√	√
	Adaptive Digit Ordering Test (DOT-A)		√	√	√
	Map Search – subtest from the Test of Everyday Attention (TEA)			√	√
	The Continuous Performance Task (CPT)			√	√

		HYA1	HYA2	HOA	AD/DLB
	Attention – subtest from the DRS-II			√	√
Visuoperception/Visuoconstruction	ROF-I			√	√
	CLOX-II			√	√
	Object Decision Task – subtest from The Visual Object and Space Perception Battery (VOSP)			√	√
	Incomplete Letters – subtest from the VOSP		√	√	√
	Object Decision – subtest from the VOSP			√	√
	Construction – subtest from the DRS-II			√	√
Executive Function	CLOX-I			√	√
	Letter Fluency – subtest from the Delis Kaplan Executive Function System (D-KEFS)		√	√	√
	Category Fluency – subtest from D-KEFS			√	√
	Category Fluency-switching - subtest from D-KEFS			√	√
	Initiation/perseveration – subtest from the DRS-II			√	√
Activities of Daily Living	Frontal Systems Scale - self-rating (FrSBe)			√	√
	Frontal Systems Scale - significant other (FrSBe)			√	√
	One Day Fluctuation Assessment			√	√
	Bristol Activities of Daily Living Scale (BADLS)			√	√

Note. Abbreviations: HYA1 = Healthy young adult group 1, HYA2 = Healthy young adult group 2, HOA = Healthy older adult group, AD = Alzheimer's disease group.
√ = test was included in the testing protocol for this sample.

The present testing protocol aimed to assess each cognitive domain using multiple tests so that a robust domain score could be used in correlational analysis investigating the relationship between sensitivity to emotion and cognitive functioning. Research has reported that deficits in the recognition of facial expressions are related to general cognitive changes, particularly associated with age (Orgeta & Phillips, 2008). There is little converging evidence supporting the role of any particular cognitive ability, although, as discussed in Chapter 1, deficits in language and visuospatial skills have been suggested as an explanation for poor performance by individuals with AD. Similarly executive deficits (Hoaken, Allaby, & Earle, 2007) constructional praxis and nonverbal memory deficits (Luzzi, Piccirilli, & Provinciali, 2007) have been shown to be associated with expression recognition deficits in other populations.

Several other issues influenced the selection of tests, specifically relating to the requirements of individuals with AD. The literature suggests that fatigue is a problem for some individuals with AD, consequently short tests (completed within 15 minutes) were chosen and the testing protocol was designed (see Table 7) to engage but not overtax an AD participant by dispersing tests throughout a session without any concentrated demands on any one particular cognitive domain for a sustained period.

Table 7. Test Protocol for Participants

Healthy Young Adults	Older Adults: Session 1	Older Adults: Session 2
General Health and Demographic screen	General Health and Demographic screen	Object decision (VOSP)
MINI screen (interview if appropriate)	M.I.N.I screen (interview if appropriate)	Incomplete Letters (VOSP)
Match words with definitions	ROF (copy)	Silhouettes (VOSP)
FER categorization task	Match words with definitions	Word List Recall/Recognition - I
FER sex discrimination task	ROF recall (3 minute delay)	Map Search (TEA)
FER priming task	FER categorization task	Word List Recall/ Recognition - II
NART	FER sex discrimination task	BREAK
Incomplete Letters (VOSP)	FER priming task	DRS-2
MBNT (CERAD)	ROF recall (30 minute delay)	ADAS-cog free interview
DOT-A	BREAK	Digits forward
Letter Fluency - (D-KEFS)	Letter Fluency - (D-KEFS)	Digits backwards
BDI-II	Category Fluency - (D-KEFS)	DOT-A
	Category Fluency-switching - (D-KEFS)	BREAK
	(S)MMSE	CPT
	NART	PPT
	CLOX	ADAS-noncog
	GDS	
	BREAK	
	MBNT (CERAD)	
	Daneman and Carpenter Reading Span Test	
	EHI	
	Homework	
	FrSBe	
	One Day Fluctuation Assessment	
	BADLS	

Note. FER = Facial expression recognition.

Test Descriptions

Each test is briefly described below in alphabetical order.

Adaptive Digit Ordering Task – DOT-A (Werheid et al., 2002)

The DOT-A provides a measure of verbal working memory and requires the participant to recall an increasing sequence of numbers in ascending order. A total score and span score are recorded with a half point added if one of the sequences is recalled correctly in the subsequent set. The tests are discontinued following the incorrect recall of any set.

Alzheimer's Disease Assessment Scale – ADAS (Rosen, Mohs, & Davis, 1984)

The ADAS was designed to provide an assessment of the major characteristics and range of dysfunction in individuals with AD. There are eleven cognitive items and ten non-cognitive items that provide two subscale measures. Each item is rated 0-5 with higher scores indicative of greater impairment. The ADAS is sensitive to AD in elderly, differentiating between AD patients and controls, and has been shown to discriminate between mild, moderate and severe AD (Zec et al., 1992).

Beck Depression Inventory-II - BDI-II (Beck, Steer, & Brown, 1996)

The BDI-II consists of twenty-one items and provides information regarding the presence of depressive symptoms. Each item is rated on a scale value of 0-3 with higher scores indicative of greater intensity of depressive symptoms. Scores below 14 suggest normal/minimal depressive symptoms (Beck et al., 1996), consequently a cut-off score of >14 was used to detect the presence of depression as part of the exclusion criteria in the present study.

Bristol Activities of Daily Living Scale - BADLS (Bucks, Ashworth, Wilcock, & Siegfried, 1996)

The BADLS is a carer rated scale for use with individuals with dementia. The ability of the patient to perform twenty daily living tasks, for example eating, mobility and hygiene, are rated and total scores range from 0 (totally independent) to 60 (totally dependent). Disparate profiles of functional ability have been shown between patients with dementia with Lewy bodies (DLB) and AD (McKeith et al., 2006).

CLOX (Royall, Cordes, & Polk, 1998)

The CLOX is used to assess both visuospatial and executive abilities. In CLOX-I the participant is required to produce a drawing of a clock that reads 1.45. In CLOX-II the participant copies a clock that the examiner has first drawn. CLOX-I&II are assessed according to fifteen separate criteria, for example, whether Arabic numerals were used, whether the sequence of 1-12 was intact and whether all numbers were inside the perimeter. Each criteria was given a score of one if correct. Scores range from 0-15 with lower scores equating to greater impairment. CLOX subscales have shown significant discriminative capacity between AD and controls, and between AD subgroups (Royall et al., 1998) and AD and MCI (De Jager, Hogervorst, Combrinck, & Budge, 2003).

Consortium to Establish a Registry for Alzheimer's Disease – CERAD (Morris et al., 1989)

The CERAD battery provides a means to assess the manifestation of cognitive impairment in AD. The present study administered the Modified Boston Naming Test and the Word List Recall and Recognition tests.

Modified Boston Naming Test – (M)BNT (Mack, Freed, Williams, & Henderson, 1992)

The MBNT provides a measure of semantic memory. The test involves the presentation of fifteen line drawings that represent five high, medium and low frequently occurring objects, for example, a tree, a house and a funnel. The participant has ten seconds to name each object. A variety of procedures have been associated with the presentation of the BNT, particularly relating to the types of cues that can be given. Neither semantic nor phonemic cues were provided in the present study. The MBNT has been shown to discriminate between AD and controls (Ferman et al., 2006; Mack et al., 1992).

Word List Recall and Recognition I&II

The word list tests are conducted in two phases: An immediate recall/recognition phase (I) and a 10-minute delay phase (II). The administration of this memory test involves the presentation of ten words on individual cards. In the first phase, the participant reads each word aloud and at the end of the trial is asked to recall as many words as possible. The same ten words are presented in different orders in three trials. Twenty words (10 list words & 10 new words) also presented individually on cards are then shown to the participant who is asked whether each word was from the learnt list or not. Following a 10-minute delay the participant is asked to recall as many words as possible from the original list and is asked to identify learnt words from the list of twenty. In addition to the mean correct and number correct in Recall-I&II and Recognition-I&II respectively, the mean errors in Recall-I and the number of errors in Recognition-I were also recorded in the present study to contribute to the cognitive subtest of ADAS.

Continuous Performance Task – CPT, based on (Conner, 1995)

The CPT provides a measure of sustained attention and is administered via a computer. It involves the 2-second presentation of a letter that appears at varying inter-stimulus intervals (2-4 seconds). The participant is required to press a key, as quickly as possible, in response to each letter except when the letter is an X. The test duration was 4 minutes in the present study. Errors of omission and commission were recorded within 1-minute blocks.

Daneman Carpenter Reading Span Test (Daneman & Carpenter, 1980)

This test provides a measure of verbal working memory. The participant is required to read aloud sentences consisting of eight to thirteen words, judge whether the sentence makes sense or not and recall the last word in each of the sentences. Trials start with two sentences, and in the present study, progress to five sentences. There are three trials in each set and 42 sentences in total. Five two-sentence practice trials are used to familiarise the participant with the test. A score of 1 is achieved for each correct recall and veracity judgment. The reading span score equates to the set in which all sentences in at least two of the three trials were recalled. A half point is added for the complete recall of one of the three trials in the subsequent set. In the present study the test was discontinued if the participant was unable to recall any of the words in two consecutive trials.

Delis Kaplan Executive Functioning System – D-KEFS (Delis, Kaplan, & Kramer, 2001)

The verbal fluency subtest of the D-KEFS was used to measure verbal executive functions across three conditions:

Letter Fluency

The participant is required to generate as many different words as they can in 60-seconds that start with the letters F, A and S. The participant must not produce proper nouns, numbers or the same word with different endings. Letter fluency has been shown to discriminate AD from healthy controls and those with DLB (Metzler-Baddeley, 2007).

Category Fluency

The participant is instructed to name as many different words as they can in 60-seconds associated with a specific semantic category. Animals and boys names were used in the present study. Category fluency is shown to discriminate AD from healthy controls (Metzler-Baddeley, 2007).

Category Fluency-switching

The participant is required to alternate between two semantic categories and generate as many words as possible in 60 seconds. Fruits and pieces of furniture were used in the present study. Each condition is scored with regard to the total number of correct words generated, the number of words in each 15 second interval, the number of repetition errors, and the number of set-loss errors. The total number of switches is also scored in the category switching condition. Raw scores were then converted to age corrected scaled scores. Verbal Fluency has been reported to differentiate AD from controls (Standish, Molloy, Cunje, & Lewis, 2007).

Dementia Rating Scale-2 – DRS-2 (Jurica, Leitten, & Mattis, 2001)

The DRS-2 is a screen of impaired cognitive function that measures memory, attention, initiation/perseveration, construction ability and conceptualisation. The five sub-scales provide an overall measure of cognitive function. Scores range from 0-144 with lower scores indicative of greater impairment. Sub-scale scores are scaled and combined to provide a total scale score.

Digit Span: Wechsler Memory Scale III – WMSIII (Wechsler, 1997)

The Digit Span subtest was used in the present study to provide a measure of working memory/attention from verbal presentation.

Digits Forward

The participant is required to recall a sequence of numbers. The sequences range from two to nine numbers and there are two sequences in each set resulting in sixteen trials.

Digits Backward

The participant must recall the numbers in reverse order. The sequences range from two to eight numbers, with fourteen trials in total. Each correct sequence scores one point to provide a total score. The digit span score is the maximum set correctly recalled in both sequences. A half point is added if one of the sequences is recalled correctly in the subsequent set. The span tests are discontinued following the incorrect recall of any set. Individuals with DLB have been shown to perform poorly compared to those with AD (Calderon et al., 2001).

Edinburgh Handedness Inventory – EHI (Oldfield, 1971)

The short version of the EHI was used to provide a quantitative assessment of handedness. The EHI is a self-report measure of hand preference for 10 everyday activities. The assessment results in a laterality quotient where right handedness is +30 and left handedness is -30.

Frontal Systems Scale – FrSBe (Grace & Molloy, 2001)

The FrSBe was used to quantify behaviors associated with frontal lobe brain damage. A self-rated version and family-rated version were used and both versions consisted of 46 items. Each item is rated on a 5-point scale relating to behavior before illness or injury and at the present time. Scores have been shown to be related to deficits in the abilities of daily living in AD (Norton, Malloy, & Salloway, 2001).

General Health and Demographic Screen

The inclusion and exclusion criteria were checked during the collection of general information. To be included in the study, participants had to fulfil a number of inclusion criteria. All participants had to have normal or corrected to normal vision, and have English as their primary spoken language. Furthermore, participants had to have no history of alcohol dependence, poorly controlled diabetes, or major depression in the last six months because these disorders have been previously shown to impact on the ability to recognise facial expressions (Frigerio, Burt, Montagne, Murray, & Perrett, 2002; Surguladze et al., 2005). Similarly, participants were required to have no history of a significant psychiatric condition requiring hospitalisation, neurological, thyroid, or cardiovascular disorder and were not to be currently involved in trials of psychoactive drugs. Basic demographic data was gathered as well as information regarding current medications and conditions.

Geriatric Depression Scale - GDS (Yesavage & et al., 1982)

The GDS consisted of 30 items and provided a basic screening measure for depression in older adults. Each item is answered ‘yes’ or ‘no’ and scores range from 0-30 with higher scores indicative of more depressive symptoms. The GDS has been validated with AD patients and cut-off values >= 9 have been recommended to screen for depression (Korner et al., 2006).

MINI International Neuropsychiatric Interview – MINI (Sheehan et al., 1997)

The MINI is a brief structured screen and interview used to detect psychopathology indicative of Axis I psychiatric disorders according to DSM-IV (American Psychiatric Association, 1994) and ICD-10 (World Health Organisation, 1992) criteria. Twenty-one screening questions corresponding to the Axis I disorders are administered. An interview is initiated with further questions if a "yes" answer is provided to any of the screening items. The MINI was used to detect psychopathology as part of the exclusion criteria for the present study. If a specific disorder was identified the participant would be excluded from the study and referred to their health provider.

National Adult Reading Test – NART (Nelson, 1982)

An estimate of premorbid intelligence was obtained using the NART. The participant was required to pronounce 50 irregular words presented individually from the NART booklet. The words were scored 0 for incorrect pronunciation and 1 for correct pronunciation. Total raw scores were then converted to estimated premorbid IQ scores using standard procedures outlined in the NART manual.

One Day Fluctuation Assessment Scale (Walker et al., 2000)

The One Day Fluctuation Scale was used to screen for fluctuations in awareness and consisted of 7 items of confusion behavior. Scores of 0-3 for falls, fluctuation in awareness, drowsiness, attention, disorganised thinking, altered level of consciousness and communication were added to provide a severity score for fluctuating confusion.

Pyramids and Palm Trees – PPT (Howard & Patterson, 1992)

The PPT is a test designed to assess an individual's ability to access semantic information. The three-picture triad was used in the present study which comprised simple line drawings. The test required the participant to match a given item to either a target item or distracter item. For example, the participant was asked to match a line drawing of a glove to either a line drawing of a hand or a foot. There are 52 trials in the test and a score of one is given for each correct answer. The PPT test has previously been found to be sensitive to AD and discriminate between mild and moderate AD (Hodges & Patterson, 1995).

Rey-Osterreith Complex Figure Test – ROF (Lezak, 1995)

The ROF was used to assess both visual-constructional ability and memory. The participant is asked to copy the Rey figure onto a piece of paper. Without warning, the participant is asked to reproduce the figure from memory after a 3 minute delay and then after a 30 minute delay. Each figure was scored according to 18 separate components which were rated between 0-2 depending on the accuracy and correct positioning of the component. Total scores for each figure ranged from 0-36.

Map Search: Test of Everyday Attention – TEA (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994)

The map search subtest of the TEA provides a measure of visual selective attention. The participant is required to search a map for target symbols among a variety of distracter symbols and circle as many target symbols as possible in two minutes. A cue card demonstrating the symbol of interest is visible during the test. The total correctly circled in each minute is then converted to age adjusted percentile scores.

Standardized Mini-Mental State Examination - (S)MMSE (Molloy, Alemayehu, & Roberts, 1991)

The (S)MMSE provides information regarding the current cognitive status of a participant and offers standardised administration and scoring guidelines. An individual's orientation, registration, memory, attention and language are assessed to provide a score ranging from 0-30, with lower scores indicative of greater impairment. The (S)MMSE has been reported to differentiate AD from Mild Cognitive Impairment and healthy elderly (Standish et al., 2007).

Visual Object and Space Perception Battery – VOSP (Warrington & James, 1991)

The VOSP provides measures of space and object perception. A screen and two subtests were selected in the present study.

Shape Detection Screen

To ensure adequate visual sensory capability a screen is administered. The participant is required to identify the presence of a degraded X superimposed on random patterns. Each of the 20 items is scored 1 for a correct answer. The participant only moves on to the following subtests if they score >17.

Incomplete Letters

The participant is asked to name capital letters presented individually on separate cards. The test begins with two practice letters degraded by 30% and consists of 20 trial letters degraded by 70%. Correct answers are scored with a 1 (maximum total=20). A fail mark is given if the total score is below the 5th percentile for the over 50 age band (<16).

Object Decision

The participant is asked to identify the silhouette of a real object from three distracters. Each of the 20 trials consists of four silhouettes presented on cards. The participant is asked to point to the real object and each correct answer is scored 1 (maximum total=20). A fail mark is given if the total score is below the 5^{th} percentile for the over 50 age band (<14).

CHAPTER 3

Sensitivity to Emotion Specified in Facial Expressions: Healthy Young Adults

As discussed in Chapter 1, facial expressions are not always a reliable guide to the affective state of others. Only genuine expressions are coupled with emotion. Posed expressions provide no meaningful information regarding the affective state of an interaction partner; they simply represent and approximate the facial configurations that do express specific emotions. Within the vast facial expression literature very few studies have purported to examine emotion processing by providing participants with information that specifies emotion (e.g. Carroll & Russell, 1997; Davis & Gibson, 2000; Frank et al., 1993; Gosselin, Beaupre, & Boissonneault, 2002; Kohler et al., 2005; Miles, 2005; Miles & Johnston, 2007; Motley & Camden, 1988). More often than not the posed expression is employed, as an analogous substitute under the assumption that the information provided by posed and genuine expressions is largely the same given the relatively similar configurations involved in both types of expression.

The perception of information that does specify emotion from the information that does not is crucial to the functionality of emotion perception. Mistaking posed expressions for genuine expressions can result in negative outcomes for the social perceiver, for instance, offering sympathy, help or social proximity to someone disingenuous can leave an individual vulnerable to manipulation or exploitation. Likewise, approaching an individual who is smiling yet angry (i.e., responding to an expression of posed happiness as if it were genuine happiness) can leave an individual open to the potential of an avoidable confrontation. The facial expression would lose utility as an observable indicator of affective state if individuals were not able to reliably discriminate the different opportunities for action afforded by different types of expressions.

Of the few studies to investigate or acknowledge the differences between posed and genuine expressions and examine the recognition of *emotion* specified in facial expressions, research conducted by Miles and Johnston (2007) provides the most suitable platform for the current investigation as the focus centres on affect rather than expression. This research showed that healthy young adults are sensitive to positive affective state in others, differentiating between posed and genuine smiles. The latter was identified as representing that the target is happy more frequently than the former. Further, this sensitivity to the information provided by smiles had an impact on subsequent behavior, with greater cooperation being shown toward individuals displaying genuine than posed smiles (Miles, 2005) and individuals being more likely to purchase items displayed by a model displaying a genuine than a posed smile (Peace et al., 2006).

The present study aimed to replicate the former finding employing similar methodology and, with an eye to subsequent studies looking at aging and Alzheimer's disease, extend consideration to the sensitivity of healthy young adults to genuine and posed expressions of sadness and fear, in addition to happiness. It is important to accurately detect genuine sadness and fear in others, not only to avoid missing the emotion and subsequently the opportunity to act adaptively, but also to avoid the potential negative outcomes associated with disingenuous signals.

The sensitivity of healthy young adults to the underlying states of happiness, sadness and fear was tested using two tasks – an emotion categorization task and a priming task. In the categorization task, each participant was asked whether facial displays were showing and feeling each target emotion. The show and feel conditions were imposed to manipulate the decision making criteria so that response bias could be investigated, that is, whether participants simply demonstrated a proclivity to respond with one answer over the other regardless of the information being judged. This was primarily calculated to allow more accurate estimates of sensitivity to be generated, as bias was considered over different levels (Miles, 2005). The show condition involved less stringent decision-making criteria as participants were only instructed to attend to whether emotion was being shown, while the feel condition required more stringent criteria as participants were required to attend to the felt state of the targets. There would be evidence of sensitivity if posed expressions were identified as showing but not feeling target emotion while genuine expressions were identified as both showing and feeling target emotion. In other words, sensitivity is demonstrated if genuine expressions were identified as specifying the target was feeling emotion more often than posed expressions.

The priming task involved participants making judgments about the valence of words that were preceded by facial display primes. That is, each participant was ostensibly engaged in a separate task that did not require him/her to attend to the facial displays. Previous research has shown that word valence is categorized in less time when preceded by a prime of the same valence as the target (Fazio & Olson, 2003). The present research argues only genuine expressions of emotion specify positive or negative effect and are therefore conceptually related to the target words, whereas posed expressions do not. For example, genuine smiles specify positive emotion which is congruent with positive words, whereas posed and neutral expressions are not congruent given they are only simulations of positive emotion. A difference in the response times as a function of the type of expressions prime would demonstrate participants were sensitive to the emotion specified in the expressions.

A sex categorization task was also included to control for deficits in the ability to extract information from faces other than emotional information. In this categorization task, each participant was asked whether each display was of the target sex. Two samples of healthy young adults were used in the present studies. The second sample completed additional cognitive measures to allow for subsequent group matching with a sample of healthy older adults.

It was predicted that participants would show sensitivity to information that specifies sadness and fear, and hence, differentiate between genuine and posed expressions of both sadness and fear, in addition to happiness. The present study also aimed to look at whether sensitivity to emotion is a generalised skill or whether it is emotion specific. That is, whether individuals who are sensitive to one emotion are also sensitive to others. It was predicted that participants would demonstrate a generalised ability and there would be a relationship in sensitivity between the three target emotions.

Experiment 1a: Categorization task

Method

Participants

The participants were 24 young adults (female = 11) recruited from the University of Canterbury and the local community, who volunteered to participate in return for a $10 shopping voucher. Demographic characteristics are presented in Table 8. They ranged in age from 18 years to 34 years (M = 22.9 years, SD = 4.3) and had on average 7.4 years (SD = 2.6) of post-primary education. Twenty participants (83%) were right-handed. Inclusion/exclusion criteria were applied. All participants had normal or corrected to normal vision, and spoke English as their primary spoken language. Furthermore, participants had no history of alcohol dependence, poorly controlled diabetes, major depression in the last six months or a significant psychiatric condition requiring hospitalisation. They had no history of neurological, thyroid, or cardiovascular disorder and were not be currently involved in trials of psychoactive drugs. These specific exclusion criteria were applied to control for conditions that have been shown to effect emotion processing. No participants were excluded from the present study.

Table 8. Demographic Characteristics of Participants in Experiment 1a

	Mean *(%)*	SD	Range
Age	22.9	4.3	18-34
BDI-II	4.5	4.4	0-18
Education	7.4	2.6	3-13
Sex *(% female)*	46%	-	-
Handedness *(% right)*	83%	-	-

Materials

Emotion-categorization task

An emotion-categorization task was used to assess the recognition of happy, sad and fear emotions in facial expressions, using custom written software (Walton, 2004). The three emotions were assessed in separate blocks that consisted of 12 photographs [7] from the displays generated for the present research (see Chapter 2). There were four targets for each emotion and each target provided a genuine, posed and neutral facial display. Across the three emotions, seven female targets provided the 36 facial displays.

[7] An attempt was made to reduce the number of trials so that individuals with AD could complete the task within 15 minutes.

The participant was seated comfortably in front of a 14-inch laptop computer with an external keyboard displaying only YES and NO buttons. The participant was provided with an instruction sheet (see Appendix G) informing him/her that six separate questions would be asked, with each question followed by a block of photographs. The six questions (blocks) were "Are the following people showing happiness?" 2) "Are the following people showing sadness?" 3) "Are the following people showing fear?" 4) "Are the following people feeling happiness?" 5) "Are the following people feeling sadness?" 6) "Are the following people feeling fear?" Their task was to answer YES or NO for each photograph that appeared on the screen. The participant was asked if they understood the instructions or had any questions. Once each participant acknowledged he/she understood the instructions he/she was asked to attend to the first question. The order of emotion (happy/sad/fear) and condition (show/feel) blocks was counterbalanced to give twelve unique orders of presentation. Within each block of trials (e.g., Feeling happiness?), the facial displays were presented in a unique random order for each participant.

The instructions were repeated on the computer screen for each question and were followed by three practice trials completed in front of the experimenter. If the instructions were followed satisfactorily, the task was advanced to the actual trials that involved the presentation of the twelve facial displays relevant to the emotion in question. Each display remained on the screen until the participant made a response. It was then replaced by a new display. The inter-stimulus interval was randomly varied between 1500 and 3000 milliseconds to prevent anticipatory responses. The experimenter advanced to the next question and block of trials when all twelve judgments had been made. When the participant had completed all six blocks of trials (total = 72 trials), he/she was asked to complete the sex categorization task.

Sex-categorization task

A sex categorization task (Walton, 2004) was used to control for possible impairments in face perception, which might influence the ability to detect emotion in faces. The task employed a display of a neutral expression from each of eight targets (4 female). The female displays were from individuals who had completed the generation procedure described in Chapter 2 but who did not provide displays involved in the emotion categorization tasks. The male displays were provided by Lynden Miles and had been developed for research on facial expressions of emotion in a similar manner to that described in Chapter 2 (Miles, 2005; Miles & Johnston, 2007). The sex categorization task involved two questions (blocks of trials); "Are the following people male?" and "Are the following people female?" The participant was asked to answer YES or NO to each photograph by pressing the appropriate key. The participant completed both blocks of trials and the order of blocks was counterbalanced. Each block began with two practice trials, which were completed in the presence of the researcher. If instructions were understood, the researcher advanced to the actual trials and the participant was required to make eight sex judgments in each block.

General health screen and demographic information

The specific inclusion and exclusion criteria were verified for each participant by completing a semi-structured general health interview (see Appendix H). A M.I.N.I. psychiatric screen, and M.I.N.I. interview (Sheehan et al., 1998), where applicable, was completed by each participant to assess the presence of Axis 1 disorders according to DSM-IV (American Psychiatric Association, 1994) criteria. The BDI-II (Beck et al., 1996) was administered to measure depressive symptoms.

Design

The categorization task involved a 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) design, with all factors being within subjects. The 36 facial displays were presented in both the show and feel conditions, resulting in 72 trials.

Procedure

Each participant was invited to take part in a study investigating the ability of perceivers to differentiate between posed and genuine facial expressions of emotion. He/she was provided with an Information Sheet that briefly outlined the study and their rights as research participants (see Appendix I). The sheet also provided information about the definition of posed and genuine expressions, more specifically, that posed expressions are not related to how one feels while genuine expressions are the result of actual felt emotion. Each participant signed a consent form (see Appendix J) and he/she was taken to the testing room when he/she was ready to begin. The researcher administered a semi-structured general health interview and M.I.N.I. screen to verify that the participant met the specific inclusion and exclusion criteria described above. Each participant met the criteria and continued with the procedure. Following the screening, the participant completed the emotion categorization task, sex categorization task and priming task that is described as Experiment 1b.

Results

Sex-categorization

Accuracy rates were calculated by establishing the percentage of correct sex identifications across both blocks (16 trials). The mean accuracy rate was 99%. (range= 88%-100%). The participants were reliably able to detect information relevant to sex identification from facial displays. Consequently, the control task was eliminated from further analysis and no participant was excluded based on difficulties perceiving this information from the face.

Emotion-categorization

The percentage of YES responses for each participant was calculated as a function of emotion, condition and expression type and is shown in Table 9. If participants differentiate between posed and genuine expressions we would expect to find that genuine expressions were identified as both showing and as feeling the target emotion, but that posed expressions were identified as showing but not feeling the target emotion. Neutral expressions would not be identified as showing or feeling emotion. Visual inspection of the data suggests that this is the case for each emotion, as the percentage of YES responses for posed expressions is less in the feel condition than the show condition, for each emotion but there is little difference in the percentage of YES responses to genuine expressions in the show and feel conditions.

Table 9. Percentage of YES Responses by Judgment Condition and Facial Expression for each Emotion: Experiment 1a

Facial expression		Judgment condition SHOW (%YES)	FEEL (%YES)
Happy			
	Neutral	17%	11%
	Genuine	99%$_a$	95%$_a$
	Posed	96%$_a$	40%$_b$
Sad			
	Neutral	12%	17%
	Genuine	75%$_a$	64%$_a$
	Posed	78%$_a$	28%$_b$
Fear			
	Neutral	4%	2%
	Genuine	76%$_a$	73%$_a$
	Posed	94%$_b$	54%$_c$

Note. Significant differences are shown with different subscript between conditions and between posed and genuine expressions within emotion.

To confirm this observation, data were subjected to analysis of variance (ANOVA). Preliminary analyses found there was no effect of sex, handedness or presentation order on the dependant variables and therefore these factors were not considered further. A 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVA revealed main effects of Emotion, F (2,46) = 10.25, $p <$ 0.001, $\eta_p^2 = .308$, Condition, F (1,23) = 51.61, $p < .001$, $\eta_p^2 = .692$ and Expression, F (2,46) = 305.81, $p < .001$, $\eta_p^2 = .930$. These main effects were qualified by significant Condition by Expression, F (2,46) = 67.73, $p < .001$, $\eta_p^2 = .747$, and Emotion by Expression interactions F (4,92) = 12.61, $p < .001$, $\eta_p^2 = .354$, which can be seen in Figure 7 and Figure 8.

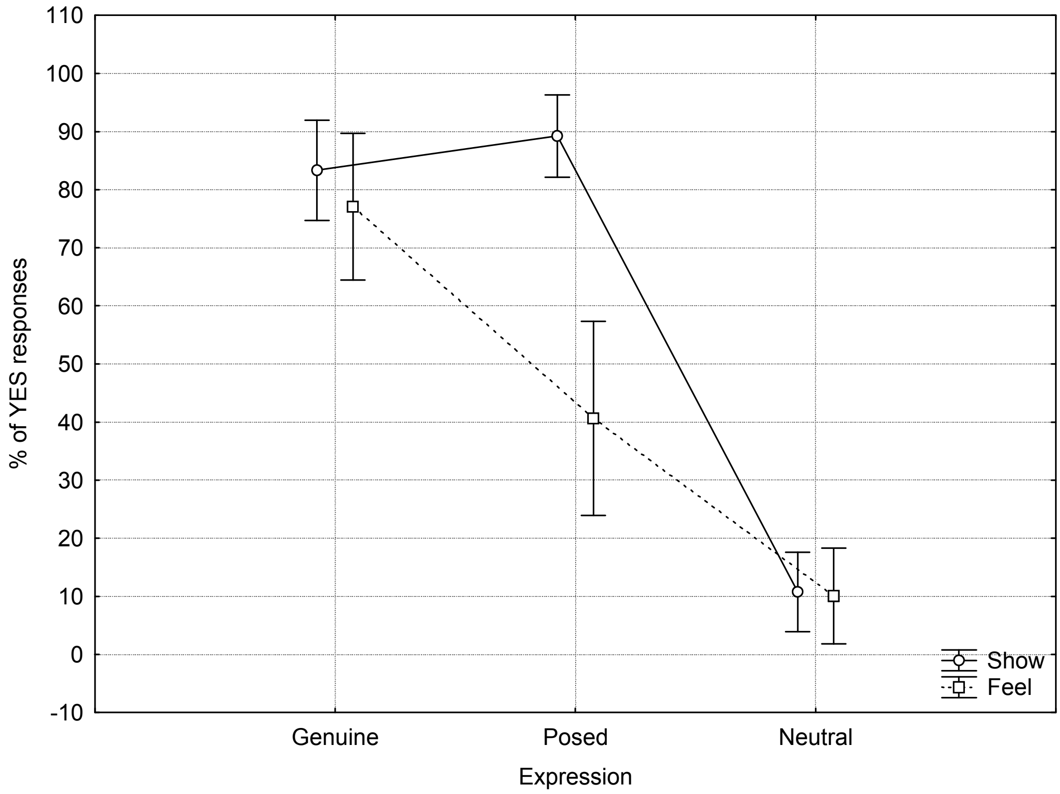

Figure 7. Percentage of YES Responses as a Function of Expression for each Condition: Experiment 1a

Tukey post-hoc tests ($p < .05$) were conducted to investigate the interactions. The Condition by Expression interaction revealed no significant difference in the percentage of YES responses in the show and feel conditions for either genuine (M = 83.3% vs. 77.1%), or neutral (M = 10.8% vs. 10.0%) expressions. There were, however, more YES responses to posed expressions in the show than the feel (M = 89.2% vs. 40.6%) condition. Furthermore, in the show condition there was no difference in the percentage of YES responses to the genuine and posed expressions, but both were significantly higher than to the neutral condition. In the feel condition, the highest percentage of YES responses was given to the genuine expressions, the lowest to the neutral expressions with posed expressions intermediate, and all differences between expression types reached significance.

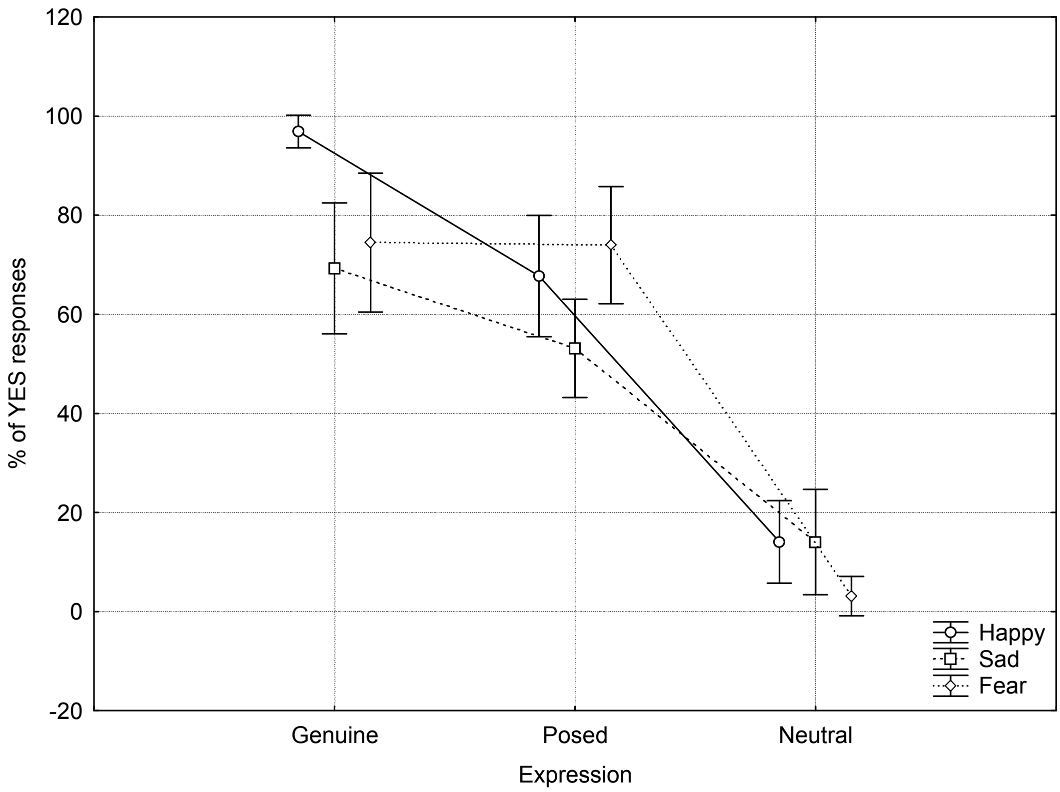

Figure 8. Percentage of YES Responses as a Function of Expression for each Emotion: Experiment 1a

Post-hoc tests compared the percentage of YES responses to each emotion type separately for each expression type. For genuine expressions, a higher percentage of YES responses was made to happy (M = 97%) than sad (M = 69%) and fear (M = 74%) which did not differ from one another. For posed expressions, significantly fewer YES responses were made to sad (M = 53%) than happy (M = 68%) and fear (M = 74%) which did not differ from one another, and there was no difference for neutral expressions. In addition, the percentage of YES responses as a function of expression type was considered separately for each emotion. For happiness and sadness, there were more YES responses to genuine than posed expressions and both were higher than neutral. For fear, there was no difference between responses to genuine and posed expressions, which were both higher than neutral. Participants, therefore, judged genuine expressions as both showing and feeling the target emotion but posed expressions as showing but not feeling the target emotion.

Sensitivity

The responses in the categorization task were further analysed using a non-parametric signal detection analysis. Two analyses were conducted, the first analysis included all expressions to look at sensitivity to emotion in facial displays; that is reliability of perceivers to detect information in the face that specifies affective state from information that does not. In other words, the first analysis looked at whether participants correctly identified that a genuine expression specified a congruent underlying emotional state, whereas neutral and posed expressions did not. Neutral expressions were removed in the second analysis to look at sensitivity to the differences between posed and genuine expressions. Sensitivity in this analysis refers to the ability to detect information that specifies affective state from information that closely approximates but is representational rather than indicative of affective state. In other words, identifying genuine expressions but not identifying posed expressions as specifying a congruent underlying emotional state.

The data from each participant was collated into hits and false alarms separately for each emotion, judgment condition and facial expression. In both analyses, a hit was defined as correctly responding YES to a genuine expression, while a false alarm was defined as responding YES to either a neutral expression or a posed expression in the first analysis and responding YES to a posed expression in the second analysis. The correction recommended by Snodgrass and Corwin (1988) was applied to the frequency of hits and false alarms to convert to the associated rates of hits and false alarms. These rates were then used to calculate measures of sensitivity (*A'*) for each participant as a function of emotion and judgment condition. The hits, false alarms and estimates of *A'* are shown in Table 10.[8]

Table 10. Mean Hit (HIT) Rates, False Alarm (FA) Rates and Estimates of A' by Judgment Condition for each Emotion: Experiment 1a

		Analysis 1			Analysis 2		
Judgment condition		HIT	FA	A'	HIT	FA	A'
Show	Happy	.89	.55	.79*	.89	.86	.53
	Sad	.71	.45	.75*	.71	.71	.53
	Fear	.71	.49	.68*	.71	.84	.39
Feel	Happy	.85	.29	.86*	.85	.43	.78*
	Sad	.62	.26	.76*	.62	.32	.71*
	Fear	.69	.31	.77*	.69	.53	.61*

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
Note. A' is compared to chance level of 0.5.
* $p < .05$.

[8] A measure of response bias (B') was also calculated to confirm that participants adopted a more stringent response criterion in the feel than in the show condition. Response bias was compared to 0 using single-sample t tests. A response bias was found in the show but not in the feel condition, therefore, participants did not demonstrate a proclivity to respond with one response over the other in the feel condition. The formula (see Appendix K) used to calculate sensitivity takes response bias into account and therefore it is not considered further.

As discussed, in the context of the first analysis, sensitivity refers to the ability to detect information relevant to recognising affective state (e.g., happy vs. not happy). The higher the sensitivity scores[9] the greater the discrimination of genuine expressions that specify emotion from expressions that do not (posed and neutral expressions). Sensitivity scores ranged from .75 to .86. Single-sample t-tests ($p < .05$) showed that the sensitivity scores were significantly greater than expected by chance (0.5), in each experimental condition, indicating that participants were indeed sensitive to the differences between experienced and non-experienced emotional states.

In the context of the second analysis, sensitivity refers to the ability to differentiate between posed and genuine expressions. The level of sensitivity in the feel condition ranged from .61 to .78. Single-sample t-tests ($p < .05$) showed that the sensitivity scores were significantly greater than expected by chance (0.5), indicating that participants were sensitive to the differences between posed and genuine expressions of each emotion. The sensitivity scores in the show condition (range = .39 - .53) were, however, not significantly greater than chance.

Analysis of variance was used to confirm these observations. Preliminary analysis showed that sex and handedness [10] did not influence sensitivity and these factors are not considered further. Separate 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) repeated measures ANOVAs were conducted for each sensitivity analysis. The first analysis revealed main effects of Emotion, $F\ (2,46) = 9.37, p < 0.01, \eta_p^2 = .289$ and Condition, $F\ (1,23) = 20.36, p < .01, \eta_p^2 = .470$ but no interaction. Post-hoc tests (Tukey $p < .05$) on the Emotion main effect

[9] It is accepted that the meaningful range of A' is from 0 – 1.00. Higher scores are indicative of higher sensitivity.

[10] Although there was a main effect of handedness, F (1,20) = 5.4, p < .05, on sensitivity scores with left-handed individuals being more sensitive than right-handed individuals (Ms = .82 v .75), there were no interaction effects between handedness and any of the key IVs (emotion; condition) and the same pattern of results was seen for both right and left-handed individuals. Hence handedness was not considered further.

showed participants were more sensitive to happiness (*M* = .82) than to sadness (*M* = .73) and fear (*M* = .72), which did not differ from one another. Participants were also more sensitive when asked how targets were feeling (*M* = .80) than when asked what targets were showing (*M* = .72).

The second ANOVA also revealed main effects of Emotion, F (2,46) = 9.67, $p < 0.01$, η_p^2 = .296 and Condition, F (1,23) = 50.19, $p < .01$, η_p^2 = .686, but no interaction. Sensitivity to the difference between posed and genuine expressions of happiness (*M* = .66) and sadness (*M* = .62) did not differ from one another and both were significantly higher than for fear (*M* = .50, Tukey, $p < .05$). Sensitivity in the feel condition (*M* = .70) was also higher than sensitivity in the show condition (*M* = .48).

Relationship between Sensitivity Variables

Kendall's tau rank order correlations were used to assess the relationship between sensitivity scores both within and across emotions and are shown in Table 11. Correlations were computed to investigate whether there was a relationship between sensitivity in the show and feel conditions for each emotion and to investigate whether there was a relationship in sensitivity to the three target emotions. These correlations look specifically at whether the participants who were sensitive in one condition, for example, were likely to be sensitive in the other condition. Similarly, the correlations examined whether the participants who were sensitive to one emotion were also likely to be sensitive to the others. The correlations were computed separately for sensitivity to emotion in facial expressions (1) and sensitivity to the difference between posed and genuine expressions (2). Bonferroni-corrected significance levels ($p < .006$) were used to control for multiple comparisons.

Table 11. Sensitivity Within and Between Emotions: Experiment 1a

				Happy		Sad		Fear	
				show	feel	show	feel	show	feel
		Mean	*SD*	τ	τ	τ	τ	τ	τ
Analysis 1	Happy (show)	.79	.05	-					
	Happy (feel)	.86	.08	.181	-				
	Sad (show)	.70	.13	.102	-.143	-			
	Sad (feel)	.76	.11	.038	-.050	.218	-		
	Fear (show)	.68	.14	.132	.341	-.036	.207	-	
	Fear (feel)	.77	.15	.046	.475*	-.136	.136	.338	-
Analysis 2	Happy (show)	.53	.09	-					
	Happy (feel)	.78	.14	.339	-				
	Sad (show)	.53	.24	-.048	-.151	-			
	Sad (feel)	.71	.16	.135	.108	.000	-		
	Fear (show)	.39	.15	.286	.355	-.108	.134	-	
	Fear (feel)	.61	.22	.135	.304	-.334	.363	.460*	-

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
* $p < .006$.

Considering the relationships within emotions, only one significant correlation between the sensitivity scores in the show and feel conditions was found. There was a positive correlation for fear in the second analysis (without the neutral expressions included), τ (24) = .46, $p < .006$, indicating that those who were more sensitive in the show condition were also more sensitive in the feel condition. Because there was no consistent relationship across conditions, however, it is not possible to collapse sensitivity scores across the show and feel conditions within each emotion.

Considering the relationship across emotions, the correlations between sensitivity scores for happy, sad and fear were considered separately in the show and feel conditions (given the lack of correlation between conditions reported above). Overall, there was little support for relationships across emotions. For the sensitivity to emotion scores (1) there was only one significant correlation in the feel condition, with those who were more sensitive to happiness also being more sensitive to fear, τ (24) = .48, $p < .006$. For the sensitivity to the difference between expressions (2) there were no significant correlations across emotions, indicating that being sensitive to one emotion was not related to being sensitive to any other emotion.

Relationship between Sensitivity and Background Characteristics

Table 12 details the correlations found between sensitivity scores and background characteristics. A significant negative correlation was found between sensitivity to happiness in the feel condition and both age τ (24) = -.39, p < .008 and years of education τ (24) = -.41, p < .008. Participants who were older and had more years of education were less sensitive to happiness when asked to attend to affective state. This relationship was not found when considering sensitivity to the differences between posed and genuine expressions, however. In fact no significant relationships were found within the second analysis.

Table 12. Correlations between Sensitivity and Background Characteristics: Experiment 1a

		Age τ	Education τ	BDI-II τ
	Age	-		
	Education	.592*	-	
	BDI-II	-.273	.023	-
Analysis 1	Happy (show)	-.120	-.370	.313
	Happy (feel)	-.392*	-.414*	.016
	Sad (show)	-.046	-.079	-.047
	Sad (feel)	.260	-.206	-.207
	Fear (show)	-.113	-.185	-.114
	Fear (feel)	-.046	-.338	-.062
Analysis 2	Happy (show)	.000	-.382	.196
	Happy (feel)	-.355	-.380	.000
	Sad (show)	.036	.186	-.049
	Sad (feel)	.208	-.184	-.210
	Fear (show)	-.158	-.211	-.128
	Fear (feel)	-.026	-.307	-.101

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
* p < .008.

Discussion

As predicted, the participants in Experiment 1a demonstrated they were sensitive to emotion specified in facial expressions, regardless of whether they were instructed to attend to felt state or not. That is, they were sensitive when asked to judge whether the target was showing emotion as well as when asked to judge whether the target was feeling emotion. Furthermore, participants were sensitive to the differences between posed and genuine expressions of each emotion, but only when instructed to consider how the target was feeling. The explicit instruction to attend to felt state, therefore, facilitated the differentiation between posed and genuine expressions. In line with many other studies (Calder et al., 2003; Gosselin et al., 1995; Hargrave et al., 2002; Kohler et al., 2004; Motley & Camden, 1988; Rosen et al., 2006; Sullivan & Ruffman, 2004a), participants in Experiment 1a were more sensitive to happiness specified in facial expressions than to either sadness or fear. They could establish, however, the veracity of happiness and sadness, that is differentiate between posed and genuine expressions, equally well, although contrary to predictions being sensitive to one was not related to being sensitive to the others.

The results of Experiment 1a suggest that the instructions to actively attend to affective state influenced whether participants were sensitive to emotion in facial expressions or not. Of particular interest, however, is whether individuals can spontaneously perceive emotion from the information provided in facial expressions, that is ‘do they’ rather than ‘can they’ detect the affective state of others. The following experiment sought to establish whether participants would attend to the different information provided by posed and genuine expressions when not explicitly required to make overt judgments of either the facial expressions or the targets displaying those expressions.

Experiment 1b: Priming task

Experiment 1a provided evidence that individuals are sensitive to information in facial expressions that specify the affective state of another person. The present study examined whether this can be demonstrated without imposing an explicit instruction to attend to facial expressions or to make explicit judgments about the facial expressions. Several studies have shown that facial expressions can be detected automatically (Batty & Taylor, 2003; Dimberg & Oehman, 1996; Stenberg, Wiking, & Dahl, 1998). Indeed the priming literature provides evidence of facial expressions as effective primes that can moderate subsequent behaviors such as valence judgments of surprise expressions (Li, Zinbarg, Boehm, & Paller, 2008), the response latency to identify word valence (Aguado, Garcia-Gutierrez, Castaneda, & Saugar, 2007) and muscle activity of the face (Dimberg et al., 2002).

Furthermore, Miles (2005; Miles & Johnston, 2007) found that the veracity of smiles employed as primes had an impact on the response time taken to judge the valence of words. Genuine smiles that specified positive affect facilitated faster response to positive words compared to neutral primes, whereas posed smiles that do not specify affect did not. A priming methodology was employed in the present study with the aim of replicating previous findings with regard to expressions of happiness, as evidenced by faster responding to positive words preceded by genuine happy expressions (congruent stimuli) compared to posed and neutral expressions which do not specify positive affective state (incongruent stimuli). In addition, the present study extended previous findings by establishing if individuals were also spontaneously sensitive to the differences in posed and genuine expressions of sadness and fear. Evidence of faster responding to negative words preceded by genuine sadness and fear expressions (congruent stimuli) compared to posed and neutral expressions (incongruent stimuli) was sought.

Given the potential consequences of inefficient perception of sadness and fear it is hypothesized that the veracity of these expressions will also moderate subsequent behavior. Specifically, it was predicted that healthy young adults would respond faster to words when primed with emotion (genuine expressions) than when primed with simulations of emotion (posed expressions) or no emotion (neutral expressions). Consequently, planned comparisons were employed to directly examine the difference in response latency between judgments preceded by posed, genuine and neutral primes. The time taken to identify positive words was compared when preceded by genuine and posed primes as well as each expression to neutral. Likewise, the time taken to identify negative words was compared when preceded by genuine and posed primes as well as each to neutral.

Method

Participants

The same 24 participants (female = 11) who completed Experiment 1a also completed Experiment 1b.

Material

Word judgment task

Seven facial displays (neutral, genuine happy, genuine sad, genuine fear, posed happy, posed sad and posed fear) from a single female target who completed the generation procedure described in Chapter 2 and who provided a set of expressions for each target emotion in the categorization task employed in Experiment 1 were used as primes in a word judgment task. To examine the effect of the facial display on response time to word valence, it was necessary to select words that were easily read and understood with very clear positive or negative valence. Ten target words (5 positive: good, honest, sincere, loyal, kind and 5 negative: bad, mean, cruel, liar, selfish) were chosen based on an extreme positive or negative likeableness rating, that is having a rating of above 3.5 on a 5 point scale or a rating below 1.5 on a 5 point scale (Anderson, 1968; Bochner, 1985). Only words with one or two syllables were chosen.[11] The participant was instructed that he/she would see several words appear on screen one at a time and his/her task was simply to judge whether the word was positive or negative, as quickly and as accurately as possible. That is, he/she was asked to quickly decide whether the word had a positive meaning or a negative meaning. The participant was also informed that before each word appeared he/she would see a photograph of a person, but his/her task was to attend to the meaning of the word. He/she was asked to respond to each word by pressing either the POSITIVE button or the NEGATIVE button on the external response keyboard. All instructions were shown on screen and were also read aloud by the researcher.

The procedure began with four practice items. A positive and a negative word not used in the actual trials were presented along with two neutral expressions from two targets not presented in the actual trials. A fixation cross appeared in the middle of the screen for a time varying from 1500-3000 milliseconds before being replaced by the facial display which was presented for 100ms. The facial display was immediately replaced by the target word, which remained on screen until a response had been made. If the instructions were followed satisfactorily, the participant proceeded to the actual trials. Each participant made a judgment on all 70 word and facial display prime combinations, which were presented in a unique random order for each participant. A 30-second break was scheduled into the procedure after every 25 trials to alleviate fatigue.

[11] Each participant demonstrated a clear understanding of the words prior to completing the task by completing a word-definition matching task (see Appendix M).

Design

The priming task was presented on a 14 inch colour computer monitor using custom-written software (Walton, 2004) and involved a 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) design with repeated measures on both factors.

Procedure

Following the completion of Experiment 1a each participant was advised they would begin another task that involved making judgments about the valence of common words. At the completion of the priming task the participant was fully debriefed, paid and thanked for his/her time.

Results

The response latency served as the dependant variable for this study. The process of cleaning the data began with the removal of incorrect responses (i.e., judging a positive word as negative and vice-versa). A visual inspection of the remaining data showed a positively skewed distribution, which did not therefore meet the normality assumptions of ANOVA. A $\log_{10}$ transformation was applied to the data from each participant and data remaining outside $M \pm 3.0$ *SD* were removed as outliers. Data cleaning removed 15 (0.9%) incorrect responses and 12 (0.7%) outliers from the data set prior to analysis. The analyses was performed on log10-transformed data but are reported as raw response times.

The median response time was calculated for each participant as a function of expression prime and word valance. Figure 9 presents the group mean response times to positive and negative words as a function of expression prime and word valence.

A visual inspection indicates that response to positive words was faster after genuine than posed happy primes and response to negative words was faster after genuine than posed fear expression primes. To confirm this observation, analysis of variance was performed to compare the effect of expression prime on response times.

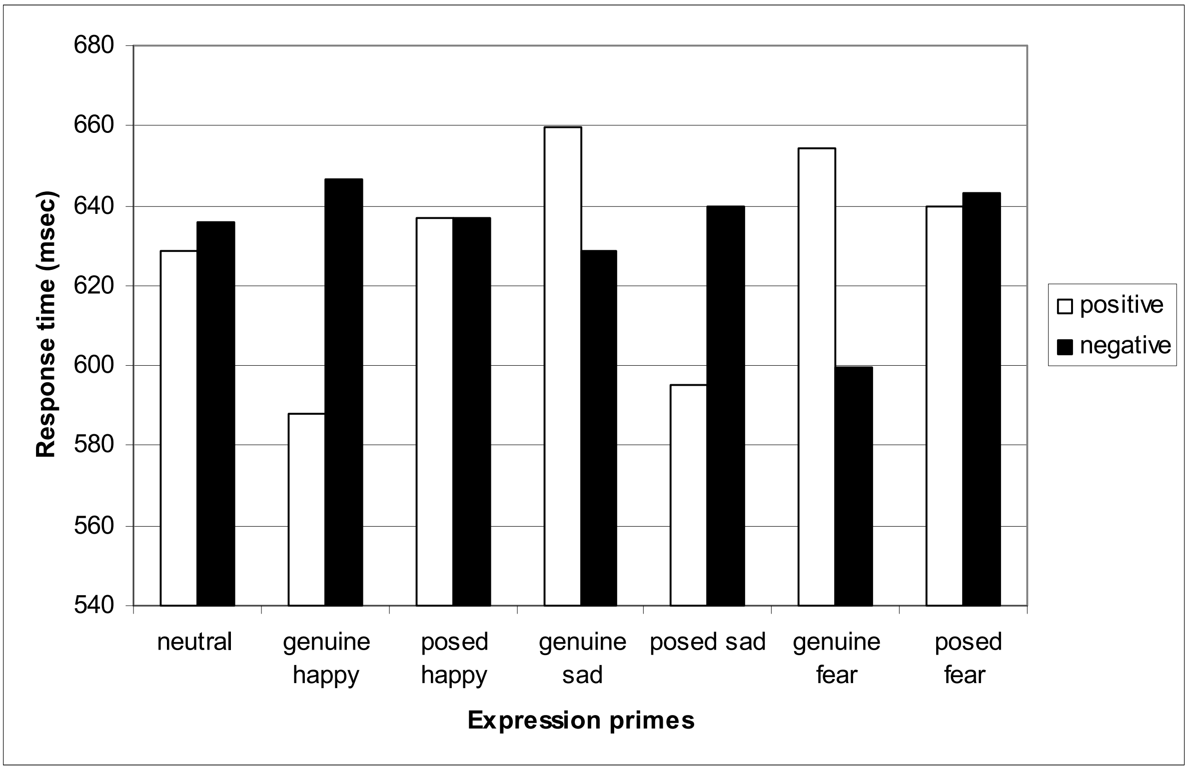

Figure 9. Response Time to Categorise Words as a Function of Facial Expression Prime and Word Valence: Experiment 1b

Neither sex nor handedness influenced response times and were not considered further. A 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) repeated measures ANOVA revealed a two-way interaction effect F (6,138) = 2.67, $p < .05$, $\eta_p^2 = .104$. The planned comparisons as stated above were performed to assess the hypothesised effects on response times. That is, the time taken to identify positive words was compared when preceded by genuine versus posed happy primes as well as each to neutral primes. Likewise, the time taken to identify negative words was compared when preceded by genuine versus posed sad primes as well as each to neutral and when preceded by genuine versus posed fear primes and each to neutral.

The mean response time to identify positive words was compared between posed and genuine happiness conditions. A significant difference was found between the time taken to identify positive words preceded by posed expressions (M = 637 msec) and genuine expressions (M = 588 msec). Specifically participants were faster to identify positive words following genuine happy expressions. No significant differences were found when time to identify positive words was compared between both posed and genuine expressions and neutral expressions (M = 629 msec).

The mean response time to identify negative words was compared between posed and genuine conditions for sadness and fear separately. A significant difference was found between the time taken to identify negative words preceded by posed fear expression (M = 643 msec) and genuine fear expressions (M = 600 msec). Participants were faster to identify negative words following exposure to genuine fear. No significant differences were found when time to identify negative words was compared between both posed and genuine fear expressions and neutral expressions (M = 636 msec). No significant differences, however, were found when time to identify negative words was compared between posed and genuine sadness conditions. Although unplanned, it is noteworthy that response to positive words was significantly slower when preceded by genuine sadness (M = 660 msec) than posed sad expressions (M = 590 msec)

Discussion

As expected, sensitivity to affective state was manifest without explicit instructions to attend to the information or make overt judgments. Participants were faster to respond to positive words following exposure to genuine than posed expressions of happiness and were faster to respond to negative words following exposure to genuine than posed expressions of fear. Experiment 1b provided evidence that individuals attend to the veracity of facial expressions and are sensitive to the meaningful differences between posed and genuine expressions. The results indicate that sensitivity to affective state is not reserved simply for explicit judgment. In addition to establishing that individuals 'can' detect affective state in others, the present study has established that individuals 'do' detect information that specifies the affective state of other people with consequences for subsequent behavior.

Experiment 2a: Categorization task

Another group of healthy young adults was recruited to complete the same tasks in Experiment 1a described above. These participants also completed several cognitive measures (see Chapter 2) and provided information that would allow for suitable group matching with subsequent samples of healthy older adults and individuals with AD. In addition to investigating sensitivity within and across emotions, the present study examined, without specific expectation, whether performance was related to these cognitive skills. The time taken to make judgments was also calculated in Experiment 2a.[12] Several studies have shown that response time provides valuable information about the level of performance achieved in judgments tasks (e.g., Ferrari & Pychyl, 2007; Myerson, Robertson, & Hale,

[12] Response time data was not available for the first group of healthy young adults.

2007; Sopory, 2006). Of particular interest in the present study is whether response time differs as a function of expression type and emotion. An examination of the time taken to make judgments may provide insight into the nature of potential deficits and the nature of group differences that are reported in Chapter 6.

It was predicted that the present study would replicate the findings of Experiment 1a and find that participants are sensitive to emotion and are able to differentiate between posed and genuine expressions. Given the finding of Experiment 1a, that sensitivity was emotion specific, no relationship between being sensitive to one emotion and another was expected in the present study. In addition, it was predicted that participants would make faster judgments of genuine and neutral expressions, because these already contain the relevant affective information, than posed expressions that do not and therefore necessarily require additional mental processing.

Method

Participants

The participants were 20 healthy young undergraduate students (female = 12) recruited from the University of Canterbury, who volunteered to participate in return for partial course credit. Demographic characteristics are shown in Table 13. As can be seen participants age ranged from 18 years to 34 years (M = 22.5 years, SD = 5.2) and they had on average 7.3 years (SD = 2.0) of post-primary education. Fourteen participants (70%) were right-handed. All participants meet the inclusion and exclusion criteria as outlined above for Experiment 1a.

Table 13.Demographic Characteristics of Participants in Experiment 1a

	Mean *(%)*	SD	Range
Age	22.5	5.2	18-34
BDI-II	5.7	3.6	0-13
Education	7.3	2.0	5-13
Sex *(% female)*	60%		
Handedness (% right)	70%		

Materials

The facial displays presented to participants in Experiment 2a were the same as those presented to participants in Experiment 1a, in both the emotion categorization task and control sex categorization task. Participants were also required to complete the same general health screen and demographic interview.

Cognitive measures

Each participant completed a number of cognitive tasks in order to allow for between group comparisons (see Chapter 6). Full details of each of these tests and the rationale for their inclusion can be found in Chapter 2. The National Adult Reading Test NART-II (Nelson, 1982)was used to provide an estimate of pre-morbid IQ. Depressive symptoms that might impact on emotion perception were measured by the Beck Depression Inventory-II (BDI-II Beck et al., 1996). The Letter fluency subtest of the Delis-Kaplan Executive Function System, (D-KEFS Delis et al., 2001) was used to provide a measure of executive function. Working memory was assessed using the Adaptive Digit Ordering Task, (DOT-A Werheid et al., 2002), while semantic memory was measured with a modified Boston Naming Test (MBNT) as part of the CERAD battery. To assess visuoperceptual skills participants were required to complete the Incomplete Letters subtest of The Visual Object and Space Perception Battery, (VOSP Warrington & James, 1991).

Design

The categorization task involved a 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) design, with all factors being within subjects.

Procedure

The same procedure was followed for Experiment 2a as for Experiment 1a. The above cognitive measures were administered to participants after they completed Experiment 2b.

Results

Sex-categorization

Accuracy rates were calculated by establishing the percentage of correct sex identifications. The mean accuracy rate was 99%. (range = 94%-100%). The participants were reliably able to detect information relevant to sex identification from facial displays; so consequently, the control task was eliminated from further analysis and no participant was removed from the sample.

Emotion-categorization

The percentage of YES responses for each participant was calculated as a function of emotion, condition and expression type and is shown in Table 14. Visual inspection suggests that genuine expressions were identified as showing and feeling the target emotion, but posed expressions were identified as showing but not feeling the target emotion, with the exception of fear where there was no difference between conditions. To confirm this observation, analyses of variance were conducted.

Table 14.Percentage of YES Responses by Judgment Condition and Facial Expression for Each Emotion: Experiment 2a

Facial expression		Judgment condition SHOW (%YES)	FEEL (%YES)
Happy			
	Neutral	15%	6%
	Genuine	$99\%_a$	$94\%_a$
	Posed	$86\%_a$	$43\%_b$
Sad			
	Neutral	18%	$25\%_b$
	Genuine	$84\%_a$	$75\%_a$
	Posed	$75\%_a$	$34\%_b$
Fear			
	Neutral	4%	4%
	Genuine	$70\%_a$	$58\%_a$
	Posed	$78\%_a$	$56\%_a$

Note. Significant difference in percentage of YES responses is shown with different subscript between conditions and between posed and genuine expressions within emotion.

Preliminary analyses revealed there was no effect of sex, handedness or presentation order, [13] and therefore, these factors were not considered further. Data were subjected to a 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVA. The analysis revealed main effects of Emotion, F (2,38) = 3.68, $p < .05$, $\eta_p^2 = .162$, Condition, F (1,19) = 33.41, $p < .001$ $\eta_p^2 = .638$, and Expression F (2,38) = 196.16, $p < .001$, $\eta_p^2 = .912$ as well as Emotion by Expression F (4,76) = 12.40, $p < .001$ $\eta_p^2 = .395$ and Condition by Expression interactions F (2,38) = 21.62, $p < .001$ $\eta_p^2 = .532$, which were qualified by a three-way interaction F (4,76) = 3.99, $p < .01$, $\eta_p^2 = .174$.

In light of a three-way interaction, separate 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVAs were conducted for each emotion. For happiness, analysis revealed a main effect of Condition F (1,19) = 38.96, $p < .01$, $\eta_p^2 = .629$

[13] There was a main effect of emotion order, F (2,17) = 8.49, p < .01, with fewer YES responses when fear judgments were made first compared to when happy or sad judgments were made first (Ms = 35.2% vs 49% & 47.7%). There were no interaction effects, however, between order and any of the key IVs (emotion; condition; expression) and the same pattern of results was seen regardless of which emotion was judged first.

and Expression F (2,38) = 275.17, $p < .01$, $\eta_p^2 = .923$ as well as an interaction effect F (2,38) = 39.90, $p < .01$, $\eta_p^2 = .634$, which is shown in Figure 10. Post hoc testing (Tukey, $p < .05$) compared the percentage of YES responses between each condition for each expression type separately and revealed there no significant differences between conditions for genuine (M = 99% vs. 95%) and neutral expressions (M = 17% vs. 12%), but there was a significant difference between conditions for posed expressions (M = 96% vs. 40%). Specifically, more YES responses were made in the show condition than the feel condition. In addition, the percentage of YES responses was compared between expression types in each condition. No difference was found between genuine and posed expressions in the show condition but there was a significant difference in the feel condition, with more YES responses to genuine than posed expressions. Significant differences between neutral and both posed and genuine expressions were found in both conditions.

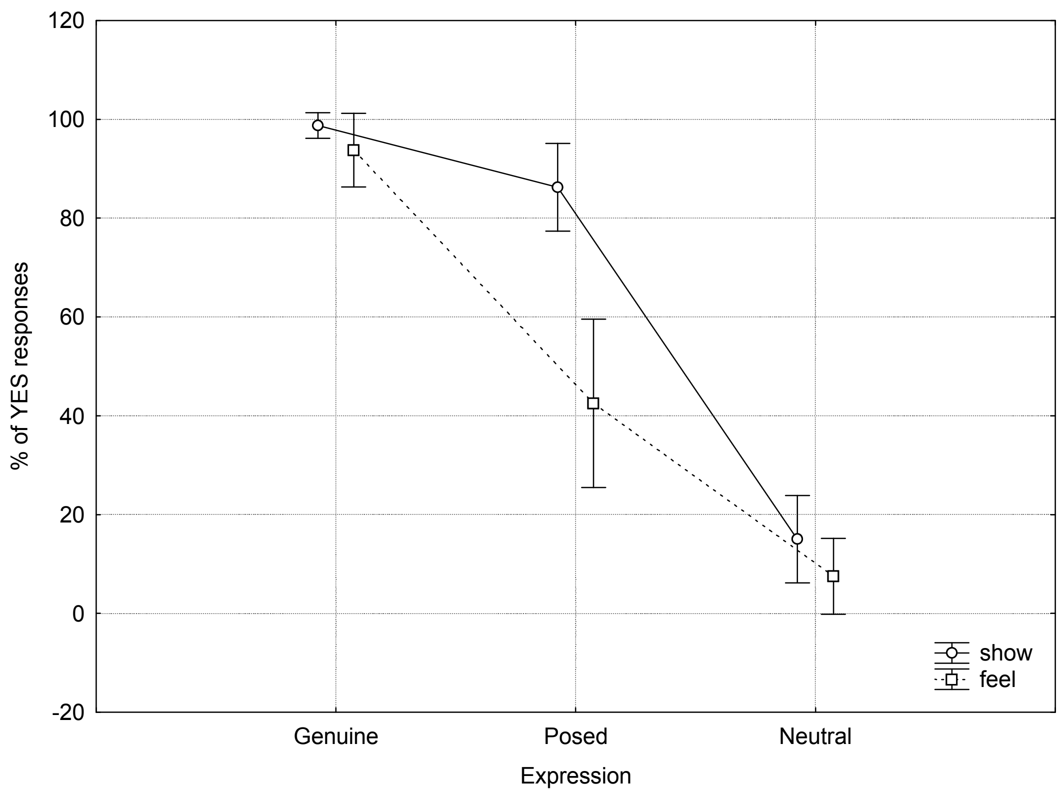

Figure 10. Percentage of YES Responses for Happiness Judgments as a Function of Expression and Condition: Experiment 2a

For sadness, analysis revealed a main effect of Condition $F(1,19) = 35.60$, $p < .01$, $\eta_p^2 = .608$ and Expression $F(2,38) = 65.33$, $p < .01$, $\eta_p^2 = .740$ as well as an interaction effect $F(2,38) = 29.66$, $p < .01$, $\eta_p^2 = .563$, which is shown in Figure 11. Post hoc testing (Tukey, $p < .05$) compared the percentage of YES responses between each condition separately for each expression type and revealed there was no significant difference between conditions for genuine (M = 75% vs. 64%) and neutral expressions (M = 12% vs. 17%), but there was a significant difference between condition for posed expressions (M = 78% vs. 28%). Specifically, more YES responses were made in the show condition than the feel condition.

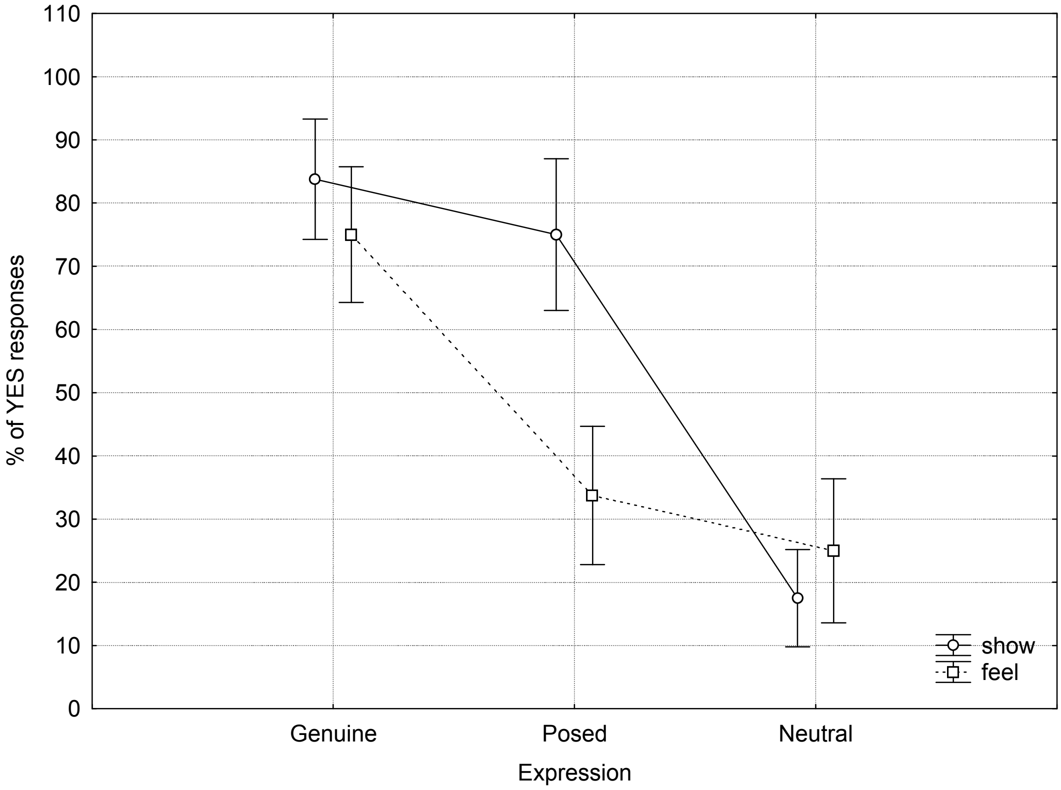

Figure 11. Percentage of YES Responses for Sadness Judgments as a Function of Expression and Condition: Experiment 2a

In addition, the percentage of YES responses was compared between expression types in each condition. No difference was found between genuine and posed expressions in the show condition but there was a significant difference in the feel condition, with more YES responses to genuine than to posed expressions. A significant difference between neutral and both posed and genuine expressions was found in the show condition, however, neutral was found to differ from genuine but not posed expressions in the feel condition.

For fear, analysis revealed a main effect of Condition F (1,19) = 15.28, $p < .01$, $\eta_p^2 = .399$ and Expression F (2,38) = 144.44, $p < .01$, $\eta_p^2 = .863$ as well as an interaction effect F (2,38) = 18.64, $p < .01$, $\eta_p^2 = .445$, which is shown in Figure 12. Post hoc testing (Tukey, $p < .05$) compared the percentage of YES responses between each condition for each expression type separately and revealed there was no significant difference between conditions for genuine (M = 76% vs. 73%) and neutral expressions (M = 4% vs. 2%), but there was a significant difference between conditions for posed expressions (M = 94% vs. 54%). Specifically, more YES responses were made in the show condition than the feel condition. In addition, the percentage of YES responses was compared between expression types in each condition. Significant differences were found between genuine and posed expressions in both conditions, specifically, more YES responses were made to posed than genuine in the show condition and more were made to genuine than posed in the feel condition. Significant differences between neutral and both posed and genuine expressions were found in both conditions. Participants, therefore, judged genuine expressions as both showing and feeling the target emotion but posed expressions as showing but not feeling the target emotion.

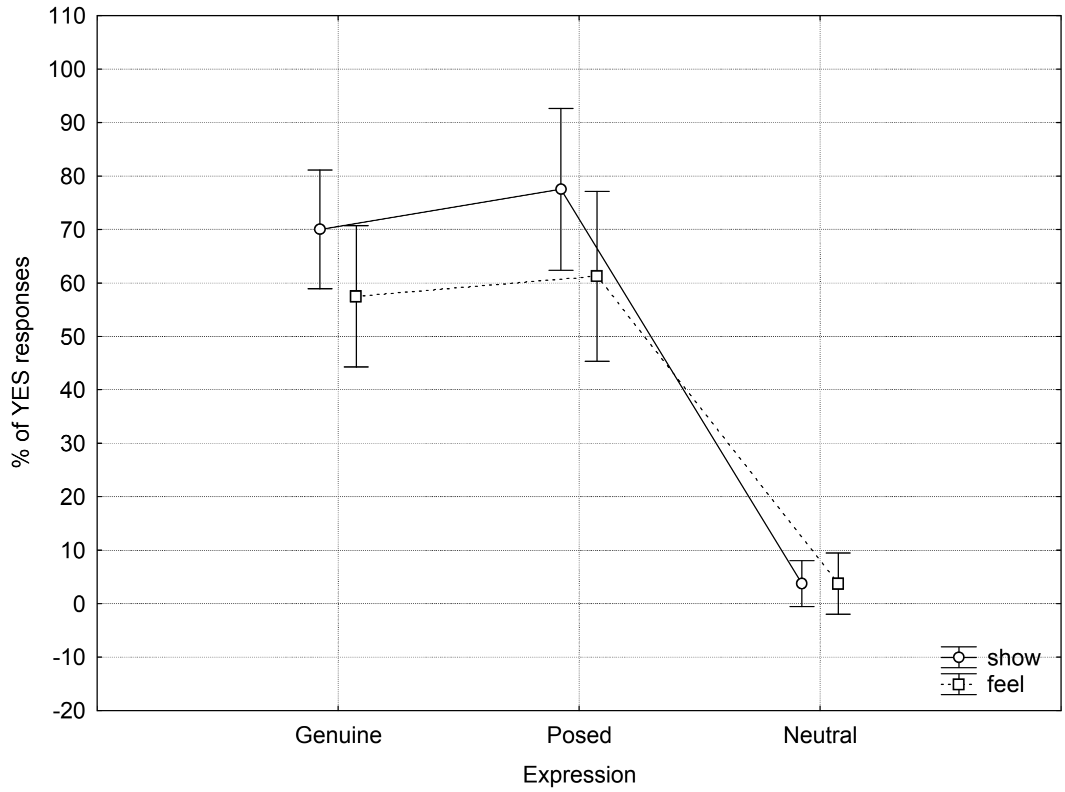

Figure 12. Percentage of YES Responses for Fear Judgments as a Function of Expression and Condition: Experiment 2a

Sensitivity

Estimates of sensitivity were calculated using the same correction and formulae as described in Experiment 1a, and likewise, were calculated for each participant as a function of emotion and judgment condition.[14] The hits, false alarms and estimates of *A'* are shown in Table 15.

As can be seen in Table 15 sensitivity scores in analysis 1 ranged from .67 - .87 in the feel condition and from .68 to .80 in the show condition. Single sample t-tests showed that all sensitivity scores were significantly greater than chance (0.5, $p < .05$). Participants, therefore, were able to detect information specifying emotion from other information that did not, even

[14] Response bias was calculated and compared to 0 to confirm that participants adopted a more stringent response criterion in the feel than in the show condition. As with Experiment 1a, a response bias was found in the show condition but not in the feel condition ($p < .05$).

when not instructed to attend to the felt state of targets (i.e., show condition). Analysis 2 revealed the level of sensitivity in the feel condition ranged from .48 to .75. Single sample t-tests showed that the sensitivity scores for happy (*M* = .75) and sad (*M* = .73) but not fear (*M* = .48) were significantly higher than expected by chance (0.5, $p < .001$), indicating that participants were sensitive to the differences between happy and sad expressions but not fear expressions. None of the sensitivity scores in the show condition was above chance.

Table 15. Mean Hit (HIT) Rates, False Alarm (FA) Rates and Estimates of A' by Judgment Condition for Each Emotion: Experiment 2a

		Analysis 1			Analysis 2		
Judgment condition		HIT	FA	A'	HIT	FA	A'
Show	Happy	.90	.51	.80*	.90	.86	.56
	Sad	.77	.47	.73*	.77	.71	.55
	Fear	.66	.44	.68*	.66	.84	.41
Feel	Happy	.84	.26	.87*	.84	.43	.75*
	Sad	.70	.32	.76*	.70	.32	.73*
	Fear	.56	.34	.67*	.56	.53	.48

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
Note. A' is compared to chance level of 0.5.
* $p < .05$.

Sex, handedness and presentation order did not influence sensitivity scores and therefore, were not considered any further. Separate 3 (Emotion: happy/sad/fear) x 2 (Condition: show/ feel) repeated measures ANOVAs were conducted on the sensitivity scores from each analysis to assess the impact of emotion and judgment condition on the level of sensitivity. Analysis 1 revealed a main effect of Emotion, F (2,38) = 21.08, $p < .001$. $\eta_p^2 = .526$. Post hoc testing (Tukey, $p < .05$) showed sensitivity to happy expressions (*M* = .83) was highest, fear lowest (*M* = .67) and sad expressions (*M* = .75) were intermediate. All differences between emotions reached significance.

Analysis 2 revealed main effects of Emotion, F (2,38) = 18.45, $p < 0.01$, $\eta_p^2 = .493$ and Condition, F (1,19) = 41.57, $p < .001$, $\eta_p^2 = .636$, but no interaction. Post-hoc tests (Tukey, $p < .05$) on the main effects showed that the mean sensitivity score for happy (M = .66) and sad (M = .64) were higher than for fear (M = .44). Sensitivity in the feel condition (M = .65) was also higher than sensitivity in the show condition (M = .51). These findings, as in Experiment 1a, suggest that participants were more sensitive to happiness compared to sadness and fear, but were as sensitive to the differences between posed and genuine sad expressions as to these differences in happy expressions. They were not sensitive to the difference in fear expressions. That is, sensitivity to happiness and sadness extends to being able to differentiate between posed and genuine expressions, while sensitivity to fear does not.

Relationship between Sensitivity Variables

The relationship between sensitivity scores both within and across emotions was assessed using Kendall's tau rank order correlations. Table 16 details the correlations with Bonferroni-corrected significance levels ($p < .006$) shown to control for multiple comparisons. The correlations were computed separately for sensitivity to emotion in facial expressions (1) and sensitivity to the difference between posed and genuine expressions (2). There were no significant correlations between the show and feel conditions for any emotion. As in Experiment 1a, sensitivity scores could not be collapsed across conditions. Consequently when considering the relationship across emotions, the correlations between sensitivity scores for happy, sad and fear were considered separately in the show and feel conditions. A significant correlation was found between sensitivity to sadness and fear, indicating that those who were more sensitive to the difference between posed and genuine sad expressions were also more sensitive to this difference in fear expressions τ (20) = .621, $p < .003$.

Table 16. Sensitivity Within and Between Emotions: Experiment 2a

				Happy		Sad		Fear	
				show	feel	show	feel	show	feel
		Mean	*SD*	τ	τ	τ	τ	τ	τ
Analysis 1	Happy (show)	.80	.06	-					
	Happy (feel)	.87	.07	.050	-				
	Sad (show)	.73	.12	-.062	-.066	-			
	Sad (feel)	.76	.14	.132	-.202	.396	-		
	Fear (show)	.68	.11	.043	.112	.152	.152	-	
	Fear (feel)	.67	.16	.348	.028	.310	.429*	.338	-
Analysis 2	Happy (show)	.56	.15	-					
	Happy (feel)	.75	.15	-.023	-				
	Sad (show)	.55	.21	.129	-.122	-			
	Sad (feel)	.73	.19	.247	-.042	.222	-		
	Fear (show)	.41	.19	.141	.126	.057	.304	-	
	Fear (feel)	.48	.22	.452	.000	.194	.621*	.450*	-

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
* $p < .006$.

Relationship between Sensitivity and Cognitive function

Kendal tau rank order correlational analysis, which is shown in Table 17, was also applied to look at the relationships between sensitivity scores and cognitive functions. Bonferroni-corrected significance levels ($p < .008$) were used to control for multiple comparisons. Only two significant correlations emerged. A negative correlation was found between sensitivity to fear in the show condition and DOT-A span scores, a measure of working memory, τ (20) = -.51, $p < .01$. This relationship was not maintained in analysis (2) when considering sensitivity to the difference between posed and genuine fear expressions. A positive correlation was found between sensitivity to happiness in the show condition and incomplete letters τ (20) =.49, $p < .01$. Again, this relationship did not extend to sensitivity to the difference between happy expressions.

Table 17. Correlations Between Sensitivity and Background Characteristics

		Mean	SD	Age τ	Education τ	BDI-II τ	PVIQ τ	DOT-A span τ	FAS total τ	VOSP letters τ	(M)BNT τ
	Age	22.45	5.17	-							
	Education	7.30	2.0	.386							
	BDI-II	5.70	3.56	.087	-.168						
	PVIQ	104.55	7.19	.331	.300	.155					
	DOT-A span	6.15	1.07	-.102	-.161	.180	.040				
	FAS total	41.45	11.38	.394	.286	.023	.431	-.076			
	VOSP letters	19.65	0.49	.138	.244	-.181	.000	-.171	-.086		
	(M)BNT	14.20	1.01	.000	.097	.174	.211	.118	.369	.075	
Analysis 1	Happy (show)	.80	.06	.162	.054	.248	-.006	-.269	-.139	.490*	-.065
	Happy (feel)	.87	.07	.114	.258	.070	.155	.018	-.081	.244	-.139
	Sad (show)	.73	.12	.263	.231	-.353	-.051	-.329	.353	-.057	-.021
	Sad (feel)	.76	.14	.109	.086	-.039	-.093	-.179	.240	.218	.266
	Fear (show)	.68	.11	-.135	.164	-.125	.184	-.506*	.136	.111	.224
	Fear (feel)	.67	.16	.164	.273	-.022	.070	-.346	.115	.199	-.007
Analysis 2	Happy (show)	.56	.15	.075	.379	.036	.129	-.264	.233	.356	.261
	Happy (feel)	.75	.15	-.085	.188	.088	.150	-.049	-.023	.196	.175
	Sad (show)	.55	.21	.127	.104	-.322	-.173	-.128	.176	-.066	-.105
	Sad (feel)	.73	.19	.060	.026	-.190	-.085	-.287	.006	.226	.083
	Fear (show)	.41	.19	-.106	.087	-.073	.054	-.419*	.224	.025	.375
	Fear (feel)	.48	.22	.108	.187	-.052	.046	-.343	.145	.171	.090

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
* $p < .008$.

Judgment response time

The response time to make judgments in Experiment 2a served as the dependant variable in the following analysis. A visual inspection of the data showed a positively skewed distribution, therefore, a $\log_{10}$ transformation was applied to the data from each participant and data remaining outside $M \pm 3.0$ *SD* were removed as outliers prior to analysis (4 responses, 0.3%). The analyses was performed on log10-transformed data but are reported as raw response times. The median response time was calculated for each participant as a function of emotion, condition and expression type.[15]

Preliminary analyses revealed there was no effect of sex, handedness or presentation order, [16] and therefore, these factors were not considered further. Data were subjected to a 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVA. The analysis revealed main effects of Emotion, F (2,38) = 17.42, $p < .01$, $\eta_p^2 = .478$, Condition, F (1,19) = 14.55, $p < .01$, $\eta_p^2 = .434$, and Expression F (2,38) = 9.71, $p < .01$, $\eta_p^2 = .338$ as well as Emotion by Condition F (2,38) = 4.40, $p < .05$, $\eta_p^2 = .188$, Emotion by Expression F (4,76) = 3.48, $p < .05$ $\eta_p^2 = .155$ and Condition by Expression interactions F (2,38) = 9.73, $p < .01$ $\eta_p^2 = .339$, which were qualified by a three-way interaction F (4,76) = 3.29, $p < .05$, $\eta_p^2 = .148$.

In light of a three-way interaction, separate 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVAs were conducted for each emotion. For

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[15] It was not possible to calculate RTs as a function of response type (YES/NO) as neutral expressions were infrequently responded YES to and genuine expressions were infrequently responded NO to in the show conditions.

[16] There was a main effect of condition order, F (1,18) = 5.73, p < .05, with faster response times when the show (M = 1432 msec) rather than the feel condition (M = 1830 msec) was presented first. There were no interaction effects, however, with any of the key IVs (emotion; condition; expression) and the same pattern of results was seen regardless of which emotion was judged first.

happiness, analysis revealed a main effect of Condition F (1,19) = 15.68, $p < .01$, $\eta_p^2 = .455$ and Expression F (2,38) = 7.70, $p < .01$, $\eta_p^2 = .288$ as well as an interaction effect F (2,38) = 9.31, $p < .01$, $\eta_p^2 = .329$, which is shown in Figure 13.

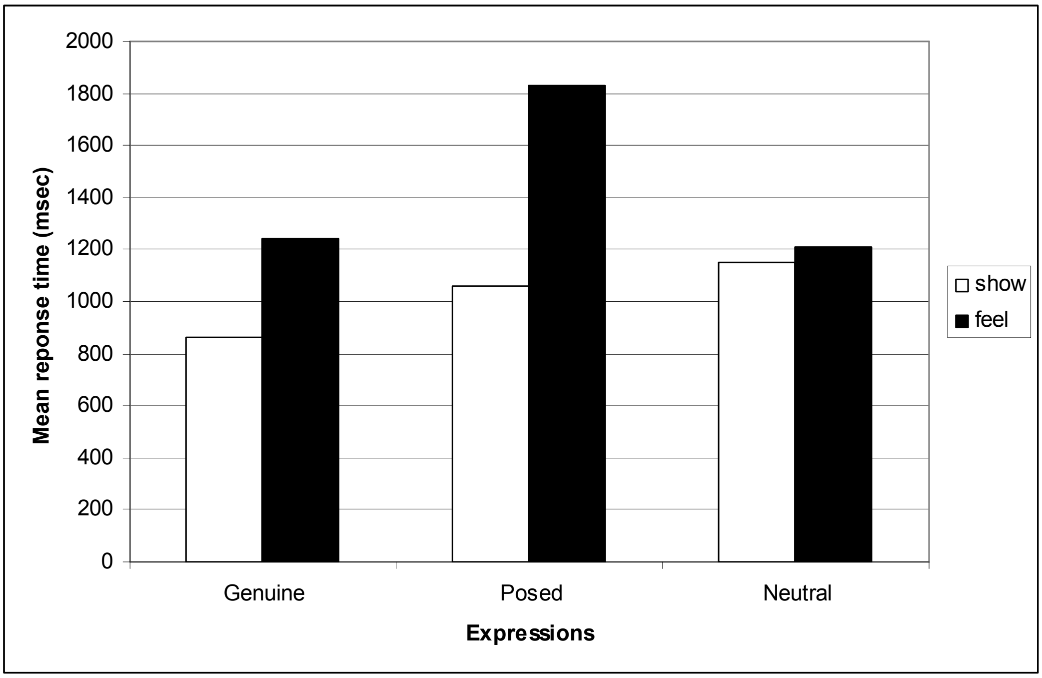

Figure 13. Mean Response Time to Identify Happy Facial Displays as a Function of Expression and Condition: Experiment 2a

Post hoc testing (Tukey, $p < .05$) compared the response time between expression types in each condition and revealed faster judgments were made to genuine than neutral expressions in the show condition (M = 865 vs. 1151 msec) with neither different to posed expressions (M = 1057 msec). Slower judgments were made to posed (M = 1832 msec) than genuine and neutral expressions in the feel condition (M = 1230 & 1211 msec) and these did not differ from one another. In addition, the response time was compared between conditions for each expression type. There was no significant difference between conditions for neutral expressions, but there was a significant difference between conditions for genuine and posed expressions. Specifically, faster judgments were made in the show condition than the feel condition.

For sadness, there was no main effects or interaction found. For fear, analysis revealed a main effect of Condition F (1,19) = 5.11, $p < .05$, $\eta_p^2 = .212$ and Expression F (2,38) = 7.39, $p < .01$, $\eta_p^2 = .280$ as well as an interaction effect F (2,38) = 6.09, $p < .01$, $\eta_p^2 = .243$, which is shown in Figure 14. Post hoc testing (Tukey, $p < .05$) compared the response time between each expression type in each condition. No difference was found between expressions in the show condition but there was a significant difference in the feel condition, with faster judgment of neutral expressions (M = 1265 msec) than posed and genuine expressions (M = 1845 vs. 1730 msec), which did not differ from each other. In addition, the response time was compared between each condition for each expression type separately and revealed there was no significant difference between conditions for neutral expressions, but there was a significant difference between conditions for posed expressions and genuine expression. Specifically, faster judgments were made in the show condition than the feel condition.

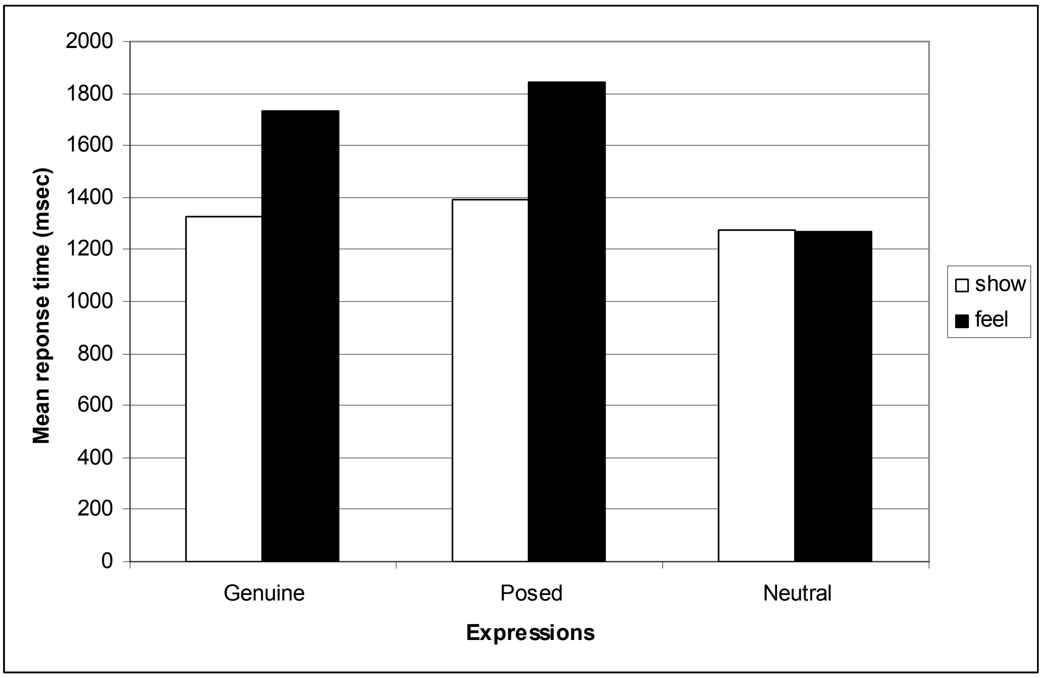

Figure 14. Mean Response Time to Identify Fear Facial Displays as a Function of Expression and Condition: Experiment 2a

These findings suggest that when required to attend to whether the target was feeling happiness, participants were faster to judge genuine and neutral expressions than posed expressions. When simply judging whether the target was showing happiness there was no difference in response time between posed and genuine expressions and only genuine expressions were faster to judge than neutral. There was no significant difference between posed and genuine expressions when judging fear, however, and both were slower than neutral. Furthermore, the type of expression did not effect the time taken to make judgments about whether the targets were showing fear. Likewise the type of expression did not effect response time when making either show or feel judgments about sadness. Judgments were faster in the show than feel condition for both posed and genuine expressions of happiness and fear but not neutral.

Discussion

As predicted, the participants in Experiment 2a demonstrated sensitivity to emotion specified in facial expressions, regardless of whether they were instructed to attend to felt state or not. Furthermore, participants were sensitive to the differences between posed and genuine expressions of happiness and sadness but only when instructed to consider how the target was feeling. They were unable to differentiate fear expressions regardless of instructions, although those who were more sensitive were also likely to be more sensitive to sadness judgments. The participants in Experiment 2a were more sensitive to happiness specified in facial expressions than to sadness and fear but they could establish the veracity of happiness and sadness equally well. Sensitivity to emotion was not reliably related to any background characteristic, mood or cognitive function as measured by working memory, executive function, visuoperceptual and semantic memory tests. The predictions concerning the time taken to make judgments were partially supported. Participants were faster to judge expressions that provided affective information (genuine and neutral expressions) than posed expressions which did not. This effect was only evident when making judgments about felt happiness, however, and was not evident when making judgments about the other target emotions or when judging whether emotion was being shown.

Although Experiment 2a has provided clear evidence that individuals are sensitive to emotion specified in facial expressions and that they demonstrate selective ability to judge the veracity of happy and sad emotion, it is less clear whether individuals will spontaneously attend to affective information. Experiment 2b seeks to investigate the proclivity toward spontaneous perception of emotion and aims to replicate the findings of Experiment 1b.

Experiment 2b: Priming task

Method

Participants

The same 20 participants (female = 12) who completed Experiment 2a also completed Experiment 2b.

Material

Word judgment task

The same seven facial displays and ten target words that were used in Experiment 1b were used in Experiment 2b.[17]

[17] Each participant demonstrated a clear understanding of the words prior to completing the task by completing a word-definition matching task (see Appendix 10).

Design

The priming task involved a 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) design with repeated measures on both factors.

Procedure

The procedure was the same in Experiment 2b as it was in Experiment 1b. In addition, participants in Experiment 2b completed the cognitive measures described in Experiment 2a at the conclusion of the procedure. These measures are described as Materials in Experiment 2a.

Results and Discussion

Data cleaning, as described in Experiment 1b, resulted in the removal of 22 (1.5%) incorrect responses and 25 (1.7%) outliers from the data set prior to analysis. The analysis was performed on $\log_{10}$-transformed data but is reported as raw response times. Figure 15 presents the response times to positive and negative words as a function of expression prime and word valence. As can be seen in Figure 16 the response time to positive words was faster after a genuine than a posed happy prime. The response time to negative words does not appear to differ as a function of the type of expression prime. To confirm this, data were subjected to a 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) repeated measures ANOVA.

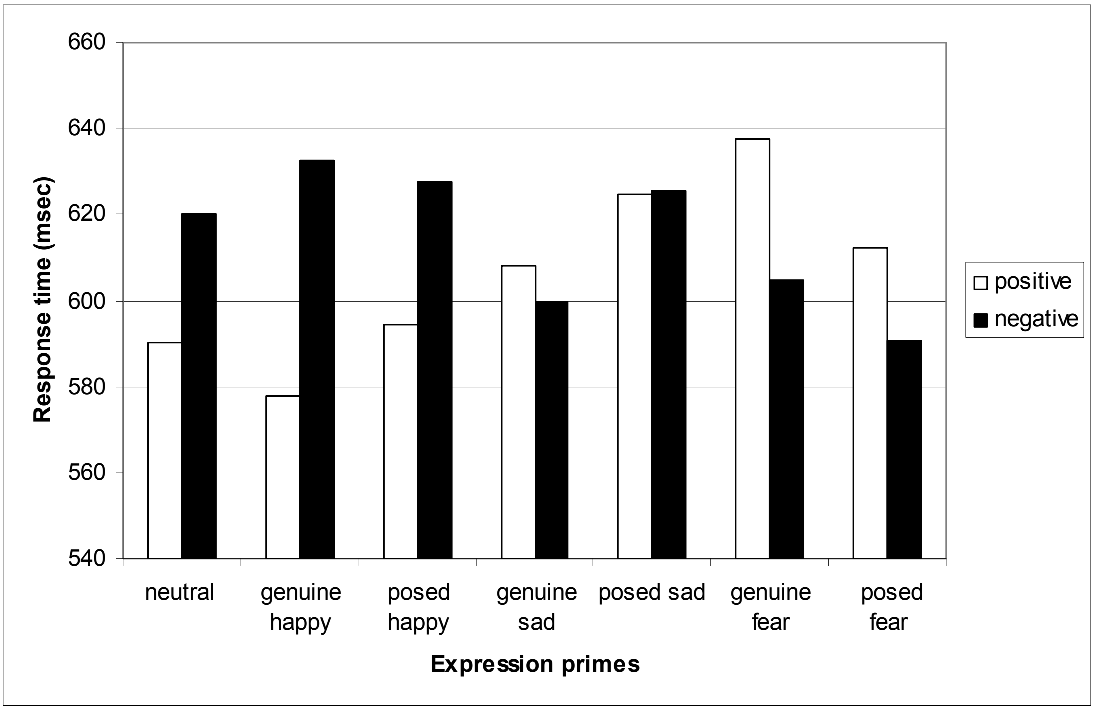

Figure 15. Response Time to Categorise Words as a Function of Facial Expression Prime and Word Valence: Experiment 2b

No significant main effects or interaction was found nor did planned comparisons to assess the hypothesized differences in response times reveal any significant differences. That is, there was no significant difference in response time when identifying positive words when preceded by genuine compared to posed expressions of happiness or either compared to neutral. Likewise, when identifying negative words there was no significant difference in response time when words were preceded by genuine compared to posed expressions of sadness or fear or either to neutral. Contrary to predictions, participants in Experiment 2b were not sensitive to affective state when engaged in a task that did not require them to make overt judgments about the facial displays.

General Discussion

The present studies aimed to replicate and extend the research reported by Miles (2005; Miles & Johnston, 2007) that investigated sensitivity to happiness, as specified in facial expressions. The results from both participant groups indicated that when explicitly asked to judge facial displays, perceivers were able to reliably detect the presence or absence of emotional state regardless of whether they were instructed to attend to felt state or not (i.e., show or feel condition). Furthermore, perceivers were reliably able to differentiate between posed and genuine expressions of happiness and sadness when asked to attend to the felt state of the target. Sensitivity to emotion was not reliably related to any background characteristic, cognitive function or measure of depressive symptoms.

Establishing sensitivity to fear was problematic. Despite being sensitive to information that specified fear from information that did not, perceivers did not differentiate between posed and genuine fear expressions. The results from Experiment 1a which found participants could differentiate were not replicated in Experiment 2a. It may well be that fear poses a risk to the perceiver that outweighs the need to establish the veracity of fear expressions. The negative consequences of not detecting fear in the environment may lean a perceiver adaptively toward considering even approximations of the emotional display as valid indicators of the underlying affective state. Conversely, the opportunity and concomitant consequences of being duped or manipulated by unauthentic fear is likely to be rare and trivial in comparison to not detecting authentic fear. In contrast, for example, the opportunity and consequence of being duped by unauthentic happiness is likely to be relatively common in comparison to fear and can have stern consequences (approaching smiling but angry person), whereas not detecting happiness poses no immediate danger to the perceiver.

The present studies also sought to establish if perceivers were sensitive to emotion when engaged in a task that did not require them to explicitly attend to the facial displays or did not draw attention to the nature of the judgment required. The research question, therefore, focused on 'do' individuals demonstrate sensitivity to emotion, rather than 'can' they demonstrate sensitivity to emotion. In this sense, the priming study engaged the participant in a task that more closely resembled real-life interactions where attention to affective state is predominantly spontaneous. The priming methodology used by Miles (2005; Miles & Johnston, 2007) was employed with additional expressions of sadness and fear included.

Few consistent findings emerged from the priming studies. However, despite not being asked to attend to the facial displays, perceivers' in Experiment 1b demonstrated sensitivity to happiness by being faster to identify positive words preceded by genuine compared to posed expressions. Given both primes were smiles, the findings suggests that the positive affective information specified by the genuine smile resulted in a preparedness for congruent positive responding that was not evident following the presentation of the affectively devoid posed smile. The same pattern was found in Experiment 2b although the difference did not reach significance. Presenting fear expressions as primes resulted in different patterns of responding. Perceivers were sensitive to fear as evidenced by faster responding to negative words preceded by genuine compared to posed expressions, but this finding was not replicated.

In summary, healthy young adults were able to reliably detect the presence or absence of emotional state regardless of whether they were instructed to attend to felt state or not. Furthermore, they could reliably distinguish between posed and genuine expressions of happiness and sadness. Sensitivity to happiness was also demonstrated spontaneously. Healthy young adults attended to the differences between posed and genuine expressions even when ostensibly engaged in another task. The accurate perception of happiness influenced their subsequent behavior. Further research is required to fully explore the inconsistent patterns of response to incidental perception of sadness and fear.

CHAPTER 4

Sensitivity to Emotion Specified in Facial Expressions: Healthy Older Adults

Having continued quality social interaction is as important as biological risk factors for preserving cognitive function (Beland, Zunzunegui, Alvarado, Otero, & Del Ser, 2005; Bennett, Schneider, Tang, Arnold, & Wilson, 2006). The consequences of impairment in the recognition of facial expressions of emotion such as poor communication, social isolation and inappropriate behavior can have a severe impact on the quality of life of older adults (Cavallero, Morino-Abbele, & Bertocci, 2007; Kharicha et al., 2007). Underlying successful social interaction is the ability to detect the affective state of interaction partners (Ekman & Rosenberg, 2005; Frank, Neil, & Paul, 2001; Keltner & Haidt, 2001). Accordingly, the experiments reported in this chapter investigated the abilities of healthy older adults to recognize the affective state of another person and to differentiate between genuine and posed expressions of emotion. The findings of these experiments may provide insights into declines in social functioning amongst older adults.

Several studies have recognized the need to investigate the impact of normal adult aging on facial expression recognition and have found selective deficits in the recognition of several negative expressions, specifically, sadness, fear (Calder et al., 2003; Keightley et al., 2006; Wong et al., 2005) and anger (Isaacowitz et al., 2007; Phillips et al., 2002a; Sullivan & Ruffman, 2004a). These deficits have been attributed to neurological changes due to aging (Calder et al., 2003), or to an attention bias to positive information (Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Mather & Carstensen, 2003), although as discussed in Chapter 1, older adults often performed better than young adults when identifying expressions of disgust. There is certainly some overlap between the neural systems that are consistently shown to subserve the recognition of facial expressions and the neural systems that are preferentially impacted by aging. Reductions in amygdala volume in old age (Grieve, Clark, Williams, Peduto, & Gordon, 2005) might explain the difficulty in recognizing fear expressions. Similarly, reductions in the anterior cingulate cortex (Garraux et al., 1999; Tisserand et al., 2002; Volkow et al., 2000) might explain problems with the identification of sadness.

Age-related neurological changes in the brain are also associated with cognitive performance[18] (Gunning-Dixon et al., 2003; Gunning-Dixon & Raz, 2000, 2003; Gunstad et al., 2006; Peters, 2006; Zimmerman et al., 2006), as well as facial expression perception. In particular, the decline in metabolism in the medial network, including the anterior cingulate, and medial prefrontal cortex, is correlated with a decline in cognitive functioning (Pardo et al., 2007). Difficulties with facial expression recognition have often been explained by deficits in general cognitive functioning in various populations, for example, schizophrenia (Russell et al., 2008), ADHD (Yuill & Lyon, 2007) and also in AD (e.g., Albert et al., 1991). Many other studies, however, have concluded that difficulties are independent of cognitive functioning (Hargrave et al., 2002; Johnston et al., 2001; Marsh & Blair, 2008) and reflect a specific emotion processing impairment. The relationship between cognitive functions and emotion perception remains unclear.

The present study investigated facial expression recognition in healthy older adults by employing the categorization and priming tasks detailed in Chapter 3. The present study also explored whether sensitivity to emotion was related to cognitive functioning, to this end, a

[18] Raz and Rodrique (2006) suggest many of the associations are modest and findings are often inconsistent.

comprehensive battery of neuropsychological measures, as detailed in Chapter 2, was completed. Given the overlap in neural structures known to support the recognition of sadness and fear and the areas affected by normal aging, it was predicted that older adults would not be sensitive to sadness and fear specified in facial expressions, but would maintain sensitivity to happiness. As in Experiment 2a, the judgment response time of healthy older adults was also examined. It was predicted that when making happiness judgments participants would be faster to judge genuine and neutral expressions than posed expressions. Given healthy older participants are not expected to demonstrate sensitivity to sadness and fear this effect was not expected with regard to making judgments about these emotions.

Experiment 3a: Categorization task

Method

Participants

The participants were 25 older adults (female = 18) recruited from the community at senior citizen meetings and activities, who volunteered to participate in return for a $30 shopping voucher. They ranged in age from 58 years to 90 years (M = 73 years, SD = 7.6) and had on average 6.2 years (SD = 4.1) post-primary education. Demographic characteristics are presented in Table 18. All participants were required to have normal or corrected to normal vision, speak English as their primary spoken language and be aged over 55 years. Furthermore, participants were required to have no history of alcohol dependence, poorly controlled diabetes or major depression in the last six months or a significant psychiatric condition requiring hospitalisation. They were also required to have no serious history of neurological, thyroid, or cardiovascular disorder and not to be currently involved in trials of psychoactive drugs.

Table 18. Demographic Characteristics of Participants in Experiment 3a

	Mean *(%)*	SD	Range
Age	73.0	7.6	58-90
(S)MMSE	28.9	1.1	26-30
DRS-2	140.9	2.6	135-144
NART PVIQ	111.9	9.0	87-124
GDS	2.9	2.8	0-8
Education	6.2	4.1	0-14
Sex *(% female)*	74%	-	-
Handedness *(% right)*	87%	-	-

Material

The facial displays employed in Experiment 3a were the same as those in Experiment 1a, in both the emotion categorization task and control sex categorization task. Participants were also required to complete the same general health screen and demographic interview.

Cognitive Measures

Each participant completed a number of cognitive tasks in order to allow for between group comparisons (see Chapter 6) and to investigate relationships between cognition and sensitivity to emotion. Full details of each of these tests and the rationale for their inclusion can be found in Chapter 2. Composite scores were calculated from all elderly participants (Healthy and AD) to provide a measure of each major cognitive domain. Reliability analyses were conducted on items within each domain (details below). Scores within each domain were standardised and the mean standardised score was calculated for each participant.

The Executive Function score consisted of scores from CLOX-I, letter fluency, category fluency, category switching and the initiation/perseveration subtest of the DRS-2. Reliability analysis was conducted on the data from all elderly participants which resulted in a suitable

Cronbach's alpha of 0.85. The Attention score combined the Test of Everyday Attention, map search scores at one and two minutes with the attention subtest of the DRS-2. A Cronbach's alpha of 0.83 was found. A measure of Episodic Memory was established by combining the following measures; ROF 3-minute delayed recall; ROF 30-minute delayed recall; the memory subtest of the DRS-2; the immediate and delayed word list recall and word list recognition scores. Reliability analysis on episodic memory items resulted in a Cronbach's alpha of 0.88. The Semantic Memory score consisted of scores from pyramids and palm trees, category fluency, the modified Boston naming test and the conceptualisation subtest of the DRS-2. A Cronbach's alpha of 0.78 was found. A measure of Working Memory was calculated from digits forwards and backwards, digit ordering span and the Daneman and Carpenter reading span and total correct scores. A Cronbach's alpha of 0.57 was found. After viewing the item-total correlations, it was decided to remove the total correct score from the Daneman and Carpenter reading test from this composite measure, which resulted in an improved reliability coefficient of 0.75. The Visuoperceptual score was calculated from the CLOX-II, ROF copy, the incomplete letters and object decision subtests from the VOSP and the construction subtest of the DRS-2. A Cronbach's alpha of 0.61 was found. Removing the ROF copy item resulted in reliability of 0.83.

General health screen and demographic information

The specific inclusion and exclusion criteria were verified for each participant by completing a standardised semi-structured interview (see Appendix H). A M.I.N.I. psychiatric screen, and interview, where applicable, was completed by each participant to assess the presence of Axis 1 disorders according to DSM-IV criteria. Two participants were excluded from the present study following this screen.

Design

The categorization task involved a 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) design, with all factors being within subjects. The 36 facial displays were presented in both the show and feel conditions, resulting in 72 trials.

Procedure

Each participant was invited to take part in a study investigating whether dementia influenced the ability to recognise facial expressions of emotion. He/she was advised of the specific inclusion/exclusion criteria required to be a control participant and was provided with an Information Sheet that briefly outlined the study and his/her rights as a research participant (see Appendix L). Signed consent (see Appendix M) was obtained from each participant and each was tested on campus at the University of Canterbury.

The investigator administered a semi-structured interview and M.I.N.I. screen to verify that each participant met the specific inclusion and exclusion criteria described above. Two participants did not meet the criteria but opted to continue with the procedure under the understanding that their data may not contribute toward the final sample of the present study. The two participants were found to have a serious history of a neurological disorder and cardiovascular disorder respectively; consequently, the data provided by these participants were removed from the sample. The final sample therefore consisted of 23 participants (17 female).

Once the screening was completed, each participant began the test protocol (see Table 7, Chapter 2). The test protocol was administered during two separate sessions, conducted one week apart. Each session took approximately 2.5 hours. The participant was asked to complete the copy phase of the Rey-Osterreith Complex Figure (ROF-I) and during a three minute delay he/she was were asked to match the personality words used in Experiment 3b to basic definitions (see Appendix N). Following the three-minute delay, the participant completed a recall phase of the ROF-II and then completed the emotion-categorization task (Experiment 3a), sex-categorization control task (Experiment 3a) and priming task (Experiment 3b). Each participant was then asked to complete ROF-II, which required they reproduce the complex figure following a 30-minute delay.

Following a scheduled break, the participant completed Letter, Category and Category Switching verbal fluency tests from the Delis Kaplan Executive Function System (D-KEFS), along with a Mini Mental Status Exam S(MMSE), the National Adult Reading Test (NART-II), an executive clock drawing task (Royall CLOX-I & II) and the Geriatric Depression Scale (GDS). The first session was concluded following another scheduled break with the participant completing a modified confrontational naming test (MBNT) from the CERAD battery, the Daneman and Carpenter Reading Span Test and the Edinburgh Handedness Inventory. The participant was instructed how to complete their homework and was issued with a pack containing the Frontal Systems Scale (FrSBe: self-rated & significant other-rated), the One Day Fluctuation Assessment Scale and the Bristol Activities of Daily Living Scale (BADLS).

The second session began with the completion of three subtests from The Visual Object and Space Perception Battery (VOSP); Shape detection, incomplete letters and object decision. The participant was then asked to complete the Word List Recall and Recognition tests from the CERAD battery and following the completion of the Map Search subtest from the Test of

Everyday Attention (TEA) he/she was asked to complete the 10-minute delay phase of the Word List Recall and Recognition test. Following a scheduled break the participant was administered the Dementia Rating Scale (DRS-2) and the cognitive scale of the Alzheimer's Disease Assessment Scale (ADAScog), as well as Digits forward, backward (WMS-III) and ordering (DOT-A) span tests. The second session was concluded, following a scheduled break, with the completion of a Continuous Performance Test (CPT), the three-picture version of Pyramids and Palms Trees and the non-cognitive scale from the Alzheimer's Disease Assessment Scale (ADASnon-cog).

Results

Sex-categorization

Accuracy rates were calculated by establishing the percentage of correct sex identifications. The mean accuracy rate was 99%. (range= 88%-100%). The participants were reliably able to detect information relevant to sex identification from facial displays. Consequently, the control task was eliminated from further analysis and no participants were excluded from subsequent data analysis

Emotion-categorization

The percentage of YES responses for each participant was calculated as a function of emotion, condition and expression type and is shown in Table 19. Preliminary analyses showed that sex, handedness and presentation order did not influence the dependant variable and therefore these factors were not included in subsequent analyses. Data were subjected to a 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/

neutral) repeated measures ANOVA. The analysis revealed main effects of Emotion, F (2,44) = 8.57, $p <$ 0.001, η_p^2 = .280 Condition, F (1,22) = 49.18, $p < .001$, η_p^2 = .691 and Expression, F (2,44) = 389.1, $p < .001$, η_p^2 = .947. In addition, significant Condition by Expression, F (2,44) = 20.37, $p < .001$, η_p^2 = .481 and Emotion by Expression F (4,88) = 16.04, $p < .001$, η_p^2 = .422 interactions were found, that were qualified by a three-way interaction F (4,88) = 2.55, $p < .05$, η_p^2 = .104.

Table 19. Percentage of YES Responses by Judgment Condition and Facial Expression for Each Emotion: Experiment 3a

Facial expression		Judgment condition SHOW (%YES)	FEEL (%YES)
Happy			
	Neutral	13%	2%
	Genuine	99%$_a$	96%$_a$
	Posed	87%$_a$	55%$_b$
Sad			
	Neutral	25%	23%$_b$
	Genuine	78%$_a$	72%$_a$
	Posed	72%$_a$	32%$_b$
Fear			
	Neutral	9%	9%
	Genuine	73%$_a$	65%$_a$
	Posed	71%$_a$	55%$_a$

Note. Significant difference in percentage of YES responses is shown with different subscript between conditions and between posed and genuine expressions within emotion.

To look at the three way interaction, separate 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVAs were conducted for each emotion. For happiness, analysis revealed a main effect of Condition F (1,22) = 34.22, $p < .01$, η_p^2 = .609 and Expression F (2,44) = 551.5, $p < .01$, η_p^2 = .962 as well as an interaction effect F (2,44) = 11.44, $p < .01$, η_p^2 = .342, which is shown in Figure 16. Post hoc testing (Tukey, $p < .05$) compared the percentage of YES responses between each condition for each expression type separately and revealed there was no significant difference between conditions for genuine

(M = 99% vs. 96%) and neutral expressions (M = 13% vs. 2%), but there was a significant difference between conditions for posed expressions (M = 87% vs. 55%). Specifically, more YES responses were made in the show condition than the feel condition. In addition, the percentage of YES responses was compared between expression types in each condition. No difference was found between genuine and posed expressions in the show condition but there was a significant difference in the feel condition, with more YES responses to genuine than posed expressions. Significant differences between neutral and both posed and genuine expressions were found in both conditions. Participants, therefore, judged genuine expressions as both showing and feeling the target emotion but posed expressions as showing but not feeling the target emotion.

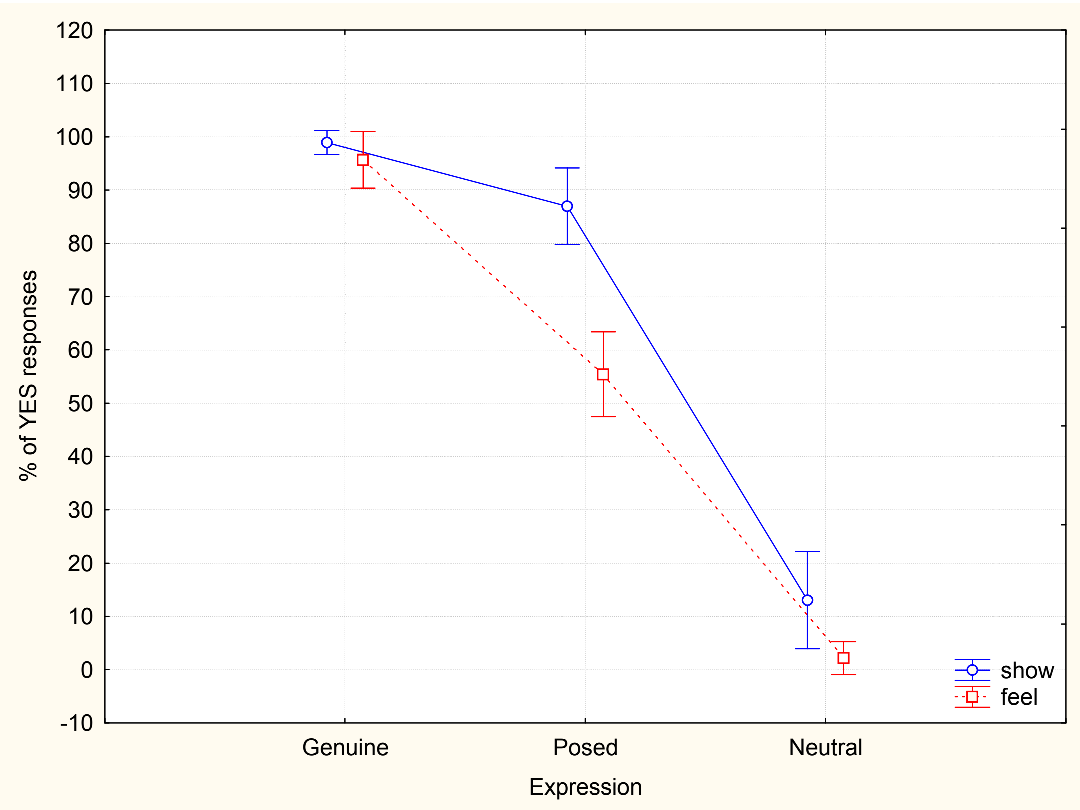

Figure 16. Percentage of YES Responses for Happiness Judgments as a Function of Expression and Condition: Experiment 3a

For sadness, analysis revealed a main effect of Condition $F\ (1,22) = 22.80$, $p < .01$, $\eta_p^2 = .509$ and Expression $F\ (2,44) = 84.53$, $p < .01$, $\eta_p^2 = .793$ as well as an interaction effect $F\ (2,44) = 12.23$, $p < .01$, $\eta_p^2 = .357$, which is shown in Figure 17. Post hoc testing compared the percentage of YES responses between each condition separately for each expression type and revealed there was no significant difference between conditions for genuine (M = 78% vs. 72%) and neutral expressions (M = 25% vs. 23%), but there was a significant difference between condition for posed expressions (M = 72% vs. 32%). Specifically, more YES responses were made in the show condition than the feel condition.

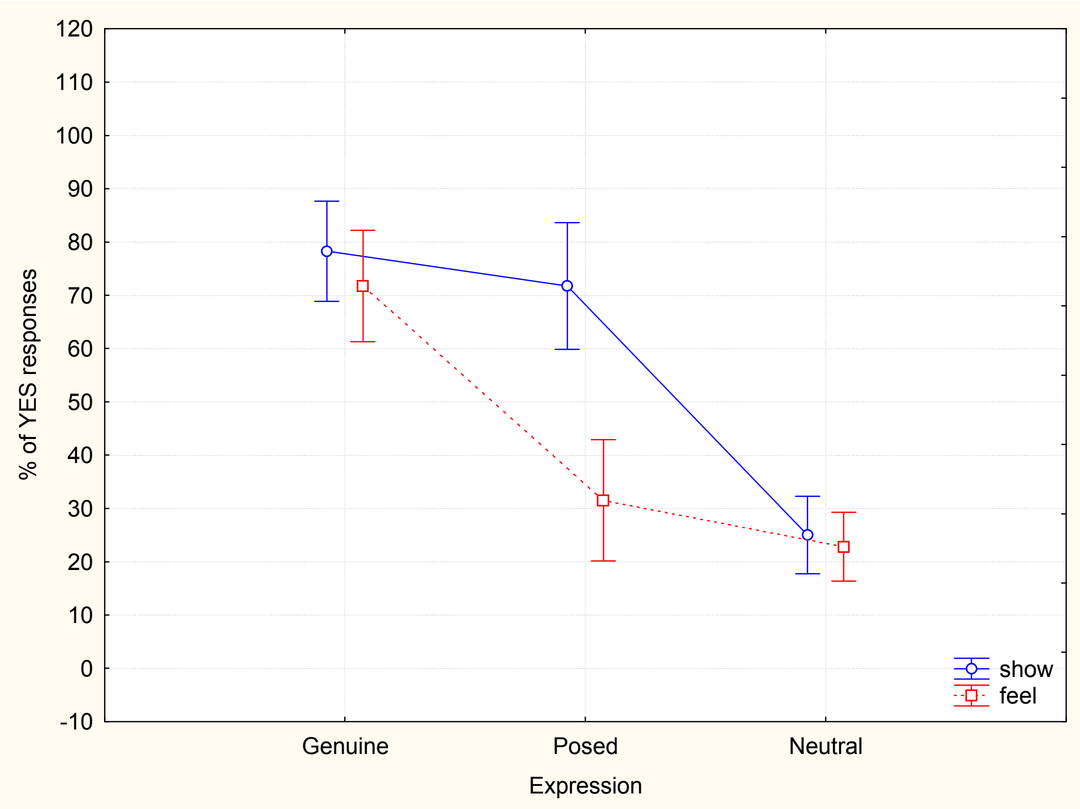

Figure 17. Percentage of YES Responses for Sadness Judgments as a Function of Expression and Condition: Experiment 3a

In addition, the percentage of YES responses was compared between expression types in each condition. No difference was found between genuine and posed expressions in the show condition but there was a significant difference in the feel condition, with more YES responses to genuine than posed expressions. A significant difference between neutral and both posed and genuine expressions was found in the show condition, however, neutral was found to differ from genuine but not posed expressions in the feel condition. Participants, therefore, judged genuine expressions as both showing and feeling the target emotion but posed expressions as showing but not feeling the target emotion.

For fear, analysis revealed a main effect of Condition F (1,22) = 7.56, $p < .05$, $\eta_p^2 = .256$ and Expression F (2,44) = 70.09, $p < .01$, $\eta_p^2 = .761$, but no interaction. More YES responses were made in the show than feel condition (M = 51% vs. 43%) and post hoc testing (Tukey, $p < .05$) on the Expression effect showed no significant difference between genuine and posed expressions (M = 69% vs. 63%), both of which were significantly higher than neutral (M = 9%).

Sensitivity

The responses in the categorization task were further analysed using a signal detection paradigm. The data from each participant was collated into hits and false alarms separately for each emotion, judgment condition and facial expression. As with the healthy young adult study (Experiment 1a), two analyses were conducted, the first included all expressions to look at sensitivity to emotion in facial displays and the second included only posed and genuine expressions to look at sensitivity to the differences between these expressions. In both analyses, a hit was defined as correctly responding YES to a genuine expression, while a false alarm was defined as responding YES to either a neutral expression or a posed expression in the first analysis and responding YES to a posed expression in the second analysis. The correction recommended by Snodgrass and Corwin (1988) was applied to the frequency of hits and false alarms to convert to the associated rates of hits and false alarms. These rates were then used to calculate measures of sensitivity (*A*') for each participant as a function of emotion and judgment condition. The hits, false alarms and estimates of A' are shown in Table 20. [19]

With regard to the first analysis that examined sensitivity to underlying affective state, sensitivity in the feel condition ranged from .72 to .86, which a single sample t-test found was significantly greater than chance (0.5, $p < .001$), for each emotion indicating that participants could reliably detect emotional from non-emotional expressions. The level of sensitivity observed in the show condition, when participants were not explicitly asked to consider actual felt emotion, ranged from .68 to .80 which a single sample t-test showed was also significantly greater than would be expected by chance (0.5, $p < .001$), for each emotion. Participants, therefore, were able to detect information specifying emotion from other information that did not, even when not instructed to attend to the felt state of targets.

Sensitivity, as calculated in the second analysis and which examines the ability to differentiate between posed and genuine expressions, ranged from .56 to .76 in the feel condition. Single sample t-tests showed that mean sensitivity scores for happiness ($M = .76$) and sadness ($M = .74$) were greater than expected by chance (0.5, $p < .01$), indicating that participants could reliably detect the difference between posed and genuine expressions. The sensitivity score for fear ($M = .56$), however, was not significantly greater than chance. The

[19] A measure of response bias (B') was also calculated to confirm that participants adopted a more stringent response criterion in the feel than in the show condition. Response bias was compared to 0 using single-sample t tests. As was found in Experiment 1a and 2a, a response bias was found in the show but not in the feel condition. Participants did not demonstrate a proclivity to respond with one response over the other in the feel condition. . The formula used to calculate sensitivity takes response bias into account and therefore it is not considered further.

level of sensitivity observed in the show condition, when participants were not explicitly asked to consider actual felt emotion, ranged from .51 to .59. Sensitivity to happiness (*M* = .59) was significantly greater than chance, showing that participants differentiated between posed and genuine expressions without explicit instruction to attend to felt state.

Table 20. Mean hit (HIT) Rates, False Alarm (FA) Rates and Estimates of A' by Judgment Condition for Each Emotion: Experiment 3a

		Analysis 1			Analysis 2		
Judgment condition		HIT	FA	A'	HIT	FA	A'
Show	Happy	.89	.50	.80*	.89	.80	.59*
	Sad	.66	.44	.68*	.66	.64	.53
	Fear	.68	.40	.71*	.68	.68	.51
Feel	Happy	.87	.31	.86*	.87	.54	.76*
	Sad	.66	.32	.76*	.66	.37	.74*
	Fear	.63	.34	.72*	.65	.55	.56

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
Note. A' is compared to chance level of 0.5.
* $p < .05$.

Preliminary analysis showed no effect of sex, handedness and presentation order on sensitivity variables calculated in the first analysis, but sex did influence the sensitivity statistics calculated in the second analysis. A separate 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) repeated measures ANOVA was conducted on the sensitivity scores from Analysis 1, while sex was included as a factor in the ANOVA conducted for Analysis 2. Analysis 1 revealed main effects of Emotion, $F\ (2,44) = 14.62, p < 0.05, \eta_p^2 = .289$ and Condition, $F\ (1,22) = 12.69, p < .01, \eta_p^2 = .289$ but no interaction. Sensitivity was higher in the feel than show condition (*M* = .78 vs. 73) and post-hoc testing (Tukey $p < .05$) showed sensitivity to happiness (*M* = .83) was higher than to sadness or fear expressions (*M* = .72 & *M* = .71), which did not differ from one another.

Analysis 2 revealed a main effect of Sex F (1,21) = 6.78, $p < 0.05$, $\eta_p^2 = .244$, Emotion F (2,42) = 4.66, $p < 0.05$, $\eta_p^2 = .182$ and Condition F (1,21) = 24.09, $p < 0.05$, $\eta_p^2 = .534$ with no interactions. Males were more sensitive to the differences between posed and genuine expressions than were females (M = .66 vs .59) and sensitivity was higher in the feel than show condition (M = .68 vs. .54). Post hoc testing (Tukey, $p < .05$) revealed sensitivity to the differences between fear expressions (M = .53) was lower than to happy and sad expressions (M = .67 & .63), which did not differ from one another.

Relationship between Sensitivity Variables

Although it was predicted that healthy older adults would not be sensitive to sadness or fear, the relationship between sensitivity variables was examined without specific expectations to maintain consistency across the reported studies. The relationship between sensitivity scores both within and across emotions was assessed using Kendall's tau rank order correlations. The correlations looked at whether the participants who were sensitive in one condition were sensitive in the other condition and whether the participants who were sensitive to one emotion were sensitive to the other emotions. The correlations are detailed in Table 21 and were computed separately for (1) sensitivity to emotion in facial expressions and (2) sensitivity to the difference between posed and genuine expressions. Bonferroni-corrected significance levels ($p < .006$) were used to control for multiple comparisons.

With regard to the relationship within emotions, no significant correlations were found, that is there was no significant relationship between those who were sensitive in the show condition and those who were sensitive in the feel condition. Consequently, sensitivity scores could not be collapsed across conditions and are considered separately when considering the relationship across emotions.

A negative correlation was found between sensitivity scores to happiness and fear in the show condition τ (23) = -.43, $p < .01$, indicating that those who were more sensitive to happiness were less sensitive to fear. This relationship was also found with regard to the sensitivity to the difference between posed and genuine expressions τ (23) = -.49, $p < .01$, indicating that those who were more sensitive to the differences between posed and genuine happy expressions were less sensitive to these differences in fear expressions. No other relationships were found between emotions, nor were sensitivity scores across emotions related in the feel condition.

Table 21. Sensitivity Within and Between Emotions: Experiment 3a

				Happy		Sad		Fear	
				show	feel	show	feel	show	feel
		Mean	*SD*	τ	τ	τ	τ	τ	τ
Analysis 1	Happy (show)	.80	.07	-					
	Happy (feel)	.86	.07	-.033	-				
	Sad (show)	.68	.12	.142	-.280	-			
	Sad (feel)	.76	.12	.128	.070	.017	-		
	Fear (show)	.71	.10	-.431*	-.109	-.013	.189	-	
	Fear (feel)	.72	.14	-.034	.000	-.038	-.167	.047	-
Analysis 2	Happy (show)	.59	.14	-					
	Happy (feel)	.76	.13	-.041	-				
	Sad (show)	.51	.19	.306	-.061	-			
	Sad (feel)	.74	.14	.005	.029	.005	-		
	Fear (show)	.51	.18	-.485*	-.361	-.126	.092	-	
	Fear (feel)	.56	.18	.064	-.105	-.111	-.014	-.030	-

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
* $p < .006$.

Relationship between Sensitivity and Cognitive function

The focus of this section is on the relationship between cognitive functioning and emotional tasks. The absolute levels of performance on cognitive tasks (Mean and SD) are presented in Table 22 and the differences between groups will be considered in Chapter 6. Kendall Tau rank order correlations were used to assess whether there was a relationship between sensitivity to emotion and cognitive functioning. The correlations were computed separately for sensitivity to emotion in facial expressions (1) and sensitivity to the difference between posed and genuine expressions (2). Bonferroni-corrected significance levels ($p < .008$) were used to control for multiple comparisons. As can be seen in Table 22, fear was the only emotion related to background characteristics, with sensitivity to the difference between fear expressions found to be positively correlated with age τ (23) = .46, p < .01, indicating older participants achieved higher sensitivity scores. No other characteristic or measure of specific cognitive domain was associated with sensitivity to emotion including depressive symptoms and general cognition as measured by both the (S)MMSE and DRS-2.

Table 22. Correlations Between Sensitivity, Background Characteristics and Cognitive Measures: Experiment 3a

		Mean (SD)	Age τ	Education τ	GDS τ	PVIQ τ	(S)MMSE τ	DRS total τ	Executive function τ	Episodic memory τ	Semantic memory τ	Working memory τ	Attention τ	Visuo perceptual τ
	Age	73.00 (7.56)	-											
	Education	6.17 (4.05)	.046	-										
	GDS	2.91 (2.76)	.379	.113	-									
	PVIQ	111.91 (9.05)	.085	.398*	.182	-								
	(S)MMSE	28.91 (1.13)	-.192	.308	-.285	.232	-							
	DRS total [a]	140.87 (2.62)	-.004	-.087	-.041	.005	.010	-						
	Executive function	.37 (.49)	-.270	.163	-.203	.104	.556*	.034	-					
	Episodic memory	.25 (.75)	-.335	.049	-.110	-.154	.336	.085	.225	-				
	Semantic memory	.38 (.40)	-.333	-.012	-.263	-.042	.463*	.337	.501*	.485*	-			
	Working memory	.39 (.35)	-.057	.257	.182	.358	.263	.098	.048	.182	.132	-		
	Attention	.31 (.62)	-.174	.115	.161	.038	.019	.255	-.020	.353	.144.	.239	-	
	Visuoperceptual	.34 (.24)	-.088	.059	-.009	.233	.014	.097	.070	-.054	.144	.083	.082	-
Analysis 1	Happy (show)	.80 (.07)	-.076	.104	.019	.005	.183	-.230	-.026	.053	-.088	.083	.088	-.018
	Happy (feel)	.86 (.07)	-.132	-.056	.067	.193	.042	-.129	-.071	-.027	.014	.134	-.144	-.153
	Sad (show)	.68 (.12)	.100	-.080	-.017	-.043	-.062	-.065	-.167	-.053	-.196	-.008	-.082	.068
	Sad (feel)	.76 (.12)	.154	-.042	-.004	-.009	.000	.061	-.183	-.370	-.278	-.004	-.225	-.139
	Fear (show)	.71 (.10)	.260	-.065	.187	.057	.000	.237	-.071	-.163	.017	.092	-.088	.035
	Fear (feel)	.72 (.14)	.058	-.151	-.100	-.043	-.038	.131	-.154	.073	.167	.191	.033	-.160
Analysis 2	Happy (show)	.59 (.14)	-.083	-.063	-.098	-.208	-.006	-.147	-.168	.046	-.113	-.010	.138	-.322
	Happy (feel)	.76 (.13)	-.163	-.085	.078	.168	.011	-.113	-.082	.009	.032	.137	-.110	-.128
	Sad (show)	.51 (.19)	-.045	-.027	-.156	-.088	.139	-.043	.022	.066	.018	-.018	.009	-.105
	Sad (feel)	.74 (.13)	.153	-.017	.098	-.013	-.053	.040	-.188	-.388	-.294	.151	-.214	-.152
	Fear (show)	.51 (.13)	.460*	.107	.241	.055	-.116	-.005	.009	-.252	-.240	-.178	-.261	.108
	Fear (feel)	.56 (.13)	.222	.009	.024	.119	-.127	.097	-.227	.045	-.018	.150	-.009	.137

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
Note. Domain scores are presented as standardized z scores.
* $p < .008$.

Judgment response time

The response time to make judgments in Experiment 3a served as the dependant variable for this analysis. A log_{10} transformation was applied to the data from each participant because of a positively skewed distribution. Data remaining outside $M \pm 3.0$ *SD* were removed as outliers prior to analysis (6 responses, 0.4%). The analyses was performed on log10-transformed data but are reported as raw response times. The median response time was calculated for each participant as a function of emotion, condition and expression type.

Preliminary analyses revealed there was no effect of sex, handedness or presentation order, and therefore, these factors were not considered further. Data were subjected to a 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVA. The analysis revealed main effects of Emotion, F (2,44) = 23.55, $p < .01$, $\eta_p^2 = .517$, Condition, F (1,22) = 20.01, $p < .01$, $\eta_p^2 = .476$, and Expression F (2,44) = 10.00, $p < .01$, $\eta_p^2 = .313$ as well as Emotion by Expression F (4,88) = 8.30, $p < .01$ $\eta_p^2 = .274$ and Condition by Expression interactions F (2,44) = 6.96, $p < .01$ $\eta_p^2 = .240$, which are shown in Figures 18 and 19 respectively.

Post hoc testing (Tukey, p < .05) on the first interaction compared the response time between each emotion for each expression type and revealed there were no differences for neutral expressions (*M* = 2239 vs. 2793 vs. 2661 msec) for happiness, sadness and fear respectively, however there was a significant difference for posed (*M* = 2312 vs. 3954 msec & 3357 msec) and genuine expressions (*M* = 1683 vs. 3507 & 3451 msec). Specifically, response time was faster when making happy judgments than both sad and fear which did not differ from one another.

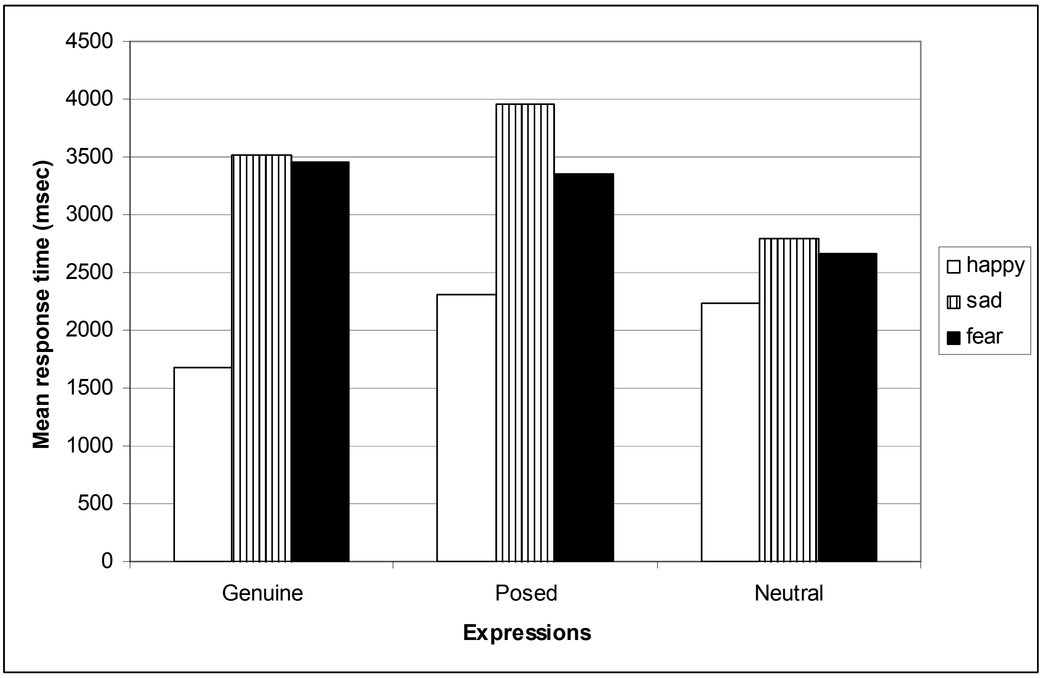

Figure 18. Mean Response Time to Identify Facial Displays as a Function of Emotion and Expression: Experiment 3a

In addition, the response time between each expression type for each emotion revealed significant differences. Specifically, faster happiness judgments were made to genuine than both posed and neutral expressions, which did not differ from one another. Slower sadness judgments were made to posed than neutral expressions. The response time to genuine expressions did not differ from either posed or neutral expressions. Finally, slower fear judgments were made to genuine than neutral expressions with no other significant differences between expressions.

Post hoc testing (Tukey, $p < .05$) on the second interaction compared the response time between each condition for each expression type separately and revealed there was no significant difference between conditions for neutral expressions (M = 2455 vs. 2655 msec), but there was a significant difference between conditions for genuine (M = 2455 vs. 3041 msec) and posed expressions (M = 2570 vs. 3819 msec). Specifically, faster judgments were made in the show condition than the feel condition.

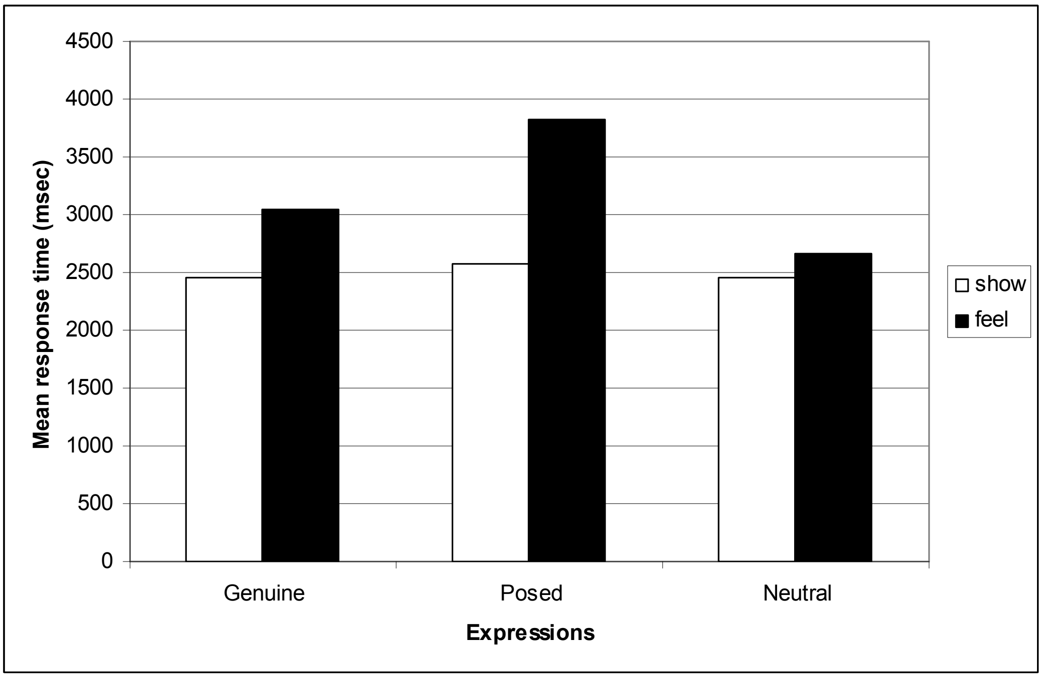

Figure 19. Mean Response Time to Identify Facial Displays as a Function of Condition and Expression: Experiment 3a

In addition, the response time was compared between expression types in each condition. No difference was found between expressions in the show condition but there was a significant difference in the feel condition, with slower judgments to posed than both genuine and neutral expressions, which did not differ from each other.

These results suggest that when attending to felt state healthy older adults were slower to judge posed expressions than genuine and neutral expressions. However, when simply judging whether emotion was being shown, there were no differences in response time between the expressions and judgments were faster than when considering felt state. In addition, healthy older adults were faster to judge happiness than sadness and fear, and different patterns of response times were found for each emotion. Only when judging happiness, was there a difference in response time between posed and genuine expressions. Specifically faster responses were made to genuine than both posed and neutral expressions. When judging sadness, healthy older adults were slower to judge posed than neutral expressions, whereas when judging fear, they were slower to judge genuine than neutral expressions.

Discussion

Older adults were sensitive to emotion specified in facial expressions regardless of whether they were asked to attend to felt state or not (i.e., show or feel condition). The findings with regard to happiness were expected, but the findings relating to sadness and fear were not, as it was predicted, older adults would not be sensitive to these emotions. In addition, older adults were sensitive to the differences between posed and genuine expressions of happiness and sadness when attending to felt state but not fear. In line with many other studies (Calder et al., 2003; Gosselin et al., 1995; Hargrave et al., 2002; Kohler et al., 2004; Motley & Camden, 1988; Rosen et al., 2006; Sullivan & Ruffman, 2004a), participants in Experiment 3a were more sensitivity to happiness specified in facial expressions than to sadness and fear. They could establish the veracity of happiness and sadness, that is differentiate between posed and genuine expressions, equally well, although being sensitive to one was not related to being sensitive to the other. A specific sex difference was also found with males demonstrating they were more sensitive to the differences between posed and genuine expressions than were females, although further research based on larger sample sizes would be needed to establish the merit of the present finding. In addition, sensitivity to emotion was not reliably related to any background characteristic or cognitive function. Finally as predicted, participants were faster to judge genuine than posed expressions of happiness but they did not demonstrate this effect when making either sadness or fear judgments.

Although Experiment 3a has provided clear evidence that older adults are sensitive to emotion specified in facial expressions and that they demonstrate selective ability to judge the veracity of happiness and sadness, it is less clear whether individuals will spontaneously attend to affective information. Experiment 3b looked at whether sensitive to affective information manifests during the incidental viewing of facial expressions that do not require overt judgments.

Experiment 3b: Priming task

The present study examined whether sensitivity to emotion can be demonstrated without imposing an explicit constraint to attend to facial expressions or to make explicit judgments about the facial expressions. A priming methodology was employed to investigate whether different types of facial expressions would moderate the response times to identify the valence of personality characteristic words. Given the findings of Experiment 3a, it was hypothesized that older adults would demonstrate sensitivity to emotion specified in facial expressions. Specifically, it was predicted that healthy older adults would respond faster to words when primed with emotion (genuine expressions) than when primed with simulations of emotion (posed expressions) or no emotion (neutral expressions). Consequently, planned comparisons will be employed to directly examine the difference in response latency between judgments preceded by posed, genuine and neutral primes. The time taken to identify positive words will be compared when preceded by genuine and posed primes as well as each to neutral. Likewise, the time taken to identify negative words will be compared when preceded by genuine and posed primes as well as each to neutral.

Method

Participants

The same 23 participants (female = 17) who completed Experiment 3a also completed

Experiment 3b.

Materials

Word judgment task

The same seven facial displays (neutral, genuine happy, genuine sad, genuine fear, posed happy, posed sad and posed fear) and target words (5 positive: good, honest, sincere, loyal, kind and 5 negative: bad, mean, cruel, liar, selfish) were used from Experiment 1b.[20]

Design

The priming task involved a 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) design with repeated measures on both factors.

Procedure

The procedure was the same in Experiment 3b as in Experiment 1b. Participants were asked to identify the valance of words as quickly and as accurately as they could. Each word was preceded by a facial display that was presented for 100 msec.

Results and Discussion

Data cleaning, as described in Experiment 1b, resulted in the removal of 22 (1.7%) incorrect responses and 15 (.9%) outliers from the data set prior to analysis. In addition, the data from one participant was removed because individual response latencies were consistently outside

[20] Each participant had a clear understanding of the words as evidenced by completion of word-definition task.

3 standard deviations from the group mean. The analysis was performed on $\log_{10}$-transformed data but results are reported as raw response times for clarity. Figure 20 presents the response times to positive and negative words as a function of expression prime and word valence.

A visual inspection of the data suggests that the predicted difference in response time to identify positive words was not demonstrated, although the time to identify negative words looks slower following exposure to genuine compared to posed expressions of happiness. Analysis of variance was used to confirm these observations. Preliminary analysis revealed no effect of sex or handedness, consequently these factors were not considered further. A 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) repeated measures ANOVA was used to compare the effect of expression prime on response time.

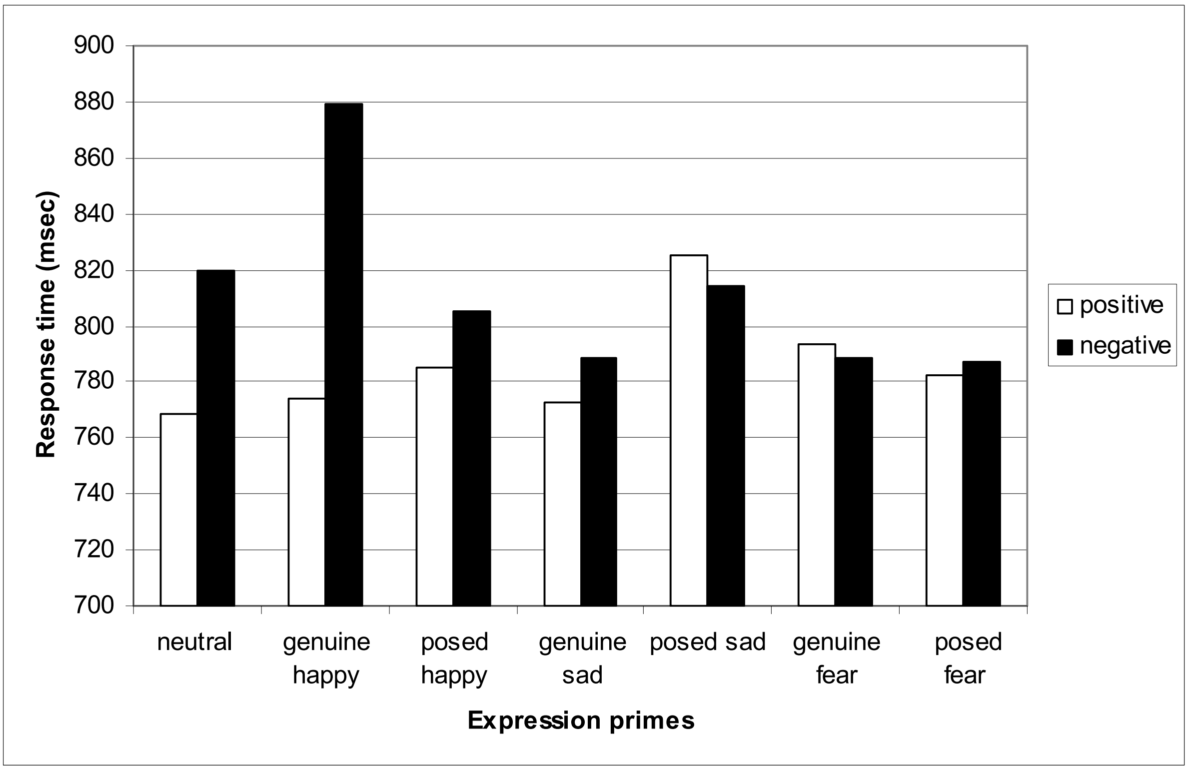

Figure 20. Response Time to Categorise Words as a Function of Facial Expression Prime and Word Valence: Experiment 3b

No significant main effects or interaction was found nor did planned comparisons to assess the hypothesized differences in response times reveal any significant differences. That is, there was no significant difference in response time when identifying positive words when preceded by genuine compared to posed expressions of happiness or either compared to neutral. Likewise, when identifying negative words there was no significant difference in response time when words were preceded by genuine compared to posed expressions of sadness or fear or either to neutral. Although unplanned, the difference in response time to negative words preceded by happy expressions was examined. Response times were significantly slower following the genuine happy prime than the posed happy prime (M = 880 msec vs. 808 msec). Contrary to predictions, participants did not demonstrate sensitivity to emotion specified in facial expressions and the only significant difference in response times as a function of expression prime was an inhibition effect rather than a facilitation effect as predicted.

General Discussion

As predicted, older adults were sensitive to happiness specified in facial expressions regardless of whether they were asked to attend to felt state or not. Contrary to predictions, they were also sensitive to sadness and fear. In addition, older adults were able to differentiate between posed and genuine expressions of happiness and sadness when attending to whether the targets were feeling each emotion. An advantage for positive information was demonstrated by older adults being more sensitive to happiness specified in facial expressions than to either sadness or fear. However, they could establish the veracity of happiness and sadness, that is differentiate between posed and genuine expressions when asked to attend to felt state, equally well, and therefore did not demonstrate an advantage with positive versus negative information in this skill. Older adults were faster making judgments about genuine expressions of happiness that provided affective information than posed expressions that did not.

Experiment 3b was different to Experiment 3a in that each older adult was ostensibly engaged in another task when exposed to the facial expressions. In the priming task there was no evidence that older adults were sensitive to emotion without explicit instruction to attend to facial displays and make overt judgments, as response times were not reliably different following exposure to the different types of expressions. Finally, the present study found that sensitivity to emotion specified in facial expressions was not related to any of the specific cognitive functions measured and, therefore, appears to be a distinct skill.

CHAPTER 5

Sensitivity to Emotion Specified in Facial Expressions: Individuals with Alzheimer's disease.

Alzheimer's disease (AD) is a progressive neurodegenerative disorder that is characterized by a deterioration of intellectual functioning and a change in personality (Hodges, 2006). The majority of past research has focused on the cognitive and psychiatric profiles associated with AD with surprisingly few studies examining how AD influences social functioning. Interpersonal and social problems are often, however, a feature of AD (Chiu et al., 2006). Given the association between social function and the ability to detect affective states in others (Ekman & Rosenberg, 2005; Shimokawa et al., 2001), one possible cause of impairment in social function in AD is an impairment in the ability to recognize emotions in others. Accordingly, the experiments reported in this chapter investigated the ability of individuals with AD to recognize the affective state of another person, and especially to differentiate between genuine and posed expressions of emotion.

Individuals with AD experience pervasive structural and morphological changes in the brain and early pathology is known to preferentially affect the medial temporal lobe structures such as the entorhinal cortex, hippocampus and amygdala (Boccardi et al., 2003; Poulin & Zakzanis, 2002; Rosen et al., 2005; Wenk, 2003). As discussed in Chapter 1, several studies highlighted the central role of the amygdala in emotion processing (Adolphs, 2002a; Adolphs & Spezio, 2006; Blair et al., 1999; Vuilleumier & Pourtois, 2007) and the hippocampus and/or amygdala-hippocampal junction have also been implicated in the modulation of facial expression perception (Holt et al., 2005; Reinders et al., 2006). Damage to these structures may well result in deficits during facial expression perception.

The recognition of facial expressions in AD has been investigated in several studies and findings have been inconsistent, although the majority of studies do report some impaired performance relative to healthy elderly controls (Allender & Kaszniak, 1989; Cadieux & Greve, 1997; Hargrave et al., 2002; Kohler et al., 2005; Roudier et al., 1998). The present study investigated facial expression recognition in AD by employing the categorization and priming tasks detailed in Chapter 3. The simple instructions and response format are well suited to individuals with cognitive impairment. Simplifying the task, while retaining fine-grain discriminations (i.e., posed versus genuine expressions) that are unlikely to produce ceiling effects, means that individuals with general cognitive decline are not disadvantaged in the testing situation.

Given the overlap in neural structures known to support emotion processing and the areas involved in AD pathology, as well as the social problems that are characteristic of AD, it was predicted that individuals with AD would not be sensitive to affective state specified by facial expressions. The present study also investigated, without specific expectations, whether sensitivity to emotion was related to specific cognitive functions. A comprehensive battery of neuropsychological measures, as detailed in Chapter 2, was completed to assess the relationships between sensitivity to emotion and cognitive functioning. As in Experiment 2a, the judgment response time of individuals with AD was also examined. It was predicted that given the expected lack of sensitivity to emotion specified in facial expressions there would be no difference between expressions in the time taken to make judgments.

Experiment 4a: Categorization task

Method

Participants

The participants were nine patients diagnosed with Alzheimer's disease (AD, female = 3) by a Psychogeriatrican. Participants were recruited from the outpatient clinic of The Princess Margaret Hospital or from the Papanui Medical Centre both in Christchurch, New Zealand. They ranged in age from 69 years to 87 years (*M* = 76.8 years, *SD* = 5.7) and had on average 4.1 years (*SD* = 3.9) post-primary education. Demographic characteristics are presented in Table 23.

All AD participants had a diagnosis of possible or probable AD according to the criteria of the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's disease and Related Disorders Association (NINCDS/ADRDA). Participants were required to have normal or corrected to normal vision, speak English as their primary spoken language and be aged over 55 years. Furthermore, participants were required to have no history of alcohol abuse or dependence, poorly controlled diabetes, or major depression in the last six months[21] and no significant psychiatric condition unrelated to the diagnosis of AD that required hospitalisation. They were also required to have no serious history of neurological, thyroid, or cardiovascular disorder and not to be currently involved in trials of psychoactive drugs.

[21] One participant scored above the cut=off (>=9) on the GDS.

Table 23. Demographic Characteristics of Participants in Experiment 4a

	Mean *(%)*	SD	Range
Age	76.8	5.7	69-87
(S)MMSE	22.7	3.7	17-28
DRS-2	121.3	14.3	89-140
NART PVIQ	107.2	8.4	93-121
GDS	6.6	3.3	4-14
Education	4.1	3.9	0-13
Sex *(% female)*	33%		
Handedness *(% right)*	89%		

Materials

The facial displays used in Experiment 4a were the same as those presented to participants in Experiment 1a, in both the emotion categorization task and control sex categorization task. Participants were also required to complete the same general health screen and demographic interview.

Cognitive Measures

Each participant completed a number of cognitive tasks in order to allow for between group comparisons (see Chapter 6) and to investigate relationships between cognitive functioning and sensitivity to emotion. Full details of each of these tests and the rationale for their inclusion can be found in Chapter 2. To achieve a composite score for each of the cognitive domains of interest, scores for all elderly participants within each domain were standardised and the mean score was calculated for each participant. The tests used to measure each cognitive domain and the Cronbach's alpha for each domain have been reported in Chapter 4.

General health screen and demographic information

The specific inclusion and exclusion criteria were verified for each participant by completing a standardised semi-structured interview (see Appendix H). A M.I.N.I. psychiatric screen, and interview, where applicable, was completed by each participant to assess the presence of

Axis 1 disorders according to DSM-IV criteria. No participant was excluded.

Design

The categorization task involved a 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) design, with all factors being within subjects. The 36 facial displays were presented in both the show and feel conditions, resulting in 72 trials.

Procedure

Each participant, with their support person/spouse, was invited to take part in a study investigating whether dementia influenced the ability to recognise facial expressions of emotion. The invitation was extended from the participant's Psychogeriatrician or G.P. during a regular outpatient consultation. Each participant was advised of the specific inclusion/exclusion criteria and was provided with an Information Sheet that briefly outlined the study and his/her rights as a research participant (see Appendix L). The researcher contacted individuals and their support person/spouse who had expressed an interest in participating in the study. Contact was made no less than one week following the invitation, to allow for consultation and consideration. Signed consent was obtained from each participant and from his/her support person or spouse (see Appendix M and Appendix O). The participant was tested either on campus at the University of Canterbury or at his/her own home if appropriate (1). The researcher completed all testing sessions. The same testing protocol employed in Experiments 3a and 3b, as described in chapter 4, was followed with regard to the assessment of AD participants.

Results

Sex-categorization

Accuracy rates were calculated by establishing the percentage of correct sex identifications. The mean accuracy rate was 99%. (range = 94%-100%). The participants were reliably able to detect information relevant to sex identification from facial displays. Consequently, the control task was eliminated from further analysis. In addition, no participant was excluded from further analyses on basis of this task.

Emotion-categorization

The percentage of YES responses for each participant was calculated as a function of emotion, condition and expression type and is shown in Table 24

Table 24. Percentage of YES Responses by Judgment Condition and Facial Expression for Each Emotion: Experiment 4a

Facial expression		Judgment condition SHOW (%YES)	FEEL (%YES)
Happy			
	Neutral	36%	17
	Genuine	100%$_a$	94%$_a$
	Posed	89%$_a$	75%$_a$
Sad			
	Neutral	22%	36%$_b$
	Genuine	81%$_a$	81%$_a$
	Posed	83%$_a$	72%$_a$
Fear			
	Neutral	19%	14
	Genuine	64%$_a$	72%$_a$
	Posed	78%$_a$	61%$_a$

Note. Significant difference in percentage of YES responses is shown with different subscript between conditions and between posed and genuine expressions within emotion.

Preliminary analyses showed that sex, handedness and presentation order did not influence the dependant variable and therefore these factors were not included in subsequent analyses. Data were subjected to a 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/ neutral) repeated measures ANOVA. The analysis revealed main effects of Emotion, F (2,16) = 3.74, $p <$ 0.05, η_p^2 = .318 and Expression, F (2,16) = 107.7, p < .001, η_p^2 = .931 as well as a significant Condition by Expression interaction F (2,16) = 4.2, p < .05, η_p^2 = .344, which is shown in Figure 21.

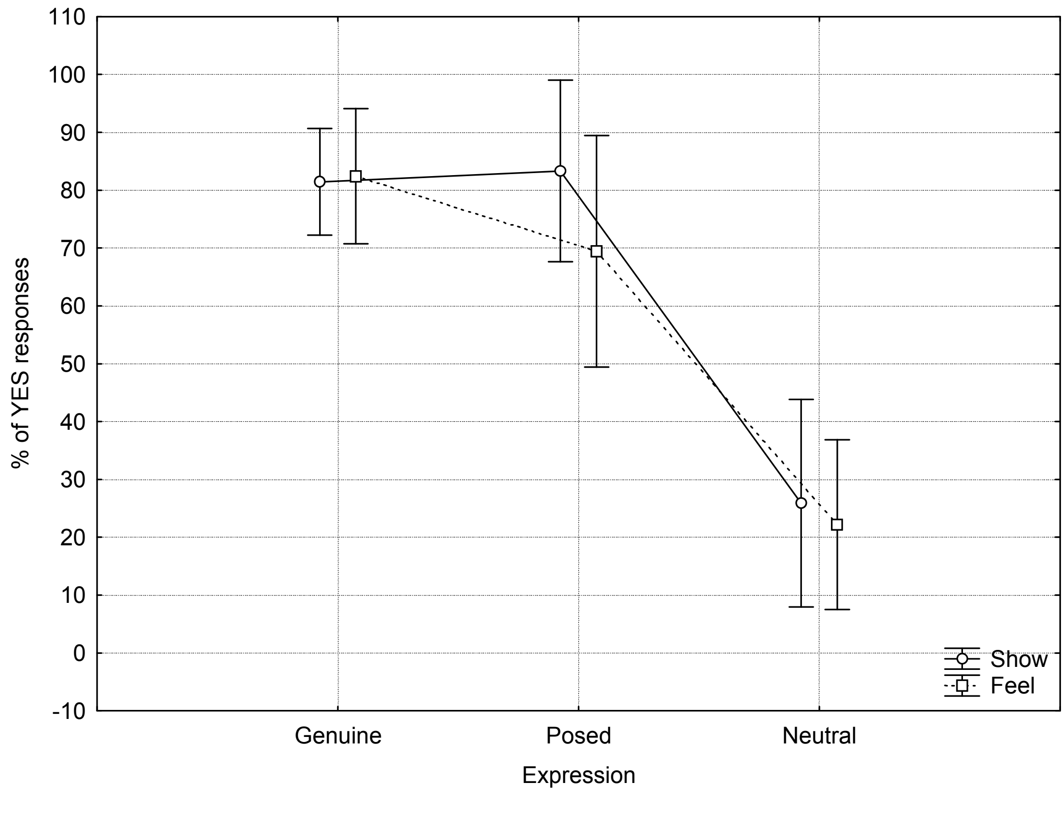

Figure 21. Percentage of YES Responses as a Function of Expression Type for Each Condition: Experiment 4a

Post-hoc analyses (Tukey, p < .05) of the Condition by Expression interaction revealed no significant difference in the percentage of YES responses in the show and feel conditions for either genuine (*M* = 81.4% vs. 82.4%), or neutral (*M* = 25.9% vs. 22.2%) expressions. There were, however, more YES responses to posed expressions in the show than the feel (*M* = 83.3% vs. 69.4%) condition. Furthermore, in the show condition there was no difference in the percentage of YES responses to the genuine and posed expressions, but both were significantly higher than to the neutral expressions. In the feel condition, the highest percentage of YES responses was made to genuine expressions, the lowest to the neutral expressions with posed expression intermediate, and all differences between expression types reached significance. Participants, therefore, judged genuine expressions as both showing and feeling the target emotion but posed expressions as showing but not feeling the target emotion.

Sensitivity

The data from the emotion-categorization task was further analysed using signal detection analysis. Two analyses were again conducted to look at (1) sensitivity to emotion in facial displays and (2) sensitivity to the differences between posed and genuine expressions. [22]

As can be seen in Table 25 the level of sensitivity in the feel condition for the first analysis ranged from .71 to .78. Single sample t-tests showed the sensitivity scores were significantly greater than would be expected by chance (0.5, $p < .01$), indicating that participants could reliably detect emotional expressions from non-emotional expressions. The level of sensitivity observed in the show condition, when participants were not explicitly asked to consider affective state, ranged from .60 to .76. Single sample t-tests showed the sensitivity

[22] Single sample t-tests found the bias scores for happy and sad judgments were significantly different from zero in both conditions, ($p < .05$), indicating that participants did not adopt a more stringent approach when asked to attend to the felt state of targets and had a proclivity to respond YES. Conversely, the response bias when making fear judgements in both conditions did not differ significantly from zero. The formula used to calculate sensitivity takes response bias into account and therefore it is not considered further.

scores for happy (M = .76) and sad (M = .69) but not fear (M = .60) were significantly greater than would be expected by chance (0.5, $p < .01$). Sensitivity in the second analysis ranged from .41 to .58 across both conditions. Single sample t-tests showed that mean sensitivity scores did not differ than that expected by chance (0.5) for any of the target emotions in either the show or the feel conditions, indicating that participants could not reliably detect the difference between posed and genuine expressions even when asked to attend to the affective state of targets.

Table 25.Mean Hit (HIT) Rates, False Alarm (FA) Rates and Estimates of A' by Judgment Condition for Each Emotion: Experiment 4a

Judgment condition		Analysis 1 HIT	FA	A'	Analysis 2 HIT	FA	A'
Show	Happy	.90	.60	.76*	.90	.86	.55
	Sad	.74	.53	.69*	.74	.77	.48
	Fear	.61	.49	.60	.61	.70	.41
Feel	Happy	.86	.48	.78*	.86	.77	.58
	Sad	.74	.54	.69*	.74	.74	.49
	Fear	.68	.39	.71*	.68	.66	.52

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
Note. A' is compared to chance level of 0.5.
* $p < .05$.

Preliminary analysis showed no effect of sex, handedness and presentation order on sensitivity scores, and therefore these factors were not included in the following analyses. Separate 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) repeated measures ANOVAs were conducted to assess the impact of emotion and judgment condition on both sensitivity scores. With regard to Analysis 1, only a main effect of Condition was revealed F (1,8) = 5.58, $p < .05$, $\eta_p^2 = .411$, with higher sensitivity in the feel compared to the show condition (M= .73 vs. .68). Similarly, only a main effect of Condition was found in Analysis 2 F (1,8) = 6.20, $p < .05$, $\eta_p^2 = .437$, with higher sensitivity to the difference between posed and genuine expressions in the feel compared to the show condition (*M* = .53 vs. .48).

Relationship between variables

The relationship between sensitivity scores both within and across emotions was assessed using Kendall's tau rank order correlations. The correlations were computed separately for (1) sensitivity to emotion in facial expressions and (2) sensitivity to the difference between posed and genuine expressions. Bonferroni-corrected significance levels ($p < .006$) were used to control for multiple comparisons. As can be seen in Table 26 there was no significant correlations within or across emotions. The participants who were sensitive in one condition were no more likely to be sensitive in the other condition; likewise, there was no relationship between being sensitive to one emotion and sensitivity to another.

Table 26. Sensitivity Within and Between Emotions: Experiment 4a

				Happy		Sad		Fear	
				show	feel	show	feel	show	feel
		Mean	*SD*	τ	τ	τ	τ	τ	τ
Analysis 1	Happy (show)	.55	.10	-					
	Happy (feel)	.58	.17	.361	-				
	Sad (show)	.48	.17	-.069	.678	-			
	Sad (feel)	.49	.10	-.105	.000	.030	-		
	Fear (show)	.41	.14	.135	-.121	-.203	-.235	-	
	Fear (feel)	.52	.21	.367	-.030	-.114	-.203	.310	-
Analysis 2	Happy (show)	.76	.09	-					
	Happy (feel)	.78	.10	.051	-				
	Sad (show)	.69	.09	-.303	.618	-			
	Sad (feel)	.70	.09	-.552	.298	.634	-		
	Fear (show)	.60	.13	-.347	.536	.351	.192	-	
	Fear (feel)	.71	.15	.093	.101	.197	-.135	.194	-

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
* $p < .006$.

Relationship between Sensitivity and Cognitive functioning

Kendall Tau rank order correlations were used to assess whether there was a relationship between sensitivity to emotion and cognition. Bonferroni-corrected significance levels ($p <$ .008) were used to control for multiple comparisons. As can be seen in Table 27 no significant correlations were found, indicating that sensitivity to emotion was not related to performance in any specific cognitive domain. Such an interpretation should be accepted with caution, however, as several correlations that did not exceed conventional thresholds for statistical significance were indicative of large effect sizes and accordingly are likely reflective of noteworthy relationships. Given the small sample size and the corrections made for multiple comparisons, it may well be that the present analysis lacked the power to find meaningful relationships between sensitivity to emotion and cognition.

Table 27. Correlations Between Sensitivity, Background Characteristics and Cognitive Measures: Experiment 4a

		Mean (SD)	Age τ	Education τ	GDS τ	PVIQ τ	(S)MMSE τ	DRS total τ	Executive function τ	Episodic memory τ	Semantic memory τ	Working memory τ	Attention τ	Visuo perceptual τ
	Age	76.78 (5.74)	-											
	Education	4.11 (3.92)	-.122	-										
	GDS	6.63 (3.29)	.222	.118	-									
	PVIQ	107.22 (8.38)	.310	.000	-.297	-								
	(S)MMSE	22.67 (3.67)	.145	.032	-.510	.294	-							
	DRS total [a]	121.33 (14.3)	.354	-.194	-.275	.090	.800*	-						
	Executive function	-.94 (.63)	-.111	-.122	-.445	-.197	.435	.530	-					
	Episodic memory	-.98 (.70)	.197	-.093	-.074	-.085	.377	.412	.444	-				
	Semantic memory	-1.04 (.80)	.000	.122	-.297	.085	.725*	.589	.167	.278	-			
	Working memory	-1.03 (1.02)	-.056	.183	-.445	.028	.551	.471	.222	.000	.611	-		
	Attention	-.90 (.62)	-.222	-.183	.113	-.057	.294	.508	.479	.254	.254	.085	-	
	Visuoperceptual	-.86 (1.19)	.056	-.061	-.667	.197	.841*	.707	.500	.167	.667	.722*	.254	-
Analysis 1	Happy (show)	.80 (.07)	.100	-.146	-.471	.439	.522	.389	.033	.233	.233	.300	-.237	.433
	Happy (feel)	.86 (.07)	-.090	.000	-.520	.550	.219	.064	.150	-.090	.030	.269	-.061	.329
	Sad (show)	.68 (.12)	-.229	.094	-.264	.145	-.030	-.061	.400	-.057	-.057	.229	.145	.172
	Sad (feel)	.76 (.12)	.377	.127	.231	.294	-.061	-.062	.145	.087	-.319	-.551	.353	-.261
	Fear (show)	.71 (.10)	.085	.185	-.113	.114	.530	.448	.028	.141	.548	.366	.171	.423
	Fear (feel)	.72 (.14)	.167	.122	.000	-.085	.203	.236	-.167	-.056	.444	.278	-.085	.222
Analysis 2	Happy (show)	.59 (.14)	-.089	.244	-.453	.090	.558	.378	.267	.535	.445	.267	-.181	.445
	Happy (feel)	.76 (.13)	-.225	.211	-.460	.293	.067	-.170	.160	-.289	.032	.225	-.065	.225
	Sad (show)	.51 (.19)	-.126	.000	-.041	.128	-.461	-.501	.000	-.378	-.504	-.126	-.096	-.252
	Sad (feel)	.74 (.13)	-.043	.283	.326	.044	-.584	-.639	-.043	-.215	-.559	-.559	.087	-.559
	Fear (show)	.51 (.13)	-.093	.136	.041	.126	.000	-.099	-.155	-.526	.155	.464	.000	.217
	Fear (feel)	.56 (.13)	.378	-.064	.077	-.118	-.121	.031	-.203	-.319	.029	.087	-.118	.029

Note. Analysis 1 includes posed, genuine and neutral expressions.
Note. Analysis 2 includes posed and genuine expressions.
Note. Domain scores are presented as standardized z scores.
* $p < .008$.

Judgment response time

The judgment response time in Experiment 4a served as the dependant variable for this analysis. A visual inspection of the data showed a positively skewed distribution, therefore, a $\log_{10}$ transformation was applied to the data from each participant and data remaining outside $M \pm 3.0$ *SD* were removed as outliers prior to analysis (2 responses, 0.3%). The analyses was performed on log10-transformed data but are reported as raw response times.

The time taken to make judgments was also analysed. Preliminary analyses revealed there was no effect of sex, handedness or presentation order, and therefore, these factors were not considered further. Data were subjected to a 3 (Emotion: happy/sad/feel) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) repeated measures ANOVA. The analysis revealed main effects of Emotion $F\ (2,16) = 6.65$, $p < .01$, $\eta_p^2 = .454$ and Expression $F\ (2,16) = 4.84$, $p < .05$, $\eta_p^2 = .377$ with no interactions. Post hoc testing (Tukey, $p < .05$) showed that faster happiness judgments were made (*M* = 2128 msec) than sadness (*M* = 3184 msec) and fear judgments (*M* = 3573 msec), which did not differ. In addition, genuine expressions were judged faster (*M* = 2506 msec) than posed (*M* = 3111 msec) and neutral expressions (*M* = 3105 msec), which did not differ from one another.

Discussion

It was predicted that individuals with AD would not be sensitive to affective information specified in facial expressions. Somewhat contrary to the prediction, individuals with AD were able to distinguish information that specified affective state from information that did not. Specifically, they were sensitive to happiness and sadness regardless of whether they were instructed to attend to felt state or not, while they were sensitive to fear emotion only when instructed to attend to felt state. Individuals with AD were not, however, sensitive to the differences between posed and genuine expressions, they made no distinction between information that specified and information that represented the affective state of others even when explicitly asked to make judgments about how the targets were feeling. The judgment condition, that is being explicitly instructed at attend to affective state, did not facilitate differentiation between these expressions. Participants did, however, make faster judgments of genuine expressions than posed and neutral expressions

These findings also highlight that happiness was no more readily identified than sadness and fear. Individuals with AD were similarly sensitive to each emotion but similarly unable to distinguish posed from genuine displays of each emotion. The advantage consistently found in recognizing positive compared to negative emotion was not evident in the present study. There was also no relationship between the likelihood of being sensitive to one emotion and another. The participants who were sensitive to happiness, for instance, were no more likely to be the participants who were sensitive to sadness. Similarly, there was no relationship between sensitivity to emotion and background characteristics or cognition. This suggests that sensitivity to emotion specified in facial expressions is a distinct skill and is independent of cognitive functioning, although larger sample sizes may be needed to confirm this finding.

The results of Experiment 4a suggest that individuals with AD have limited sensitivity to emotion. Furthermore, the instructions to actively attend to affective state did not facilitate AD participant's sensitivity to emotion in facial expressions. The present study also investigated whether individuals with AD would spontaneously perceive emotion when they are not required to attend to the information specified in facial displays. The following experiment looked at whether differentiation of posed and genuine expressions manifests during incidental viewing of facial expressions that do not require overt judgments.

Experiment 4b: Priming task

A priming methodology was employed to investigate whether different types of facial expressions would moderate the response times to identify the valence of words. Based on the findings of Experiment 4a, it was hypothesized that individuals with AD would not be sensitive to emotion specified in facial expressions, as evidenced by no significant difference in response time as a function of expression prime.

Method

Participants

The same 9 participants (female = 4) who completed Experiment 4a also completed Experiment 4b.

Material

Word judgment task

The same seven facial displays (neutral, genuine happy, genuine sad, genuine fear, posed happy, posed sad and posed fear) and ten target words (5 positive: good, honest, sincere, loyal, kind and 5 negative: bad, mean, cruel, liar, selfish) were used from Experiment 1b.[23]

[23] Each participant demonstrated an understanding of the words by completing the word-definition matching task. Prompts were given to each AD participant. Prompts included reading the definition aloud to the participant, asking in turn if each option was the best definition, and asking the participant to define each word in their own words and choose a definition that best matched their own definition.

Design

The priming task involved a 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) x 2 (Word valence: positive/negative) design with repeated measures on both factors.

Procedure

The procedure was the same in Experiment 4b as it was in Experiment 1b. Participants were asked to identify the valance of words as quickly and as accurately as they could. Each word was preceded by a facial display that was presented for 100 msec.

Results and Discussion

Data cleaning, as described in Experiment 1b, resulted in the removal of 159 (25.2%) incorrect responses and 6 (1%) outliers from the data set prior to analysis. The analysis was performed on log_{10}-transformed data but is reported as raw response times. Figure 22 presents the response times to positive and negative words as a function of expression prime and word valence. Visual inspection of the data suggests that there is no pattern or trend toward a difference in response time as a function of expression prime, to confirm this, analysis of variance was performed. No effect of sex was found, consequently a 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) repeated measures ANOVA was used to compare the effect of expression prime on response time.

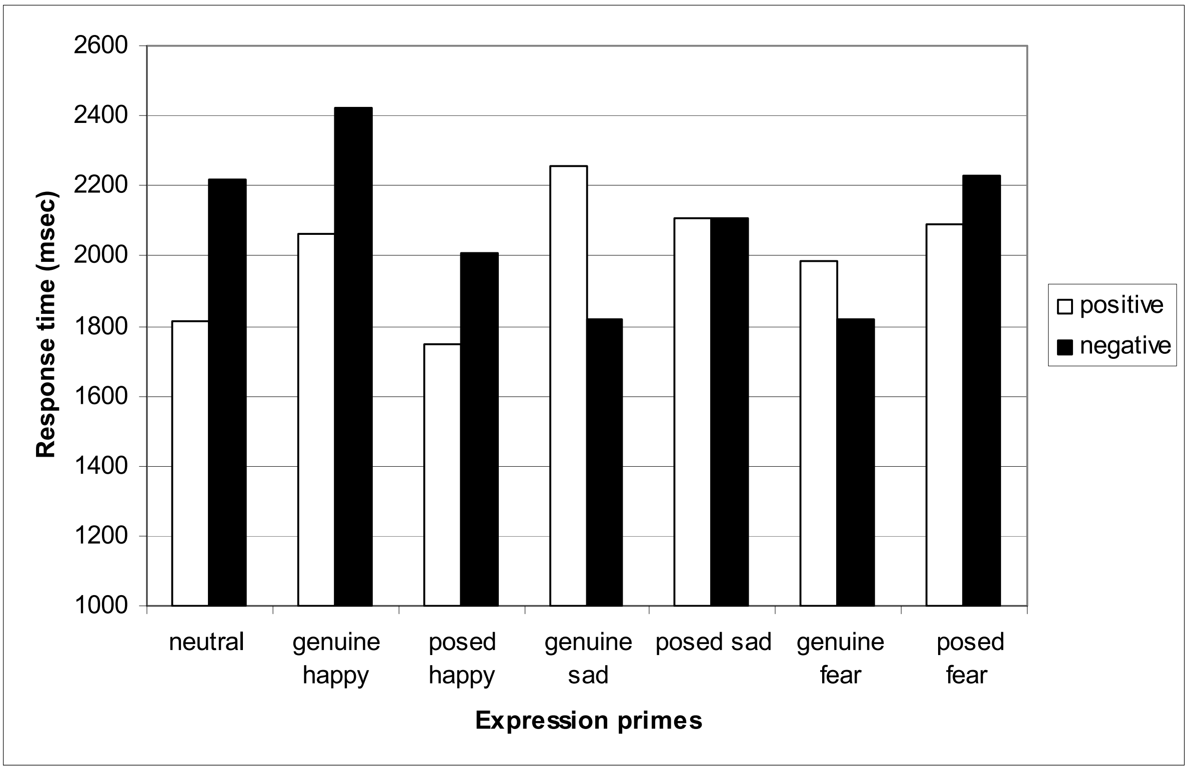

Figure 22. Response Time to Categorise Words as a Function of Facial Expression Prime and Word Valence: Experiment 4b

No main effects were found and although this was predicted to be consistent the planned comparisons performed in Experiments 1b, 2b and 3b were also performed in 4b and no significant differences were found. These results suggest that individuals with AD were not spontaneously sensitive to affective state. It is noteworthy that participants made errors on more than a quarter of the word valence judgments. In addition, more errors (64%) were made to incongruent trials (e.g., when genuine happy display preceded negative word) than congruent trials.[24] The effect of expression prime on error rate was investigated in the following analysis. A 7 (Prime: neutral/genuine happy/genuine sad/genuine fear/posed happy, posed sad and posed fear) x 2 (Word valence: positive/negative) repeated measures ANOVA revealed an Expression by Word valence interaction F (6,48) = 2.93, $p < .05$, $\eta_p^2 = .268$,

[24] It was not possible to perform this analysis with healthy young and healthy older adults as few errors were made by these groups.

which is shown in Figure 23. The same planned comparisons were used to assess the effect on errors as were used to assess the effect on response times. No significant differences were found.

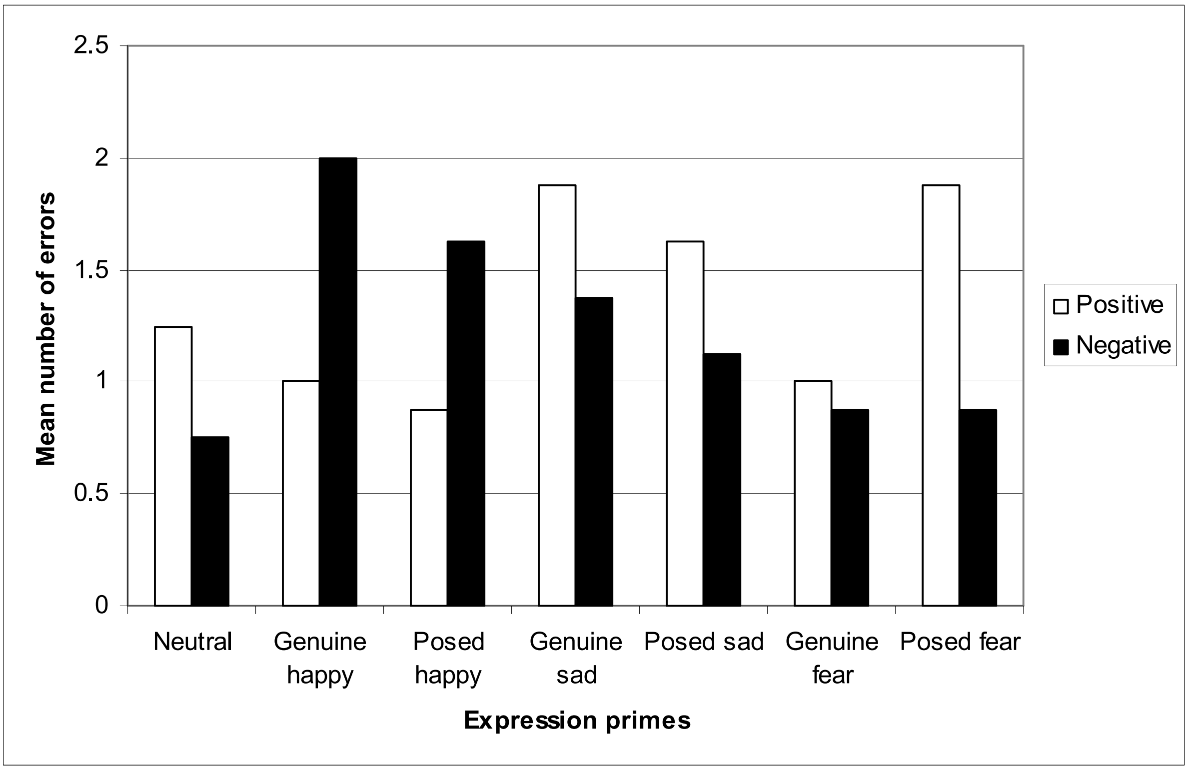

Figure 23. Mean Errors as a Function of Expression Prime and Word Valence: Experiment 4b

General Discussion

The present study investigated whether individuals with AD were sensitive to affective state as specified in facial expressions. Contrary to predictions, individuals with AD were sensitive to emotion and distinguished between information that did specify emotion (genuine expressions) from information that did not (posed and neutral expressions). Participants perceived, however, information that specified (genuine) and information that closely approximated (posed) affective state without systematic distinction regardless of the emotion being judged. That is, they did not differentiate between posed and genuine expressions. The present study also investigated whether individuals with AD were sensitive to emotion when engaged in a task that did not require them to explicitly attend to the facial displays or did not draw attention to the nature of the judgment required. There was no evidence that participants with AD were sensitive to emotion as neither response times nor error rates were reliably different following exposure to the different types of expressions. Finally, the present study found that sensitivity to emotion specified in facial expressions was not related to any specific cognitive function and appears to be a distinct skill.

CHAPTER 6

Sensitivity to Emotion Specified in Facial Expressions: Group Comparisons

Chapter 3, Chapter 4 and Chapter 5 have reported findings from two emotion perception tasks that were completed by samples of healthy young adults, healthy older adults and individuals with AD, respectively. The purpose of the present chapter was to examine differences in sensitivity to emotion specified in facial expressions by making comparisons between the three groups of participants. The specific focus was to look at whether healthy aging effects sensitivity to emotion, and whether, given the effects of aging, AD effects sensitivity to emotion. To examine the two key comparisons the sensitivity of healthy older adults and healthy younger adults to emotion specified in facial expressions was compared. To examine the effects of AD, despite aging, the sensitivity of individuals with AD was compared to the sensitivity of healthy older adults.

In previous chapters, the relationship between sensitivity to emotion and cognitive functioning has been examined by looking at the correlations between these two functions. In the present chapter, information is provided about the level of cognitive and behavioural functioning of the three groups. As can be seen in Table 28 there was a significant difference between the healthy groups and the AD group on all measures except for NART estimated verbal IQ. Specifically, on all measures individuals with AD performed more poorly than healthy adults did. There were also significant differences between the healthy young and healthy older groups. Higher IQ scores were found for the older group, but the older group performed less well on the digit-ordering test than did the young group. These findings demonstrate that the AD group have significant cognitive impairment relative to individuals of similar age without AD. Differences in verbal IQ do not offer any explanation for group differences in sensitivity as there was no relationship between IQ and sensitivity to emotion in the healthy either young or older adult groups.

Table 28. Measures used to Assess Cognitive and Behavioural Functions

		HYA (n=20)		HOA (n=23)		AD (n= 9)		Post hoc comparison
		M	*SD*	*M*	*SD*	*M*	*SD*	
Background	GDS			2.9	2.8	6.6	3.3	c
	BDI-II	5.7	3.6					
	PVIQ (est. NART-II)	104.6	7.2	111.9	9.05	107.2	8.4	a
	(S)MMSE	-	-	28.9	1.1	22.7	3.7	c
	DRS-II - *total*	-	-	140.9	2.6	121.3	14.3	c
	DRS-II – *age & education adjusted scaled*	-	-	12.7	1.9	5.9	3.1	c
	ADAS-cog.	-	-	3.7	1.9	16.9	9.4	c
	ADAS-noncog	-	-	.52	.85	3.2	1.8	c
Episodic Memory	ROF II	-	-	17.9	5.7	8.4	5.6	c
	ROF III	-	-	16.8	5.4	7.7	5.6	c
	Word Recall I	-	-	7.2	1.4	4.6	1.1	c
	Word Recall II	-	-	6.7	2.0	2.3	2.7	c
	Word Recognition I	-	-	19.8	.42	17.2	3.2	c
	Word Recognition II	-	-	19.5	1.1	14.1	3.9	c
	Memory subtest *DRS-II –age scaled*	-	-	11.8	1.9	5.1	4.1	c
Semantic Memory	Pyramids and Palm Trees	-	-	51.2	1.2	46.9	4.2	c
	(M)BNT	14.2	1.0	14.5	.85	12.9	1.4	b c
	Conceptualisation subtest *DRS-I – age scaled*	-	-	11.7	1.6	8.1	4.2	c
	Category Fluency - *total*	-	-	40.2	10.2	21.0	5.7	c
	Category Fluency - *scaled*	-	-	12.8	3.5	5.4	2.1	c
Working Memory	D&C Reading Span Test - *total*	-	-	19.8	8.3	7.0	4.8	c
	D&C Reading Span Test - *span*	-	-	2.3	1.0	1.2	.27	c
	Digits Forward	-	-	10.7	2.5	8.0	1.7	c
	Digits Backward	-	-	7.2	2.5	4.0	1.6	c
	Digit Ordering-total	8	2.3	6.2	1.8	3.1	2.5	a b c
	Digit Ordering-span	6.2	1.1	4.7	.82	3.3	1.7	a b c
Attention	Map Search I *TEA scaled*	-	-	9.5	3.1	3.5	2.3	c
	Map Search II *TEA scaled*	-	-	9.9	2.9	5.4	2.4	c
	Attention – *subtest from the DRS-II-scaled*	-	-	12.2	1.6	10.6	2.5	c
Visuoperception	ROF-I	-	-	32.7	7.3	24.8	11.9	c

Table 27. *Continued*

	CLOX-II	-	-	14.4	.72	11.0	3.5	c
	Object Decision subtest *VOSP*	-	-	18.2	1.9	15.4	2.3	c
	Incomplete Letters subtest *VOSP*	19.7	4.9	19.4	.79	17.6	2.7	b c
	Construction subtest *DRS-II-scaled*	-	-	9.9	.63	8.4	1.9	c
Executive Function	CLOX-I	-	-	13.4	1.5	9.9	3.7	c
	Letter Fluency-*total*	41.5	11.4	35.5	10.8	24.9	8.3	b c
	Letter Fluency-*scaled*	11.8	3.3	10.4	3.1	7.1	2.4	b c
	Category Fluency-switching - *total*	-	-	14.1	3.5	8.2	3.3	c
	Category Fluency-switching - *scaled*	-	-	12.8	3.5	5.7	4.0	c
	Initiation/perseveration subtest *DRS-II-scaled*	-	-	11.0	2.0	7.7	3.0	c
Daily Living	FrSBe self-rating - *before*	-	-	n/a	n/a	68.0	24.7	-
	FrSBe self-rating - *after*	-	-	71.0	14.8	94.0	20.1	c
	FrSBe sig. other rating – *before*	-	-	n/a	n/a	73.4	34.3	-
	FrSBe sig. other rating – *after*	-	-	n/a	n/a	111.0	25.6	-
	One Day Fluctuation Assessment	-	-	.05	.22	3.6	3.7	c
	Bristol Activities of Daily Living Scale	-	-	.11	.46	6.9	6.2	c
Cognitive domains (standardised)	Executive function	-	-	.37	.49	-.94	.63	c
	Attention	-	-	.25	.75	-.98	.70	c
	Episodic Memory	-	-	.38	.40	-1.04	.80	c
	Semantic Memory	-	-	.39	.35	-1.03	1.02	c
	Working Memory	-	-	.31	.62	-.90	.62	c
	Visuoperception	-	-	.34	.24	-.86	1.2	c
		-	-					

Note. Abbreviations: HYA = Healthy young adults (second sample only), HOA = Healthy older adults, AD = Alzheimer's disease group.
Note. n/a = not applicable for this group to complete the measure.
abc: a = HYA and HOA different, b = HYA and AD different, c = HOA and AD different, (Tukey, $p < .05$).

The categorization tasks reported in previous chapters, yielded sensitivity scores which as stated are used in the present chapter to make two key comparisons. The first comparison is to establish if there are age-related effects in sensitivity to emotion and the second comparison is to establish if AD effects sensitivity, given any age effects. The sensitivity scores from the two healthy young groups have been combined to form a single healthy young adult group. [25] Results from a group matching analysis are reported first, followed by the results from two case-matched analyses. The time taken to make judgments was also recorded in the categorization task and will be compared between groups in the present chapter. The first case-matched analysis compared healthy young and healthy older adults matched for NART estimated verbal IQ to control for intelligence. The second compared healthy older adults and individuals with AD matched by age and NART estimated IQ. Reporting comparisons from two case-matched designs was preferable to matching participants from each of the three groups as closer matches could be achieved within pairs with regard to verbal IQ. Only Group effects, where relevant, are reported given other effects have been reported in the earlier chapters.

The large difference in response latency and error rate found between groups in the priming task, in particular, between the AD and healthy older adult groups, makes it difficult to perform meaningful statistical comparisons. Consequently, the final section of the present chapter will discuss the different pattern of results found between the groups, rather than state statistical comparisons.

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[25] There were no significant differences between the two healthy young groups.

Group-matched Comparisons

Table 29 presents estimates of sensitivity (*A*') from analysis 1 as a function of group, emotion and judgment condition. As discussed previously, Analysis 1 included all expressions to look at sensitivity to emotion in facial displays; that is being able to detect information in the face that specifies affective state from information that does not.

The level of sensitivity ranged from .60 to .80 in the show condition and .67 to .87 in the feel condition. As reported in the previous chapters, sensitivity scores were significantly greater than chance (0.5) for each group with the exception of fear in the show condition for the AD group. Each group was therefore able to detect information in facial expressions that specified underlying affective state and distinguish this from facial expressions that did not specify emotion. Furthermore each group was able to do so regardless of whether they were explicitly asked to judge felt state or not, the only exception being when AD participants were making judgments about fear expressions in the show condition.

Table 29. Comparison between Groups on Estimates of A' by Judgment Condition and Emotion (Experiments 1a – 4a)

			HYA	HOA	AD
Happy	Show	A'	.79	.80	.76
	Feel	A'	.86	.86	.78
Sad	Show	A'	.72	.68	.69
	Feel	A'	.76	.76	.69
Fear	Show	A'	.68	.71	.60*
	Feel	A'	.72	.72	.71

Note. A' is compared to chance level of 0.5.
Note. * Not significant, $p < .05$.

To examine the differences more closely a 3 (Group: HYA/HOA/AD) x 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) ANOVA with repeated measures on the last two factors was conducted to investigate whether there were group differences in sensitivity scores. A main effect of Group F (2,73) = 3.32, $p < .05$ $\eta_p^2 = .083$, Emotion F (2,146) =

27.53, $p < .01$ $\eta_p^2 = .274$ and Condition F (1,73) = 23.78, $p < .01$ $\eta_p^2 = .246$ was found, but there were no interactions. Post hoc testing (Tukey, $p < .05$) on the effect of Group showed that the AD group ($M = .70$) were less sensitive than the healthy young and healthy older groups ($M = .76$ & .75), which did not differ from one another. It appears aging did not effect the ability to be sensitive to emotional facial expressions and while individuals with AD were able to differentiate information that did from information that did not specify affective state at a level above chance, they were less sensitive than healthy individuals.

A comparison between groups on sensitivity scores from analysis 2, when neutral expressions were removed, was also conducted. In this context, sensitivity refers to the ability to differentiate between posed and genuine expressions. As can be seen in Table 30 the level of sensitivity ranged from .40 to .59 in the show condition and from .49 to .77 in the feel condition. Single sample t-tests showed that mean sensitivity scores were no greater than the level expected by chance (0.5) in the show condition ($p < .05$), except for happy judgments made by the healthy older adult group. A lack of sensitivity in the show condition is not unexpected given the responses made to neutral expressions have been removed. As stated, analysis 2 looks specifically at whether participants discriminated between posed and genuine expressions. It would be expected that sensitivity to these differences would manifest in the feel condition where participants were instructed to consider the felt state of targets. In the feel condition the two healthy groups produced sensitivity scores greater than chance when making happy and sad judgments whereas the AD group did not. This indicates that healthy adults were able to differentiate between posed and genuine expressions of happiness and sadness at a level above chance, but individuals with AD were not able to make such distinctions.

Table 30. Comparison between Groups on Estimates of A' by Judgment Condition and Emotion (Experiments 1a – 4a, neutral data removed)

			HYA	HOA	AD
Happy	Show	A'	.55	.59*	.55
	Feel	A'	.77*	.76*	.58
Sad	Show	A'	.54	.53	.48
	Feel	A'	.72*	.74*	.49
Fear	Show	A'	.40	.51	.41
	Feel	A'	.55	.56	.52

Note. A' is compared to chance level of 0.5, * $p < .05$.

To investigate group differences further, a 3 (Group: HYA/HOA/AD) x 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) ANOVA with repeated measures on the last two factors was conducted on sensitivity (2) scores. This revealed main effects of Group F (2,73) = 4.83, $p < .05$ $\eta_p^2 = .117$, Emotion F (2,144) = 26.58, $p < .01$, $\eta_p^2 = .270$ and Condition F (1,72) = 84.75, $p < .01$, $\eta_p^2 = .541$, as well a Condition by Group interaction F (2,73) = 4.11, $p < .05$, $\eta_p^2 = .101$, which is shown in Figure 24. Post hoc tests (Tukey, $p < .05$) on the interaction showed there was no difference between groups in the show condition (M = .49 & .54 & .48), with no group demonstrating sensitivity to the difference between posed and genuine expressions. In the feel condition there were significant differences between the AD group and both healthy groups, which did not differ from each other (M = .53 vs .68 & .68). In addition, sensitivity was higher in the feel than show condition for the healthy young groups, but not the AD group. When explicitly asked to attend to the felt state of targets, healthy adults were able to differentiate between posed and genuine expressions but individuals with AD were not.

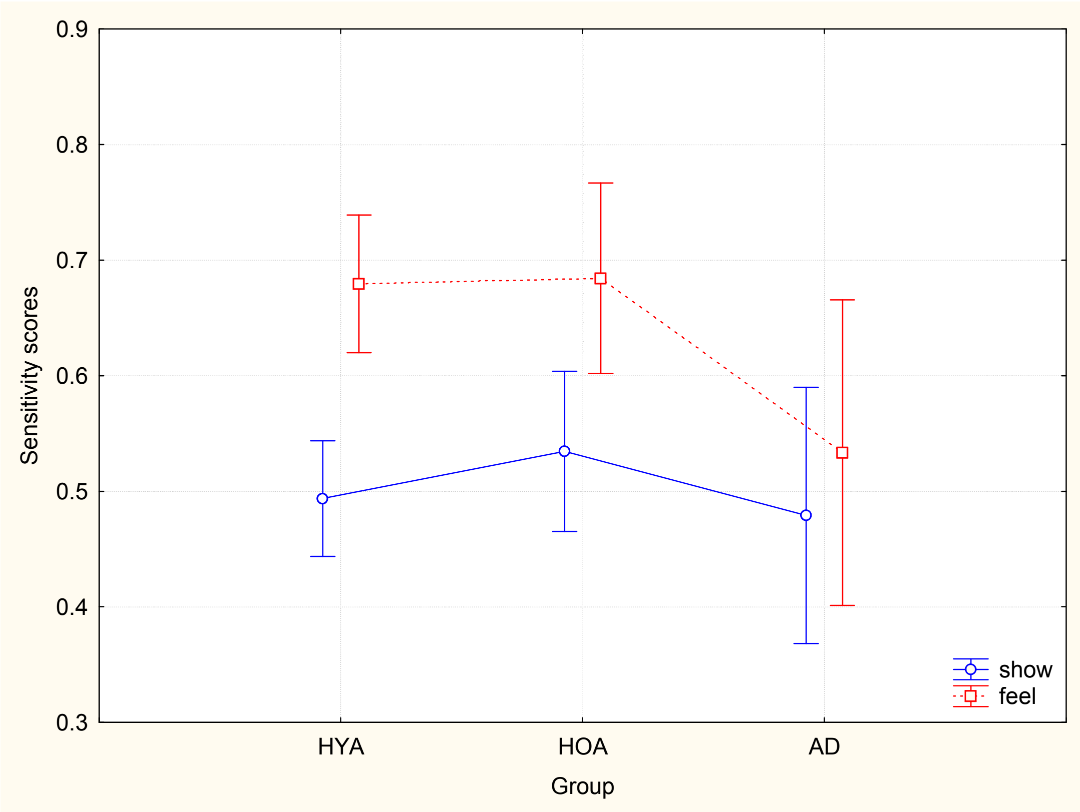

Figure 24. Sensitivity to the Difference Between Posed and Genuine Expressions as a Function of Group for Each Condition

Case-matched Comparisons

The Effect of Aging on Sensitivity

The first case-matched comparison included fifteen healthy young adults and fifteen healthy older adults. A match based on NART estimated verbal IQ was made for each healthy young participant from the second healthy young study to a healthy older participant ($\underline{+}$ 6 points). It was not possible to match five healthy young participants based on verbal IQ, therefore, their data were removed. The mean difference between verbal IQ was 2.4, which ranged from 0-6 points. The ratio of males to females was the same for each group, although it was not possible to match based on sex. A dependent means t-test revealed there was no significant difference in years of post primary education between the groups (M = 7.5 vs. 5.8). The demographic characteristics of each group are presented in Table 31. Analysis was performed on sensitivity scores calculated in Experiments 2a and 3a, which investigated participant's sensitivity to affective state specified by facial expressions when explicitly required to make overt judgments.

Table 31. Demographic Characteristics of Case-Matched Young Adults and Older Adults

	HYA (n=15)		HOA (n=15)	
	Mean; *% (sd)*	Range	Mean; *% (sd)*	Range
Age	22.9 (5.5)	18-34	73.0 (5.5)	64-87
NART PVIQ	106.5 (7.3)	91-117	108.1 (8.1)	87-117
BDI-II / GDS	5.6 (3.3)	0-13	3.3 (2.9)	0-8
Education	7.5 (2.2)	5-13	5.8 (3.7)	1-13
Sex *(% female)*	66.7%	n/a	66.7%	n/a
Handedness *(% right)*	66.7%	n/a	80%	n/a

Separate 2 (Group: AD/HOA) x 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) repeated measures ANOVAs were conducted on sensitivity (1&2) scores. There was no main effect of Group, nor were there any interactions. This indicates there was no specific effect of aging on the ability to detect emotion from facial expressions and distinguish posed from genuine expressions.

The effect of AD on sensitivity

The second case-matched comparison included nine AD participants and nine matched healthy elderly participants. Participants were matched on age (± 3 years) and NART estimated verbal IQ (± 6 points). One AD participant was matched to a healthy participant of the same age despite an 18-point difference in verbal IQ, as this was the only match.[26] The demographic characteristics of each group are presented in Table 32. The mean difference in

[26] Results did not differ when this pair was removed (N = 8). Consequently, the pair was retained to improve the sample size.

age was 1.4 years, which ranged from 0-3 years and the mean differences between verbal IQ was 4.4 points, which ranged from 0-18 points. A dependent means t-test ($p < .05$) revealed that there was no mean difference between the two groups in age (M = 76.8 vs. 76.2), PVIQ (M = 108.7 vs. 109.2), years of post primary education (M = 4.1 vs. 4.2) or GDS (M = 6.6 vs. 4.1). As expected, (S)MMSE scores (M = 22.7 vs. 28.2) and DRS-2 (M = 121.3 vs. 141.2) scores were significantly lower in the AD group than the healthy older group. It was not possible to match based on sex as three male AD participants were better matched in age and IQ to a healthy female participant. Sex matched cases would have been preferable given healthy older males were found to be more sensitive to the difference between posed and genuine expressions in an earlier study. The ratio of males to females was higher, however, in the AD group.

Table 32. Demographic Characteristics of Case-Matched Older Adults and AD Participants

	AD(n=9)		HOA (n=9)	
	Mean; *% (sd)*	Range	Mean; *% (sd)*	Range
Age	76.8 (5.7)	69-87	76.2 (6.1)	66-87
(S)MMSE	22.7 (3.7)	17-28	28.2* (1.3)	26-30
DRS-2	121.3 (14.3)	89-140	141.2* (1.8)	138-143
NART PVIQ	108.7 (8.8)	93-121	109.2 (6.6)	95-117
GDS	6.6 (3.3)	4-14	4.1 (3.0)	0-8
Education	4.1 (3.9)	0-13	4.2 (3.5)	0-11
Sex *(% female)*	33.3%	n/a	66.7%	n/a
Handedness *(% right)*	88.9%	n/a	77.8%	n/a

* $p < .01$.

Analysis was performed on sensitivity scores calculated in Experiments 3a and 4a which investigated participant's sensitivity to affective state specified by facial expressions when explicitly required to make overt judgments. Separate 2 (Group: AD/HOA) x 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) repeated measures ANOVAs were conducted on sensitivity (1&2) scores. Main effects of Group F (1,8) = 14.91, $p < .01$, $\eta_p^2 = .651$, Emotion F (2,16) = 13.46, $p < .01$, $\eta_p^2 = .627$ and Condition F (1,8) = 5.43, $p < .05$, $\eta_p^2 = .404$ were found for sensitivity (1) scores with no interactions. Post hoc testing (Tukey, $p < .05$) on the Group effect showed the healthy older group was more sensitive than the AD group ($M = .78$ vs. .70).

Main effects of Group F (1,8) = 25.34, $p < .01$, $\eta_p^2 = .760$, Emotion F (2,16) = 5.46, $p < .05$, $\eta_p^2 = .406$ and Condition F (1,8) = 12.16, $p < .01$, $\eta_p^2 = .603$ were found for sensitivity (2) scores, as well as a Group by Condition interaction F (1,8) = 17.64, $p < .05$, $\eta_p^2 = .440$, which is shown in Figure 25.

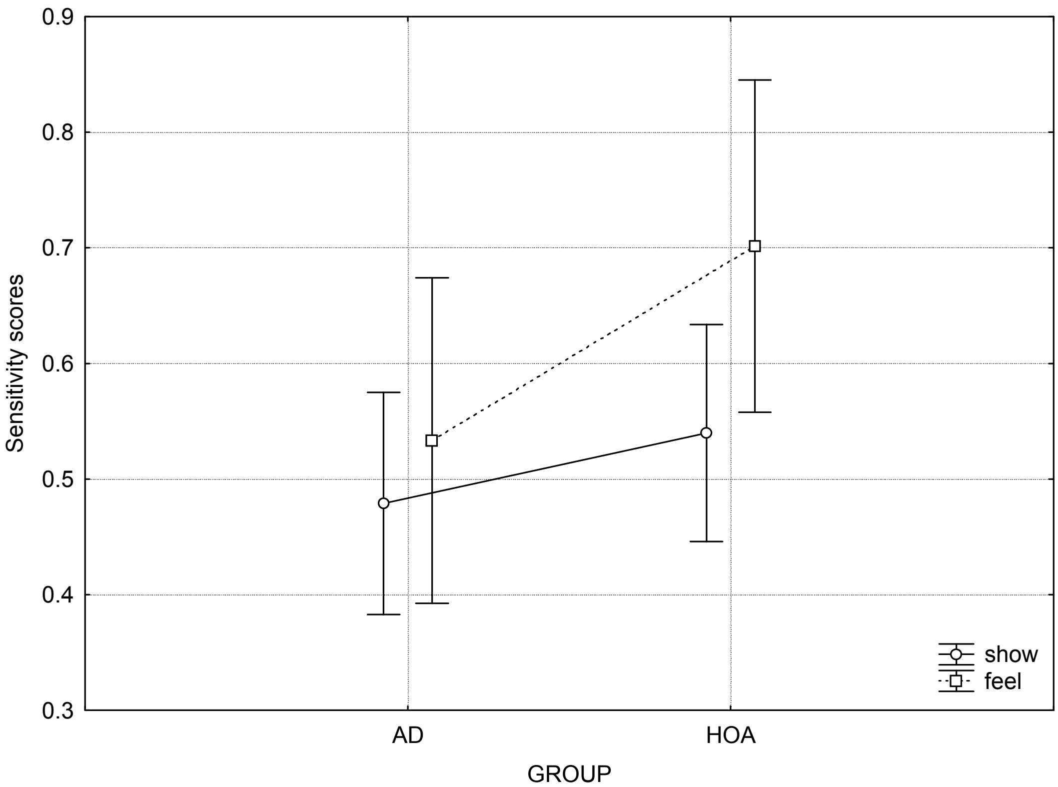

Figure 24. Sensitivity to the Difference between Posed and Genuine Expressions as a Function of Group for Each Condition

Post hoc tests (Tukey, $p < .05$) on the interaction compared sensitivity scores between conditions for each group and found no difference between the show and feel condition for the AD group ($M = .50$ & $.53$) while there was a significant difference for the healthy group ($M = .54$ & $.70$). In addition, the scores in each condition were compared between groups and revealed no difference in the show condition between the AD and healthy groups, however, sensitivity in the feel condition was higher for the healthy than the AD group.

In summary, aging did not effect sensitivity to emotion specified in facial expressions, nor did aging effect the ability to specifically distinguish posed from genuine expressions. In contrast, AD did effect the ability to detect emotion and in particular, the ability to distinguish posed from genuine expressions.

Judgment Response Time

Group Comparisons

To examine group differences in time taken to make judgments about facial displays in the categorization task a 3 (Group: HYA/HOA/AD) x 3 (Emotion: happy/sad/fear) x 2 (Condition: show/feel) x 3 (Expression: genuine/posed/neutral) ANOVA with repeated measures on the last three factors was conducted on response times. This revealed main effects of Group $F\,(2,49) = 23.70$, $p < .01$ $\eta_p^2 = .492$, Emotion $F\,(2,98) = 38.39$, $p < .01$, $\eta_p^2 = .439$, Condition $F\,(1,49) = 21.48$, $p < .01$, $\eta_p^2 = .305$ and Expression $F\,(2,98) = 14.50$, $p < .01$, $\eta_p^2 = .228$, as well as Condition by Expression $F\,(2,98) = 8.72$, $p < .01$, $\eta_p^2 = .151$, Emotion by Expression $F\,(4,196) = 7.01$, $p < .01$, $\eta_p^2 = .125$ and Condition by Emotion interactions $F\,(2,98) = 5.35$, $p < .01$, $\eta_p^2 = .098$ that were qualified by a three-way interaction

F (4,198) = 4.11, p < .01, η_p^2 = .077. A Group by Expression F (4,98) = 3.07, p < .01, η_p^2 = .111 interaction was also found as in shown in Figure 26.

Post hoc testing (Tukey, p < .05) on the Group by Expression interaction revealed there were significant differences between groups for each expression type. Specifically the healthy young group were faster than both the healthy older group and AD group when judging genuine (M = 1349 vs. 2729 & 2506 msec) posed (M = 1560 vs. 3112 & 3112 msec) and neutral expressions (M = 1300 vs. 2553 & 2965 msec). In addition, the differences between expressions for each group were compared. For the healthy young and older groups judgments were slower to posed than neutral expressions with no other differences reaching significance. For the AD there were no significant differences.

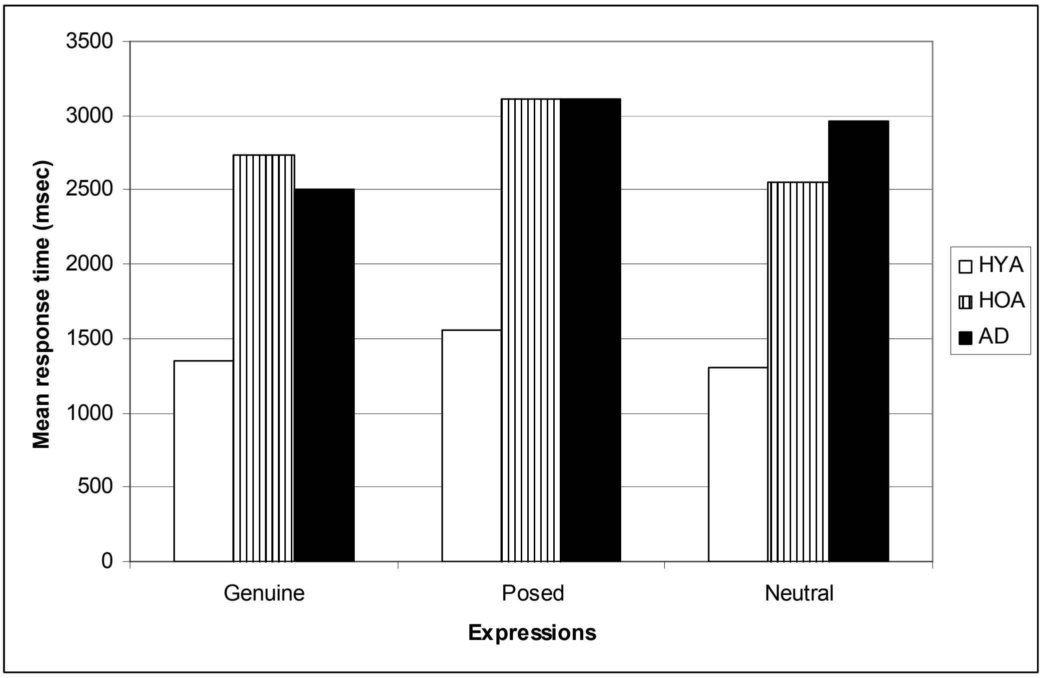

Figure 25. Mean Response Time to Make Judgments of Facial Displays as a Function of Group for Each Expression

The Priming Task

Group Comparisons

The priming tasks were conducted to investigate whether individuals would demonstrate an ability to differentiate between types of expressions (genuine, posed and neutral) without being explicitly instructed to attend to facial displays or to make explicit judgments.

Response times as a function of expression type were analysed and planned comparisons were performed to examine the effect of genuine happy compared to posed happy expressions on the time to identify positive words. Both posed and genuine expressions were also compared to neutral. Only the healthy young group demonstrated sensitivity to the difference between posed and genuine expressions by responding faster to positive words preceded by genuine primes than posed primes. It is noteworthy, however, that the healthy older group also revealed a significant difference. Healthy older adults were slower to respond to negative words preceded by genuine primes than posed primes. Genuine happiness appears to have facilitated quicker responding to congruent stimuli in healthy young adults and inhibited the response to incongruent stimuli in healthy older adults.

Planned comparisons also examined the effect of genuine sad compared to posed sad expressions on time to identify negative words. Both posed and genuine expressions were also compared to neutral. No group was sensitive to sadness as the response times did not differ as a result of any of the expression primes. The same pattern of results was found for fear in each group, that is, no group demonstrated sensitivity to fear emotion when engaged in the priming task.[27]

The groups differed in overall response latency. The AD group (*M* = 2049 msec) was slower than the healthy older group (*M* = 799 msec) which was slower than the healthy young group (*M* = 261 msec). Groups also differed in the number of errors that were made. The AD group made 25.2% errors compared to only 1.2% and 1.7% for the healthy young and older groups respectively. There was no evidence that the type of expression prime effected the error rate, thus, there is no evidence that the AD group were sensitive to the affective state of the targets.

In summary, each of the groups demonstrated they were sensitive to happiness and sadness specified in facial expressions, although individuals with AD were less sensitive than both healthy young and healthy older adults. Unlike the healthy participants, individuals with AD were not able to differentiate between posed and genuine expressions of happiness and sadness. The present research did not find that aging effected sensitivity to emotion as specified in facial expressions and healthy older adults were as sensitive as healthy young adults were.

[27] The first sample of healthy young adults was sensitive to fear in the priming task but this effect was not maintained when both samples of healthy young adults were combined to examine group differences.

CHAPTER 7

General Discussion and Conclusions

The present research investigated whether healthy young adults, healthy older adults and individuals with AD were sensitive to the emotional state of others as specified by their facial expressions. Knowing the affective state of an interaction partner is a fundamental aspect of successful communication and social interaction. Such knowledge can be used to better predict how others may behave and therefore how they should be interacted with. Facial expressions provide a highly visible source of affective information; however, facial expressions are not always a reliable source of this information, as it is not always advantageous for individuals to reveal such dispositional information.

Two tasks were employed in the present research - a categorization task and a priming task. In the categorization task participants had to identify each facial expression as either showing, or not and feeling, or not, the target emotion. The task was a modified form of a signal detection task and two measures of sensitivity were calculated. The first sensitivity measure assessed the extent to which participants were sensitive to the differences between faces that did and did not display felt emotion (i.e., differentiating genuine expressions from posed and neutral expressions). The second sensitivity measure assessed the extent to which participants were sensitive to the difference between posed and genuine expressions of each target emotion. In the priming task, participants categorized target words as being either positive or negative in valence. The words were preceded by a facial display. The priming task is based on emotional congruence. That is, recognition of the valence of the target words should be facilitated when preceded by a valence-congruent prime. Only genuine, and not posed expressions, convey emotion and, hence, can be emotionally congruent with the target words. Therefore, if participants spontaneously attended to the nature of the facial expression primes (which they were told to ignore) they would show facilitated identification of emotion-congruent words after genuine expression primes, relative to posed or neutral expression primes. In other words, positive words would be identified faster when preceded by genuine than posed expressions of happiness and negative words would be identified faster following exposure to genuine than posed expressions of sadness and fear.

The findings for each of the three participant groups have been discussed individually in the previous chapters, and some comparisons between groups were reported in Chapter 6. A recap of these findings is provided below including a discussion of the implications of these findings in terms of the understanding of the recognition of emotional states in others and the impact of aging and AD on the recognition of emotional states. Further consideration is given to the implications of these findings for the care and management of individuals with AD. Directions for future research are also considered.

The present research found that healthy young and healthy older adults, as well as individuals with AD were sensitive to happiness, sadness and fear emotion specified in facial expressions. That is, the results from the first sensitivity measure showed that these individuals could all reliably detect, at a level higher than expected by chance, whether targets were experiencing emotion or not by attending to their facial expressions. Specifically, individuals could differentiate expressions of emotional experience (genuine expressions) from the other facial expressions (posed and neutral expressions). Furthermore, the present research provided evidence that aging does not adversely influence sensitivity to emotion. Healthy older adults were not only sensitive to emotion at a level higher than expected by chance; there was no significant difference in the level of sensitivity between healthy young and healthy older adults. Although individuals with AD were also sensitive to the three target emotions at a level higher than expected by chance, they were significantly less sensitive than their healthy age-matched counterparts and the healthy young adults were.

The finding that young adults can differentiate expressions of emotional experience from other expressions is consistent with previous research that has demonstrated healthy young adults are sensitive to happiness specified in facial expressions (Miles, 2005; Miles & Johnston, 2007). The present research extended these findings and provided evidence that healthy young adults are also sensitive to sadness and fear specified in facial expressions and, furthermore, that healthy older adults and individuals with AD are sensitive to the three target emotions as well. These findings suggest that sensitivity to emotion specified in facial expressions is a robust skill unaffected by aging and largely maintained in AD despite the difficulties found relative to healthy individuals.

The lower sensitivity scores of individuals with AD were largely driven by an inability to reliably differentiate between posed and genuine expressions. That is, the results from the second measure of sensitivity showed that individuals with AD were not sensitive to the meaningful differences between posed and genuine expressions even when they were asked to directly attend to whether the targets were experiencing emotion or not. When making judgments they did not differentiate between the two types of facial expressions and identified that posed expressions specified the experiencing of emotion as often as genuine expressions did. In contrast, the present research found that both healthy young adults and healthy older adults were sensitive to the differences between posed and genuine expressions of happiness and sadness and therefore, they could reliably detect whether targets were experiencing happy and sad emotion or whether they were simulating the expression of such emotion. This suggests that they were sensitive to the meaningful differences between these two types of expressions and did not simply regard them as equivalent. It is worth noting that the healthy individuals were only sensitive to the differences between posed and genuine expressions in the feel condition, that is, they were sensitive when explicitly instructed to attend to the emotional state of the targets. It appears, therefore, that individuals need to focus on emotional experience before such sensitivity is manifest. None of the groups was sensitive to the different affective states underlying posed and genuine fear expressions. As discussed in Chapter 3 it may be that fear poses a risk to an individual that essentially outweighs the need to establish the veracity of fear expressions. The negative consequences of not detecting fear in the environment may see an individual adaptively consider even approximations of the emotional display as valid indicators of the underlying affective state. In contrast, the opportunity and concomitant consequences of being duped or manipulated by unauthentic fear is likely to be rare and trivial in comparison to not detecting authentic fear. Conversely, the opportunity and consequence of being duped by unauthentic happiness is likely to be relatively common in comparison to fear and can have stern consequences (approaching smiling but angry person), whereas not detecting happiness poses no immediate danger to the perceiver.

As with the first sensitivity measure, the particular focus of the present research was to establish whether aging and AD influenced sensitivity to the differences between posed and genuine expressions. The results showed that healthy aging does not influence sensitivity. Sensitivity scores on the second measure of sensitivity were not only significantly greater than chance level for the healthy older adult participants, but were no different from the sensitivity scores for the healthy young adults. In contrast, individuals with AD demonstrated impairment. Sensitivity scores for the AD participants did not differ from chance level, and they were significantly less sensitive than the healthy age-matched counterparts and healthy young adults were. These findings suggest that AD compromises sensitivity to the different emotional states underlying posed and genuine expressions. These difficulties cannot be explained by factors relating to aging, per se, as no age-effects were found, rather the difficulties are evident as a consequence of the AD illness.

Taken together the findings from the two measures of sensitivity suggest that there are some limitations with the sensitivity to emotion of individuals with AD that are not due to aging. When making judgments about genuine, posed and neutral expressions, individuals with AD could reliably detect whether emotion was present or absent, that is they could distinguish genuine expressions from posed and neutral expressions. However, when responses to neutral expressions were removed in the second sensitivity measure, as a means to directly compare the judgments made to just posed and genuine expressions, they did not systematically differentiate between these expressions. In contrast, the findings from the two measures of sensitivity also provides clear evidence that not only are healthy young and older adults sensitive to emotion specified in facial expressions and sensitive to the meaningful differences between posed and genuine expressions, there is no adverse influence of aging on this important aspect of social perception.

There is an important caveat to the conclusion that aging does not influence sensitivity to emotion, however, that was revealed when examining the time taken to make judgments about each of the facial expressions. The findings for each of the groups has been discussed in previous chapters, however, the key finding to emerge is that healthy older adults and individuals with AD were considerably slower than healthy young adults to make their judgments. Although it is common to find that older adults perform tasks more slowly than young adults do (e.g., Lindeboom & Weinstein, 2004; Myerson et al., 2007), the extra time taken to make judgments about the facial expressions in the categorization task indicates older adults have employed additional resources or relied on crucial resources for longer to complete the tasks.

Consideration of the results relating to response times is of particular relevance to the healthy older adults. The examination of sensitivity scores revealed no differences between healthy young and healthy older adults, however, reports of emotion perception deficits and associated social functioning difficulties suggest that differences exist that sensitivity scores do not capture. It is important to acknowledge that social interactions are dynamic exchanges that are often subject to temporal constraints. Being sensitive to emotion specified by facial expressions requires not only accurate judgments but also quick judgments (Bargh & Ferguson, 2000). Making judgments too slowly likely compromises the adaptive function of accurate social perception (Ambady, LaPlante, & Johnson, 2001; Bar, Neta, & Linz, 2006). For example, effective social communication requires that individuals interact in a reciprocal fashion; each interaction partner is attending to and adjusting their behavior in light of, amongst other factors, information about affective state. If an individual is unable to detect and, therefore, tailor their response to accommodate such information then there is an increased risk of miscommunication and less successful interactions (Adams, Ambady, Macrae, & Kleck, 2006; Boraston et al., 2007).

The slower response times of older compared to younger adults found in the present research might lead to these unsuccessful social interactions. Thus, while older adults can be sensitive to emotion via facial expression, the utility of such sensitivity in actual social interactions might be limited if they are too slow to detect affective information. Whether the additional resources that appear to have been relied upon in the present research would or could necessarily be employed outside the context of completing a measured task is unclear. Specifically, it is unclear whether older adults would take the extra time needed to make accurate judgments during social interactions in real life settings. The artificial nature of the experimental context might have motivated the older adults to spend more time making their judgments and this additional allocation of time resources might have improved the accuracy of their judgments. Future research is warranted to assess whether response time might influence sensitivity to emotion and whether such compensatory measures would be evident in situations outside the laboratory.

It is important to consider how the results of the present research align with the major findings of previous research investigating the influence of aging and AD on facial expression recognition. With regard to the healthy older adults, the present research is consistent with studies that report that the perception of happiness is maintained in older age (Calder et al., 2003; MacPherson et al., 2006; Phillips et al., 2002a; Sullivan & Ruffman, 2004a; Wong et al., 2005). Furthermore, the task employed to assess the perception of happiness in the present research involved making more subtle judgments than traditional facial expression recognition tasks and therefore avoided many of the constraints associated with interpreting results that included ceiling effects. No support was found, however, for the many studies that found that the perception of sadness poses difficulties for older adults (Calder et al., 2003; Keightley et al., 2006; MacPherson et al., 2006; Phillips, MacLean, & Allen, 2002b; Sullivan & Ruffman, 2004a; Suzuki et al., 2007; Wong et al., 2005). The healthy older adults showed no deficits regarding the perception of sadness compared to healthy young adults in the present research.

Some of the studies reviewed in Chapter 1 suggested that difficulties with the recognition of sadness reflect neurological changes due to aging that effect regions important for the identification of sadness (Calder et al., 2003; Sullivan & Ruffman, 2004a; Wong et al., 2005). The present research, however, suggests that despite any neurological changes associated with aging, older adults were in fact able to recognize sadness, and were able to differentiate between posed and genuine expressions of sadness. It may be that the previous research, which has employed different types of facial expressions and displayed them within very different experimental tasks than does the present research, has shown deficits that are a function of the task rather than a general deficit with the perception of sadness. For example, the additional task complexity inherent in traditional facial expression recognition tasks, together with the neurological changes in areas subserving sadness perception, might culminate in a specific deficit in the recognition of sad facial expressions; one that is not evident with other expressions subserved by more intact regions. Alternatively, it may be that the posed expressions employed, together with the neurological changes, might culminate to produce the difficulties shown in previous research. Posed facial expressions might require that mental processes be invoked to take information that is representational and treat it as if it were indicative of emotion. Poor performance in previous research, like that found for sad and not disgust, for example, might only manifest when the mental processes required involves facial expressions linked to areas compromised by age. In contrast, the simplicity of the tasks and the ecological validity of the expressions used in the present research might not stretch the regions or networks that subserve the perception of sadness, and which, have been compromised by aging.

The findings relating to AD, specifically the finding that individuals with AD are sensitive to emotion, are consistent with several studies showing individuals with AD maintain the ability to recognise facial expressions (Bucks & Radford, 2004; Burnham & Hogervorst, 2004; Fernandez-Duque & Black, 2005; Lavenu et al., 1999; Ogrocki et al., 2000). Whereas the previous research has focused on the recognition of facial expressions, the present research has provided evidence that emotion perception via facial expressions is maintained in AD. Several previous studies, however, have concluded that impairments exist because individuals with AD performed significantly less well than healthy control participants did (Allender & Kaszniak, 1989; Hargrave et al., 2002; Kohler et al., 2005). While the present research also finds this to be the case, it is argued that sensitivity is maintained, given individuals with AD were more sensitive than expected by chance. Rather the present research suggests that the sensitivity of individuals with AD is limited by a lack of specific sensitivity to the meaningful differences between posed and genuine expressions.

The lack of sensitivity to the specific differences between these expressions may be explained by the way in which individuals with AD attend to the face. Individuals with AD have previously been shown to scan facial expressions differently than healthy controls (Ogrocki et al., 2000). For example, individuals with AD focused less on the face and in particular the eye region than did healthy older adults when involved in a facial expression recognition task. They were also found to spend more time looking at irrelevant areas of the face than healthy older adults did (Ogrocki et al., 2000). A tendency to not fixate sufficiently on the eye region would seriously limit any attempt to detect the differences between posed and genuine facial expressions, in particular, as the physiognomic differences between these two types of expressions are most evident in the muscle movement around the eye region. For example, the Duchenne marker specifying felt happiness is evident only with fixation on the eye region.

Findings of a specific deficit in the ability to differentiate between posed and genuine expressions might also be explained by fewer opportunities to practice and maintain the skill. Individuals with AD have less opportunity for social interactions (Mackenzie, 2006) and likely are less motivated to engage fully in social interactions. This is consistent with the level of apathy that is often associated with AD (Mizrahi & Starkstein, 2007; Weiner, Hynan, Bret, & White, 2005). Without suitable stimulation, the ability to detect the more subtle aspects of facial expressions like the difference between posed and genuine expressions may deteriorate and this requires further investigation. Encouragement toward continued social interactions would benefit individuals for whom there is likely a lack of self-directed interest.

The present research also aimed to investigate the spontaneity of individuals' sensitivity to emotion. In other words, the present research sought to establish if individuals 'do' detect the meaningful differences between different types of facial expressions rather than just 'could' they. The results from the categorization task provided evidence that individuals could be sensitive to emotion when explicitly instructed to attend to the target and the experience of emotion, but of particular interest was whether individuals do attend to the target and the experience of emotion without such explicit instruction. To this end, a priming task was employed and the findings suggest that only healthy young adults spontaneously attended to the different emotions underlying posed and genuine expressions. Specifically, they responded faster to positive words preceded by congruent positive facial expressions (genuine happy expressions) than incongruent facial expressions (posed happy expressions). Neither healthy older adults nor individuals with AD demonstrated they were sensitive to emotion spontaneously when engaged in a task that did not require them to make explicit judgments about whether others were experiencing emotion. That is, without the explicit instruction to attend to targets and attend to whether they were experiencing emotion, the older adults did not appear to differentiate between expressions that specified emotion and expressions that did not.

These findings can be interpreted as indicative of a limitation in sensitivity to emotion specified in facial expressions in older age and AD. It may well be that the sensitivity demonstrated in the categorization task was achieved only through explicit instruction to first attend to the emotional states of the targets. This finding and such a conclusion could have implications for the actual social interactions of older adults and individuals with AD. They may, for example, have no difficulties confirming whether someone is feeling sad via their facial expression when prompted by other, perhaps verbal cues, to take particular notice, but may not be sensitive without such prompts. Such prompts, however, rarely occur during social interactions. It is important for successful social interaction that individuals spontaneously attend to the affective state of interaction partners. Any factors, such as a lack of self-directed focus toward affective information that might lead to less successful social interactions, are likely to lead to less frequent social interactions. A variety of research has found such a consequence then impacts on quality of life (Arthur, 2006; Cavallero et al., 2007; Deary et al., 2007; Li & Liang, 2007).

The contribution of social perception deficits to difficulties with social interactions is likely to be more acute in the AD population given the concomitant difficulties with cognitive functioning and other behavioral disruptions that also adversely effect social interactions. That is, social interactions, in general, can be impeded by other cognitive and behavioral functions as well as social perception deficits. Those individuals with cognitive as well as social/emotion perception deficits are likely to experience more severe disruptions in their social interactions. Attempts at communicating how one is feeling should perhaps involve multi-modal channels of expression and directed encouragement to attend to this information. It is likely that the communication of emotional experience to individuals with specific difficulties is enhanced by the effort to integrate information from more than one mode of expression (Flom & Bahrick, 2007).

Another novel finding of the present research was that sensitivity to emotion was found to be emotion specific rather than a generalized skill that was applied or demonstrated across the three target emotions. Individuals appear to be selectively sensitive to specific emotions, as there were no consistent relationships found across emotions. In other words, when considering the emotional state of the targets, those who were more sensitive to one emotion, for example happiness, were not likely to be the ones more sensitive to both sadness and fear. This suggests that individuals do not develop a general sensitivity to emotion but rather develop specific sensitivities to some emotions more than others develop. These findings are consistent with many previous findings from behavioral and imaging research that suggests the ability to identify facial expressions, as investigated by traditional facial expression recognition tasks, is an emotion specific skill (for reviews see Calder & Young, 2005; Vuilleumier & Pourtois, 2007). This is underpinned by the findings that disparate neural substrates underlie the perception of different emotions.

The finding that sensitivity to emotion is specific is also consistent with an experiential explanation, however, in so far as, individuals become more sensitive to some emotions because of their direct experience with some emotions more than others. For example, the unique environment of different individuals may not offer as much opportunity to develop sensitivity to some emotions compared to others. Individuals who have more experience or are highly motivated to differentiate between genuine (spontaneous) and posed (deliberate) facial expressions of happiness, for instance, do not necessarily also encounter the same opportunities or have the same investment in detecting such differences in sad expressions and vice-versa.

Another aim of the present research was to investigate the relationship between sensitivity to emotion specified in facial expressions and cognitive functions. Specifically, the aim was to identify which aspects, if any, of cognitive functioning were associated with this specific social perception skill. Several studies examining facial expressions recognition in AD have attributed poor performance to the general cognitive decline associated with the disease

(Albert et al., 1991; Bucks & Radford, 2004; Koff et al., 1999; Kohler et al., 2005; Roudier et al., 1998). However, the nature of the relationship between cognitive functions and perception of emotion was unclear. Again, the findings for each group are reported in previous chapters but it is noteworthy, given the associations previously found between cognitive functions and emotion perception, that when each group of individuals was considering the felt state of targets their sensitivity to emotion was not related to their level of functioning in any particular cognitive domain. That is, sensitivity to emotion specified in facial expressions was not related to working memory, episodic memory, semantic memory, attention, executive functions or visuoperception.

The finding that sensitivity to emotion is not related to cognitive functions is consistent with only a few previous studies that have shown that the ability to recognize facial expressions is a discrete skill unrelated to cognitive functions (Allender & Kaszniak, 1989; Hargrave et al., 2002; Maurage, Campanella, Philippot, Martin, & de Timary, 2008). The majority of published studies find that deficits in facial expression recognition are either accounted for by, or are related to, the general level of cognitive functioning of populations of interest. The identification of a relationship between cognitive functioning and facial expression recognition, however, may reflect that cognitive resources are more keenly required to complete traditional facial expression recognition tasks than are required during the tasks employed in the present research. The identification tasks employed in traditional facial expression recognition tests, for example, often require the participant to remember the verbal options provided, or when a printed list of response options is provided, the participant must still consider and be cognizant of the relative merits of each option. The cognitive skills required to complete such a task arguably overshadow or even interfere with emotion recognition. In contrast, the categorization task employed in the present research requires the participant to simply attend to the emotional state of the target and indicate whether emotional experience is present or absent. Reducing the need to recruit cognitive resources when completing an emotion perception task might reduce the interdependence of these functions and highlight the disparate nature of cognitive functioning and emotion perception.

One of the major findings of the present research that has been highlighted is that sensitivity to emotion is maintained in AD. The maintenance of the ability to detect whether emotion is being experienced by attending to facial expressions has important implications for the care and management of individuals with AD. Caregivers and people involved in the assessment and management of AD patients needs should be aware that although individuals with AD may be less responsive to the attempts to communicate with them, they are likely to still maintain the robust skill of detecting whether emotion is being experienced. Many studies have highlighted the frustrations and stresses associated with providing care for those with AD (Connell, Janevic, & Gallant, 2001; Covinsky et al., 2003; Hubbell & Hubbell, 2002) and specifically the challenges involved with social interactions (Gallagher-Thompson, Dal Canto, Jacob, & Thompson, 2001). These situations can lead to the experience of a variety of negative emotions that are likely displayed in facial expressions and therefore are likely to be perceived by individuals with AD. Frequently perceiving the negative emotional experiences of other people can have a detrimental effect on the mood of AD individuals (Goodman & Shippy, 2002; Joiner, 1994), particularly when there is still an awareness of the antecedent events and individuals with AD might perhaps feel like the cause of such experiences.

However, the present research also found that despite sensitivity largely being maintained there is a specific limitation, in so far as, individuals with AD have difficulty telling posed expressions apart from genuine expressions. This too can have implications, because as well as the consequences of inaccurate emotion perception, such as approaching the smiling but angry person, individuals with AD are also vulnerable to deception. Individuals with AD might accept all facial expressions at face value, so to speak, and miss the opportunity to detect when an interaction partner has decoupled their affective experience from their facial expressions. Specifically, for example, an individual with AD might erroneously accept an interaction partner as friendly, likeable and trustworthy when they display posed smiles that do not actually specify such attributes.

As mentioned already, individuals with AD should be encouraged to continue participating in social interactions, not only to achieve the many benefits that social interaction has on quality of life and cognitive functioning, but also as a means to offer remediation to emotion perception skills through practice. Several studies have shown the benefit of more formal training strategies in the remediation of deficits in emotion perception in a variety of other clinical populations such as autism (Solomon, Goodlin-Jones, & Anders, 2004), intellectual disability (McAlpine, Singh, Ellis, Kendall, & Hampton, 1992) and schizophrenia (Combs et al., 2007; Combs, Tosheva, Wanner, & Basso, 2006). There are obvious differences between these groups and AD, particularly regarding the ability to learn new information, however, such examples provide insight into the feasibility of remediation and highlight the functional gains that can be made. Remediation that involves re-learning to focus more on the eye region of the face as well as discrimination training to differentiate examples of posed and genuine expressions might result in improved sensitivity to emotion in facial expressions. Any improvement in sensitivity to emotion is likely to improve social interactions and social functioning as well as reduce the risks associated with misperceptions. A behavioral approach to raise the operant level of verbal behaviors and re-establish verbal communication has been somewhat successful even with individuals with severe AD (Henry & Horne, 2000).

The findings that sensitivity to the difference between posed and genuine expressions was not related to cognitive functioning and that such sensitivity is unaffected by healthy aging suggests that difficulties in this social perception skill might be a specific sequelae of AD and one worthy of consideration as a potential early social behavior marker of AD. Delaying the onset of AD by five years would result in half the number of cases worldwide (Kawas & Corrada, 2006; Plassman et al., 2007). Given there is evidence that degeneration begins years before the emergence of clinical signs (e.g., Bondi et al., 2008), the reasonably long prodromal period provides the opportunity to detect initial changes that might distinguish pre-clinical AD from normal aging. Early detection has implications for early treatment and allows individuals with AD and their families more quality time to understand and prepare for the illness. There is a vast literature of research that has investigated the early cognitive changes that are sensitive to AD as a means to better identify preclinical AD patients (for reviews see Bondi et al., 2008; Grossman et al., 2006). Recent conclusions suggest the utility of cognitive markers is limited given there is a substantial overlap in scores between individuals who will and will not be diagnosed with AD (Backman & Small, 2007). Consequently, it is suggested that other markers such as social markers should be included in profiles as indicators to increase accuracy (Backman & Small, 2007). The utility of a test to distinguish posed from genuine facial expressions is worthy of further consideration and future research effort, especially given the need to develop measures that have high face validity and offer novelty to difficult to engage populations.

The small sample size of the AD group in the present research limits the confidence one can have when generalizing the reported findings. However, the effect sizes found, when comparing individuals with AD to matched controls were large and therefore there was sufficient power in the present research. Larger sample sizes would be preferable, however, and would allow for the identification of subgroups of individuals with AD. AD is a relatively heterogeneous disease, in which the clinical presentation and neuropsychological profiles can vary considerably. Few studies examining facial expression recognition have identified, for example, predominantly right and left hemisphere impaired AD groups (Cadieux & Greve, 1997). Cadieux and Greve (1997) report that different patterns of performance were seen as a function of which hemisphere was predominantly impaired. Given the hemispheric advantages often reported in relation to emotion perception, future research would benefit from any attempt to consider such variance to improve the assignment of participants to more homogeneous groups.

Of particular relevance for future research is to examine the differential performance of individuals with various types of neurodegenerative diseases and different types of dementia in particular. Research looking at the differences in facial expression recognition between AD and Fronto-temporal dementia (FTD), for instance, cite comparable levels of cognitive decline yet show more impairment in expression recognition by participants with FTD than AD. Traditional measures of facial expression recognition might tap into aspects of cognitive functioning that are also more keenly effected in FTD than AD. That is, despite similar levels of general cognitive function, the cognitive impairments associated with FTD more so than AD might be more heavily recruited during the completion of traditional facial expression recognition tasks. An investigation of emotion perception employing a methodology similar to the present research is warranted to establish if differences between dementia types exist in the sensitivity to emotion specified in facial expressions.

Furthermore, future research is needed to more fully examine the influence sensitivity to emotion has on subsequent behavior. Miles (2005) reported that healthy young individuals were more likely to cooperate with interaction partners expressing genuine than posed smiles, and hence, empirically demonstrated a functional role of sensitivity to smile veracity within social interaction. Similar future research is required to empirically demonstrate the behavioral outcomes associated with the accurate perception of the emotional state specified by posed and genuine expressions of negative expressions also. It is important to understand more about the consequences of accurate social perception so that better predictions can be made about the types of behaviors that result from inaccurate social perceptions.

In conclusion, the present research provided one of few empirical investigations of emotion perception that has employed ecologically valid facial expressions. Each of the facial displays generated specifically for the present research provided the participant with information about whether emotion was being experienced or not by the targets from whom they were asked to make affective judgments. By providing individuals with information that did or did not specify emotion, the present research was able to offer empirical evidence that individuals are sensitive to sadness and fear specified in facial expressions as well as support previous findings relating to happiness. Furthermore, the present research has contributed to our understanding of the influence of aging on emotion perception by revealing that healthy older adults are as sensitive as healthy younger adults are to the underlying affective state of interaction partners. The limitation inherent in making slower judgments was identified and the present research highlights this as a pertinent area for future research. In addition, the present research extended our knowledge about the influence of AD on emotion perception. Individuals with AD continue to be sensitive to emotion specified in facial expressions, although the AD illness does adversely effect such sensitivity. Their sensitivity is limited by an inability to reliably detect the meaningful distinctions between posed and genuine expressions. The present research also provided novel evidence that sensitivity to emotion is emotion specific and unrelated to cognitive functions. It is argued therefore that the methodology employed in the present research offers the opportunity to investigate a specific aspect of social functioning that is more indicative of emotion perception than cognitive functioning.

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Appendix A: Normative Ratings for IADS and IAPS Stimuli

IADS Ratings

	No.	Pleasure *M*	Pleasure *SD*	Arousal *M*	Arousal *SD*	Dominance *M*	Dominance *SD*
Walking	722	4.15	1.28	5.43	1.90	4.30	1.81
FemScream2	276	1.91	1.49	7.74	1.64	2.60	1.98
PuppyCry	105	4.76	2.72	5.44	2.17	4.86	2.15
BabyCry	261	2.84	1.61	6.49	1.66	3.77	2.16
Victim	286	2.03	1.34	7.35	1.67	2.47	1.72
CarWreck	424	1.95	1.61	7.82	1.56	2.16	1.72
BikeWreck	600	1.94	1.40	7.68	1.52	2.39	1.81
BabyLaugh	110	7.92	1.55	6.04	2.08	6.65	1.90
EroticFem1	201	7.84	1.52	7.36	1.74	6.57	2.15
ClockTick	708	4.38	1.28	4.56	2.07	4.65	1.85
TypeWriter	322	4.42	1.46	4.51	1.80	5.20	1.78

IAPS (female) Ratings

	No.	Pleasure *M*	Pleasure *SD*	Arousal *M*	Arousal *SD*	Dominance *M*	Dominance *SD*
Tumor	3261	1.70	1.43	5.92	2.60	3.52	2.35
Baby	2661	4.46	2.72	6.27	2.06	4.13	1.88
SadChild	2800	1.41	0.79	5.87	2.13	2.99	2.18
Infant	3350	1.76	1.72	5.78	2.21	3.28	2.50
DisabledChild	3300	2.35	1.30	4.96	1.98	4.57	1.79
Mug	7009	4.89	0.96	3.26	1.96	6.51	2.10
Checkerboard	7182	5.03	1.38	4.02	2.11	5.35	2.06
AttractiveMan	4572	7.52	1.37	6.30	1.78	6.21	2.32
EroticMale	4561	6.10	2.00	5.90	2.27	5.10	1.78
Women	1340	7.63	1.52	5.25	2.24	5.85	1.75
Monkies	1811	7.95	1.51	5.21	2.57	6.10	1.71
Adult	2020	5.97	2.13	3.41	2.01	5.64	1.77
Attack	6550	2.08	1.90	7.20	1.83	2.55	2.28
Spider	1205	3.22	1.62	5.94	2.22	3.72	2.15
Mutilation	3060	1.66	1.71	7.34	2.10	2.88	2.26

Appendix B: Example from the Response Sheet: Facial Expression Generation

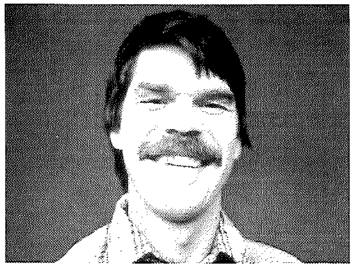
Please circle the ONE label that best describes how you felt while looking at the photo.
If you circle any label other than neutral, please mark the strength of your reaction.

Happy Fear Angry Sad Neutral Disgust Surprise

Mild Moderate High

Fear Angry Neutral Happy Sad Disgust Surprise

Mild Moderate High



Happy Neutral Surprise Disgust Sad Fear Angry

Mild Moderate High

Angry Sad Fear Happy Disgust Surprise Neutral

Mild Moderate High

Appendix C: Information Sheet: Facial Expression Generation

University of Canterbury
Department of Psychology

Information Sheet: Reactions to video clips: a pilot study

You are invited to take part as a participant in a pilot study looking at people's reactions to a variety of film material.

In this study, we are asking people to evaluate some video clips and we would like to record people's reactions to these video clips. It is important for our research that we record people's natural responses to the video clips, so that we can then judge whether this process will be used in future research.

You will be alone in the experimental room while you watch the video clips and you will be asked to look into the video camera as much as possible. As this is a pilot study, we will be showing you a number of different types of video clips. Some of these clips may appear to be bland and will not elicit any obvious reaction – this is fine! The reactions elicited will vary from person to person. For example, what somebody finds funny another person might find slightly embarrassing. We have no prior expectations about how any of our video clips will elicit reactions in viewers, so don't think about your reactions until we ask you some specific questions. Just relax and enjoy watching the videos!

The second time you watch the video clips you will be asked to answer some questions about each one, including your own reactions to the clip. Again, remember that different things influence people in different ways, so do not worry about how you are responding, just answer the questions as you feel is appropriate for you.

Our research is concerned only with reactions to everyday situations. Consequently, there is no intention to expose participants in this project to material likely to produce extreme reactions. However, you are of course free to discuss your reactions or the video material with the experimenter and you are free to stop being involved in the study at any point. If so, please just indicate this to the experimenter by coming out of the experimental room – the experimenter will be in the adjacent room.

It is estimated that your participation in this project will take approximately 60 minutes. As a participant in this project, you have the right to withdraw at any time including the withdrawal of any information you provide.

The results of this research may be published, but you will not at any stage be identified as a participant. You will be provided with a further opportunity at the completion of this project to consider whether you wish to give permission for your information to be used in future research, and therefore, any subsequent publication.

This project is being conducted at the University of Canterbury, under the supervision of Dr Lucy Johnston and Dr John Dalrymple-Alford of the University of Canterbury and Dr Richard Porter of the University of Otago, Christchurch School of Medicine. If you have any questions or concerns about participation in this project please feel free to contact Tracey McLellan (03) 3642987, ext. 7704 or alternatively Dr Lucy Johnston ext. 6967 or Dr John Dalrymple-Alford ext. 6998.

The project has been reviewed and approved by the University of Canterbury Human Ethics Committee

Appendix D: Summary of the Procedure used to Generate Facial Expressions

Block 1	Task	Relax	
	IADS	Clock tick (708)	
		Typewriter (322)	
	IAPS	Tumor (3261)	
		Baby (2661)	
		Sad child (2800)	
		Infant (3350)	
		Disabled child (3300)	
		Mug (7009)	
		Checkerboard (7182)	
	Task	Task Passport photo	
		ID card	
	IAPS	Attractive man (4572)	
		Erotic male (4561)	
		Women (1340)	
		Monkeys (1811)	
		Adult (2020)	
		Attack (6550)	
		Spider (1205)	
		Mutilation (3060)	
	Task	Pretend sad	
		Pretend fearful	Reaction sheet
Block 2	Task	Sing National Anthem	
		Stop	
		Permission to show tape	
		Stop	
Confederate stimuli		Fake sad reaction to blank slide	
		Fake fearful reaction to blank slide	
		Fake disgust reaction to blank slide	
	Scenario	Display sad face	
		Display frightened face	Reaction check
	Sad song	Think about sad event	Confirm reaction
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	
		Female scream (276)	
		Puppy cry (105)	
		Baby cry (261)	
		Victim(286)	
		Car wreck (424)	
		Bike wreck (600)	
		Baby laugh (110)	
		Erotic female (201)	Reaction sheet
	Task	Relaxation	
	IADS	Clock tick (708)	
		Typewriter (322)	
	Task	Pose a sad face	
		Pose a fearful face	
		Smile for a licence photo	Reaction sheet

Appendix E: Debriefing Sheet and Consent Form: Facial Expression Generation

University of Canterbury
Department of Psychology

Debriefing sheet: Reactions to video clips: a pilot study

Thank you for being involved in this project. You have been told that you were involved in a pilot study designed to evaluate which video clips were good at producing a reaction in people. Although this was one purpose of the study, we also wanted to capture genuine facial expressions of emotion on videotape for use in future studies. To enable us to do this, we did not initially disclose the full aims of the project when you were invited to participate. This omission was necessary, as participants are often inhibited in their expression of emotion if they experience any pressure to display specific emotions.

Your ratings of how you felt after watching each of the video clips and participating in the tasks will be useful in allowing us to identify the various emotions elicited. The video footage produced in this study and the still shots taken from this footage will be used in various projects relating to the investigation of emotion processing. Subsequent work will involve showing the posed and genuine expressions of emotion to participant groups and looking at how sensitive people are to the differences.

Now that you are aware of the real aim of the project, we would like you to consider whether you still wish to be involved and have your facial expressions used in our future studies. If you would like to continue in the project, please provide informed consent for the use of any video footage and photographs for future research. No identifying information about you will be attached to your photos. Of course, you may still choose to withdraw your photos at any time.

If you do not feel comfortable with your image being used in future research, we will permanently remove your video footage as soon as possible. In this case, we thank you very much for your participation today and ask you to indicate your decision by completing the appropriate response on the attached consent form.

If you have any questions regarding this information or any concerns arising from your participation in this project, please feel free to ask the researcher. You may also contact any of the following people by telephone (03) 364 2987, Tracey McLellan, ext. 7704, Dr Lucy Johnston, ext. 6967 or Dr John Dalrymple-Alford, ext. 6998.

Consent form

Generation of stimulus material for use in research examining the differentiation of posed and genuine facial expressions of emotion.

Introduced as:
Reactions to video clips: a pilot study

I have read and understood the description of the above-named project. On this basis, I agree to continue as a participant in this project and am willing to be included as a model in the resulting facial expression series. I understand that the facial expression series will be shown to others for the purpose of future research and I consent to publication of the results of this project with the understanding that no identifying information will be attached to my image.

I understand that I may at any time withdraw from the project, including withdrawal of any information I have provided.

NAME (please print):…………………………………………………….

Signature:

Date:

I have read and understood the description of the above-named project. I do not wish to continue as a participant in this project and I do not consent to the use of my photographs for future research. I understand that by choosing not to continue in this project, the information I have already provided will be destroyed as soon as possible.

NAME (please print):…………………………………………………….

Signature:

Date:

Appendix F: Summary of the Affective Responses of Targets used in the Present Research

Participant 3

			Affect/intensity
Block 1	Task	Relax	
	IADS	**Clock tick (708)**[28]	**neutral**
		Typewriter (322)	neutral
	IAPS	Tumor (3261)	disgust (H)
		Baby (2661)	neutral
		Sad child (2800)	sad (M)
		Infant (3350)	sad(H)
		Disabled child (3300)	sad (H)
		Mug (7009)	neutral
		Checkerboard (7182)	neutral
	Task	**Task Passport photo**	**neutral**
		ID card	happy (L)
	IAPS	Attractive man (4572)	surprise (L)
		Erotic male (4561)	surprise (H)
		Women (1340)	happy (H)
		Monkeys (1811)	**happy (H)**
		Adult (2020)	happy (H)
		Attack (6550)	neutral
		Spider (1205)	neutral
		Mutilation (3060)	disgust (H)
	Task	Pretend sad	happy (L)
		Pretend fearful	neutral
Block 2	Task	Sing National Anthem	surprise
		Stop	neutral
		Permission to show tape	surprise
		Stop	neutral
	Confederate stimuli	Fake sad reaction-blank slide	-
		Fake fearful reaction-blank slide	-
		Fake disgust reaction-blank slide	happy (L)
	Scenario	Display sad face	neutral
		Display frightened face	-
	Sad song	Think about sad event	sad(M)
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	fear (L)
		Female scream (276)	fear (H)
		Puppy cry (105)	neutral
		Baby cry (261)	sad (L)
		Victim(286)	anger (L)
		Car wreck (424)	fear (L)
		Bike wreck (600)	fear (L)
		Baby laugh (110)	happy (H)
		Erotic female (201)	happy (M)
	Task	Relaxation	
	IADS	Clock tick (708)	-
		Typewriter (322)	neutral
	Task	Pose a sad face	neutral
		Pose a fearful face	happy
		Smile for a licence photo	neutral

[28] The facial expressions elicited to stimuli in bold were selected for use in the present research.

Participant 4

			Affect/intensity
Block 1	Task	Relax	
	IADS	Clock tick (708)	-
		Typewriter (322)	-
	IAPS	Tumor (3261)	disgust (H)
		Baby (2661)	sad (M)
		Sad child (2800)	sad (H)
		Infant (3350)	sad (M)
		Disabled child (3300)	neutral
		Mug (7009)	neutral
		Checkerboard (7182)	neutral
	Task	**Task Passport photo**	**neutral**
		ID card	neutral
	IAPS	Attractive man (4572)	happy (H)
		Erotic male (4561)	surprise (M)
		Women (1340)	happy (H)
		Monkeys (1811)	happy (L)
		Adult (2020)	neutral
		Attack (6550)	fear (M)
		Spider (1205)	happy (L)
		Mutilation (3060)	disgust (H)
	Task	**Pretend sad**	**neutral**
		Pretend fearful	neutral
Block 2	Task	Sing National Anthem	surprise (M)
		Stop	neutral
		Permission to use tape	neutral
		Stop	neutral
	Confederate stimuli	Fake sad reaction-blank slide	neutral
		Fake fearful reaction-blank slide	neutral
		Fake disgust reaction-blank slide	happy
	Scenario	Display sad face	neutral
		Display frightened face	neutral
	Sad song	**Think about sad event**	**sad (H)**
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	fear (L)
		Female scream (276)	**fear (M)**
		Puppy cry (105)	neutral
		Baby cry (261)	neutral
		Victim(286)	surprise (M)
		Car wreck (424)	disgust (M)
		Bike wreck (600)	disgust (M)
		Baby laugh (110)	**happy (H)**
		Erotic female (201)	happy (H)
	Task	Relaxation	
	IADS	Clock tick (708)	surprise (L)
		Typewriter (322)	neutral
	Task	Pose a sad face	neutral
		Pose a fearful face	**neutral**
		Smile for a licence photo	neutral

Participant 5

			Affect/intensity
Block 1	Task	Relax	
	IADS	Clock tick (708)	happy(L)
		Typewriter (322)	neutral
	IAPS	Tumor (3261)	neutral
		Baby (2661)	sad (L)
		Sad child (2800)	sad (L)
		Infant (3350)	sad (M)
		Disabled child (3300)	neutral
		Mug (7009)	neutral
		Checkerboard (7182)	neutral
	Task	**Task Passport photo**	**neutral**
		ID card	neutral
	IAPS	**Attractive man (4572)**	**happy (H)**
		Erotic male (4561)	happy (H)
		Women (1340)	happy (H)
		Monkeys (1811)	happy (H)
		Adult (2020)	happy (L)
		Attack (6550)	fear (M)
			Spider (1205) neutral
		Mutilation (3060)	neutral
	Task	Pretend sad	neutral
		Pretend fearful	neutral
Block 2	Task	Sing National Anthem	-
		Stop	neutral
		Permission to use tape	neutral
		Stop	neutral
	Confederate stimuli	Fake sad reaction-blank slide	neutral
		Fake fearful reaction-blank slide	happy
		Fake disgust reaction-blank slide	neutral
	Scenario	Display sad face	neutral
		Display frightened face	neutral
	Sad song	Think about sad event	sad (H)
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	neutral
		Female scream (276)	fear (H)
		Puppy cry (105)	neutral
		Baby cry (261)	fear (L)
		Victim(286)	surprise (L)
		Car wreck (424)	fear/surprise (L)
		Bike wreck (600)	surprise (M)
		Baby laugh (110)	happy (H)
		Erotic female (201)	happy (M)
	Task	Relaxation	
	IADS	Clock tick (708)	neutral
		Typewriter (322)	**neutral**
	Task	Pose a sad face	sad (L)
		Pose a fearful face	neutral
		Smile for a licence photo	neutral

Participant 6

			Affect/intensity
Block 1	Task	Relax	
	IADS	Clock tick (708)	neutral
		Typewriter (322)	neutral
	IAPS	Tumor (3261)	disgust (H)
		Baby (2661)	neutral
		Sad child (2800)	sad (M)
		Infant (3350)	sad (M)
		Disabled child (3300)	surprise (L)
		Mug (7009)	neutral
		Checkerboard (7182)	**neutral**
	Task	Task Passport photo	neutral
		ID card	happy (L)
	IAPS	Attractive man (4572)	neutral
		Erotic male (4561)	happy (M)
		Women (1340)	happy (M)
		Monkeys (1811)	happy (L)
		Adult (2020)	neutral
		Attack (6550)	anger (M)
		Spider (1205)	fear (M)
		Mutilation (3060)	surprise (M)
	Task	Pretend sad	neutral
		Pretend fearful	neutral
Block 2	Task	Sing National Anthem	surprise (L)
		Stop	happy (M)
		Permission to use tape	neutral
		Stop	neutral
	Confederate stimuli	Fake sad reaction-blank slide	neutral
		Fake fearful reaction-blank slide	neutral
		Fake disgust reaction-blank slide	neutral
	Scenario	Display sad face	neutral
		Display frightened face	neutral
	Sad song	Think about sad event	sad (M)
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	neutral
		Female scream (276)	**fear (H)**
		Puppy cry (105)	sad (L)
		Baby cry (261)	anger (L)
		Victim(286)	sad (L)
		Car wreck (424)	fear (L)
		Bike wreck (600)	surprise (L)
		Baby laugh (110)	neutral
		Erotic female (201)	neutral
	Task	Relaxation	
	IADS	Clock tick (708)	neutral
		Typewriter (322)	neutral
	Task	Pose a sad face	neutral
		Pose a fearful face	**neutral**
		Smile for a licence photo	neutral

Participant 7

			Affect/intensity
Block 1	Task	Relax	
	IADS	Clock tick (708)	surprise (L)
		Typewriter (322)	**neutral**
	IAPS	Tumor (3261)	disgust (H)
		Baby (2661)	neutral
		Sad child (2800)	sad (L)
		Infant (3350)	sad (M)
		Disabled child (3300)	neutral
		Mug (7009)	neutral
		Checkerboard (7182)	neutral
		Task	Passport photo
	neutral		
		ID card	**neutral**
	IAPS	Attractive man (4572)	neutral
		Erotic male (4561)	surprise (L)
		Women (1340)	happy (M)
		Monkeys (1811)	happy (M)
		Adult (2020)	surprise (L)
		Attack (6550)	disgust (L)
		Spider (1205)	neutral
		Mutilation (3060)	disgust (M)
	Task	Pretend sad	neutral
		Pretend fearful	happy (L)
Block 2	Task	Sing National Anthem	fear (M)
		Stop	happy (H)
		Permission to use tape	neutral
		Stop	neutral
	Confederate stimuli	**Fake sad reaction-blank slide**	**neutral**
		Fake fearful reaction-blank slide	neutral
		Fake disgust reaction-blank slide	-
	Scenario	Display sad face	neutral
		Display frightened face	neutral
	Sad song	**Think about sad event**	**sad (H)**
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	neutral
		Female scream (276)	**fear (H)**
		Puppy cry (105)	neutral
		Baby cry (261)	neutral
		Victim(286)	surprise (M)
		Car wreck (424)	anger (M)
		Bike wreck (600)	anger (L)
		Baby laugh (110)	**happy (H)**
		Erotic female (201)	surprise (M)
	Task	Relaxation	
	IADS	Clock tick (708)	neutral
		Typewriter (322)	neutral
	Task	Pose a sad face	neutral
		Pose a fearful face	**neutral**
		Smile for a licence photo	happy (L)

Participant 8

			Affect/intensity
Block 1	Task	Relax	
	IADS	Clock tick (708)	neutral
		Typewriter (322)	neutral
	IAPS	Tumor (3261)	disgust (H)
		Baby (2661)	neutral
		Sad child (2800)	sad (M)
		Infant (3350)	sad (L)
		Disabled child (3300)	sad (L)
		Mug (7009)	neutral
		Checkerboard (7182)	neutral
	Task	Task Passport photo	neutral
		ID card	neutral
	IAPS	Attractive man (4572)	happy (M)
		Erotic male (4561)	happy (M)
		Women (1340)	happy (H)
		Monkeys (1811)	happy (H)
		Adult (2020)	happy (L)
		Attack (6550)	fear (H)
		Spider (1205)	neutral
		Mutilation (3060)	disgust (H)
	Task	Pretend sad	neutral
		Pretend fearful	neutral
Block 2	Task	Sing National Anthem	surprise (M)
		Stop	neutral
		Permission to use tape	neutral
		Stop	neutral
	Confederate stimuli	Fake sad reaction-blank slide	neutral
		Fake fearful reaction-blank slide	neutral
		Fake disgust reaction-blank slide	happy (L)
	Scenario	Display sad face	neutral
		Display frightened face	neutral
	Sad song	**Think about sad event**	**sad (H)**
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	neutral
		Female scream (276)	fear (H)
		Puppy cry (105)	neutral
		Baby cry (261)	sad (L)
		Victim(286)	**fear (M)**
		Car wreck (424)	sad (L)
		Bike wreck (600)	sad (L)
		Baby laugh (110)	happy (M)
		Erotic female (201)	happy (M)
	Task	Relaxation	
	IADS	Clock tick (708)	neutral
		Typewriter (322)	**neutral**
	Task	**Pose a sad face**	**neutral**
		Pose a fearful face	**neutral**
		Smile for a licence photo	neutral

Participant 12

			Affect/intensity
Block 1	Task	Relax	
	IADS	Clock tick (708)	surprise (L)
		Typewriter (322)	**neutral**
	IAPS	Tumor (3261)	disgust (H)
		Baby (2661)	neutral
		Sad child (2800)	neutral
		Infant (3350)	sad (M)
		Disabled child (3300)	neutral
		Mug (7009)	neutral
		Checkerboard (7182)	neutral
	Task	Task Passport photo	neutral
		ID card	happy (L)
	IAPS	Attractive man (4572)	neutral
		Erotic male (4561)	happy (L)
		Women (1340)	neutral
		Monkeys (1811)	neutral
		Adult (2020)	neutral
		Attack (6550)	neutral
		Spider (1205)	neutral
		Mutilation (3060)	disgust (M)
	Task	Pretend sad	neutral
		Pretend fearful	happy (L)
Block 2	Task	Sing National Anthem	neutral
		Stop	happy (L)
		Permission to show tape	neutral
		Stop	neutral
	Confederate stimuli	**Fake sad reaction-blank slide**	**neutral**
		Fake fearful reaction-blank slide	neutral
		Fake disgust reaction-blank slide	happy (L)
	Scenario	Display sad face	happy (L)
		Display frightened face	neutral
	Sad song	**Think about sad event**	**sad (H)**
Block 3	Scenario	Walking alone at night	
	IADS	Walking (722)	
		Female scream (276)	fear (L)
		Puppy cry (105)	neutral
		Baby cry (261)	neutral
		Victim(286)	surprise (M)
		Car wreck (424)	sad (L)
		Bike wreck (600)	surprise (L)
		Baby laugh (110)	happy (M)
		Erotic female (201)	surprise (L)
	Task	Relaxation	
	IADS	Clock tick (708)	anger (L)
		Typewriter (322)	neutral
	Task	Pose a sad face	neutral
		Pose a fearful face	neutral
		Smile for a licence photo	neutral

Appendix G: Instruction Sheet: Categorization Task

The recognition of emotion: perceiving the experience behind facial expressions of emotion.

In this experiment, you will see photographs of people appear on the computer screen. Your job is to decide whether or not they are showing each emotion and whether or not they are feeling each emotion. For instance, sometimes when people smile it does not necessarily mean that they are actually feeling happy.

Each question will appear on screen for you to read and the experimenter will also read out each question.

The photographs will appear one at a time.

Your job is to answer the question for each photograph by pressing YES or NO. For example, the first question might ask,

- "Are the following people showing happiness?"

You will press the YES button if you think they are showing happiness, or

You will press the NO button if you think they are not showing happiness

The next question might ask,

- "Are the following people feeling happiness?"

You will press the YES button if you think they are feeling happiness, or

You will press the NO button if you think that they are not feeling happiness.

Each photograph will stay on screen until you have answered YES or NO

There are six questions and each will begin with 3 practice photographs.

Before we start – Feel free to ask any questions

Appendix H: General Health Interview

General Health Interview M / F

Today's Date: ID code:

Full Name:

Date of birth: Age: GP & clinic:
GP contact no.

Satisfactory / corrected vision: Yes / No and hearing: Yes / No

Check inclusion criteria: (tick if met)

☐ English as a first language	☐ No poorly controlled diabetes
☐ Normal or corrected to normal vision	☐ No involvement in current trial of psychoactive drugs
☐ No history of alcoholism	☐ No sig. psychiatric illness requiring hospitalization
	☐ No major depression in last 6 months
No serious history of	
☐ neurological	Previous main occupation:______________________
☐ thyroid	Years of education (post primary)______________________
☐ cardiovascular (not related to diagnosis of dementia)	

Current medications, including dose:

Appendix I: Information sheet: Healthy Young Adults

Information Sheet

Recognition of Facial Expressions of Emotion

This study will examine if aging and dementia influences a person's ability to detect posed and genuine facial expressions of emotion. Participants will include Alzheimer's Dementia patients; patients with Lewy Bodies Dementia and/or Parkinson's disease with Dementia; Fronto-Temporal Dementia patients and healthy non-dementia control participants of various ages. Our aim is to establish if dementia impairs or does not impair the ability to recognize facial emotion. We also will be able to tell if a test of emotion recognition can help differentiate different types of dementia.

Your involvement in the study will take approximately 60 minutes. We will give you some standardised tasks that are frequently used in this kind of research and for the actual facial expression test; we will show you several photographs of people on a computer screen and ask you some questions about the people you see.

Please note we will seek your permission to advise your GP on your behalf should your score on the mood scale be of concern.

Your participation in this study is voluntary (your choice). You do not have to take part in this study, and you may choose to withdraw from the study at any time, without having to give any reason. The information you provide to this study will be coded for confidentiality and available only to the researchers. We will keep all coded information securely stored during the study and are required to safely archive this information once the study is completed.

The results of this study may be published but you will not be identified as a participant. You can request a summary of the results of this study by circling YES on the consent form, although it may take some time for us to collect and analyse all of the data. We appreciate the time and effort required to participate in research and although we are unable to provide cash to participants, we can compensate you with a $10 voucher.

Please ask the researcher if you have any further questions

Contact details

Tracey McLellan Ph: 364 2987 extn. 7704 (daytime), Email: tlm36@student.canterbury.ac.nz.
Assoc Prof Lucy Johnston, University of Canterbury, Phone (03) 3642987 extn. 6967
Assoc Prof John Dalrymple-Alford, University of Canterbury, Phone (03) 3642987 extn. 6998
Assoc Prof Richard Porter, Christchurch School of Medicine and Health Sciences,
richard.porter@chmeds.ac.nz

The project has been reviewed and approved by both the University of Canterbury Human Ethics Committee.

Appendix J: Consent Form: Healthy Young Adults

CONSENT FORM

The Recognition of Facial Expressions of Emotion

I have read and understood the inclusion criteria required for this study and I meet these criteria.
I have read and understood the information sheet for people taking part in the study.
I have had the opportunity to ask questions and I am satisfied with the answers I have been given.

On this basis, I agree to participate in this study.

I consent to publication of the results of this study with the understanding that I will not be identified as a participant.

I understand that my participation in this study is voluntary (my choice).

I understand that I may at any time withdraw from the project, including withdrawal of any information I have provided.

I would like a copy of the results of the study **YES / NO**

NAME (please print): ____

Signature: ____

Date: ____

Address for results:

____

I agree / disagree to the researcher informing my GP should my score on the depression rating scale indicate reason for concern.

Appendix K: Formulae for calculation of non-parametric indices of sensitivity (A') and response bias (B").

Sensitivity (A'):

- For $H \geq FA$: $A' = 0.5 + [(H - FA)(1 + H - FA)] / [4H(1-FA)]$
- For $FA > H$: $A' = 0.5 - [(FA - H)(1 + FA - H)] / [4FA(1-H)]$

Response bias (B"):

- For $H \geq FA$: $B'' = [H(1 - H) - FA(1 - FA)] / [(H(1 - H) + FA(1 - FA)]$
- For $FA > H$: $B'' = [FA(1 - FA) - H(1 - H)] / [(FA(1 - FA) + H(1 - H)]$

H = hit rate, and FA = false alarm rate.

Appendix L: Information Sheet: Older Adults

Information Sheet

Recognition of Facial Expressions of Emotion

This study will examine if aging and dementia influences a person's ability to detect posed and genuine facial expressions of emotion. Participants will include Alzheimer's Dementia patients; patients with Lewy Bodies Dementia and/or Parkinson's disease with Dementia; Fronto-Temporal Dementia patients and healthy non-dementia control participants of similar age. Our aim is to establish if dementia impairs or does not impair the ability to recognize facial emotion. We also will be able to tell if a test of emotion recognition can help differentiate different types of dementia.

Your participation is entirely voluntary (your choice) and you may take as much time as you need to make your decision. The research staff is available to answer any questions you may have before making a decision and we suggest that you discuss this decision with a friend, family member/ whanau support person. You are also welcome to bring a support person along to the testing. Participants and /or whanau may also request to say Karakia (blessings) before each session of cognitive testing.

About the study

This study is a thesis project and part of a Doctoral degree in Psychology by Tracey McLellan. The testing will be conducted at either the Van der Veer Institute for Parkinson's and Brain Research, 16 St Asaphs St, Christchurch, the University of Canterbury, Ilam Rd, Christchurch or The Princess Margaret Hosiptal, Cashmere Rd, Christchurch. We will confirm the venue if you choose to make an appointment.

What to expect as a participant

In total approximately 48 patients and 48 control participants will take part in the study. Your involvement in the study will require you attend 2 separate sessions that will take approximately 2 hours each. First, we will give you some standardised tasks that are frequently used in this kind of research. These tasks have been de designed to provide information regarding abilities such as memory, attention and problem solving. Most of the tests require short verbal answers, some require pen and paper answers.

For the actual facial expression part, we will show you several photographs of people on a computer screen and ask you some questions about the people you see.

You and your support person/caregiver will also be asked to complete some questionnaires about daily living activities at home that will take about half an hour. Because we need to match patients with control participants, we will also ask you some brief questions about 'who you are', for instance, what is/was your occupation and how many years did you spend at school. Certain types of medication can interfere with the process we are investigating; accordingly, we will ask you to advise us of any medications that you currently take.

Please note we will seek your permission to advise your GP on your behalf should your score on the mood scale be of concern or should your score on other measures indicate that further assessment is warranted. Your GP may discuss a possible referral.

Benefits, Risks and Safety

We have arranged the sequence of tests to maintain interest and to minimise fatigue. In the unlikely event that a participant may experience tiredness while completing tasks, we will add further breaks or, in the case of distress, terminate the testing. We have arranged several breaks and you of course are welcome to request a break or discontinue the tasks at any stage. No direct benefit for the participant is expected from taking part in this study; however, we hope to provide an interesting experience for those who kindly donate their time.

Participation and Your Rights

Your participation in this study is voluntary (your choice). You do not have to take part in this study, and if you choose not to take part, this will not affect any future or continuing health care. Even if you do agree to take part, you may choose to withdraw from the study at any time, without having to give any reason. The information you provide to this study will be coded for confidentiality and available only to the researchers. We will keep all coded information securely stored during the study and are required to safely archive this information once the study is completed.

The results of this study may be published but you will not be identified as a participant. You can request a summary of the results of this study by circling YES on the consent form, although it may take some time for us to collect and analyse all of the data. We appreciate the time and effort required to participate in research and although we are unable to provide cash to participants, we can compensate your travel costs by providing you with $15 vouchers for each session. If you have any concerns about your rights as a participant in this study you may wish to contact a Health and Disability Advocate (telephone 03 3777501 or (outside Christchurch) 0800 377 77 66.

This project has received ethical approval from the Upper South A Regional Ethics Committee. The investigator agrees to an approved auditor appointed by either the Ethics committee, or the regulatory authority or their approved representative, and approved by the Upper South A Regional Ethics Committee reviewing the relevant medical records for the sole purpose of checking the accuracy of the information recorded for the study.

> In the unlikely event of a physical injury as a result of your participation in this study, you may be covered by ACC under the injury Prevention, Rehabilitation and Compensation Act. ACC cover is not automatic and your case will need to be assessed by ACC according to the provision of the 2001 Injury Prevention Rehabilitation and Compensation Act. If your claim is accepted by ACC, you still might not get any compensation. This depends on a number of factors such as whether you are an earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your right to sue the investigators.

Thank you for considering this study. If you have any further questions or you wish to make an appointment, please contact:

Tracey McLellan, Department of Psychology, Ph: 364 2987 extn. 7704 (daytime), Ph: 021 022 53755 (mobile), Email: tlm36@student.canterbury.ac.nz.

Contact details for supervisors

Assoc Prof John Dalrymple-Alford, University of Canterbury, Phone (03) 3642987 extn. 6998
Assoc Prof Lucy Johnston, University of Canterbury, Phone (03) 3642987 extn. 6967
Assoc Prof Richard Porter, Christchurch School of Medicine and Health Sciences, richard.porter@chmeds.ac.nz

Appendix M: Consent Form: Older Adults

CONSENT FORM

Recognition of Facial Expressions of Emotion

I have read and I understand the information sheet for volunteers taking part in the study that examines the recognition of facial expressions of emotion. I have had the opportunity to discuss this study and I am satisfied with the answers I have been given.

I have had the opportunity to use whanau support or a friend to help me ask questions and understand the study.

I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time and that this will not affect my continuing health care.

I understand that my participation in this study is confidential and that no material that could identify me will be used in any reports.

I consent to publication of the results of this study with the understanding that I will not be identified as a participant.

I understand the compensation provisions for this study as covered by accident compensation legislation within its limits.

I understand that my Geriatrician/GP will be informed if my test scores, including my score on the mood scale, is cause for concern.

This study has been given ethical approval by the Upper South A Regional Ethics Committee. This means that the Committee may check at any time that the study is following appropriate ethical procedures.
I agree to an auditor appointed by the Ethics committee, or the regulatory authority or their approved representative approved by the Upper South A Ethics Committee reviewing my relevant medical records for the sole purpose of checking the accuracy of the information recorded for the study.

I would like a copy of the results of the study. **YES / NO**

Address for results: ____

I ____(full name) hereby consent to take part in the study: Recognition of Facial Expressions of Emotion.
And I consent to my GP being informed if any of my scores on tests indicate a cause for concern.

Signed: _____________________________ Date:_____________________

Appendix N: Match words with Definitions task

Match these words with the best definition by drawing a line to connect them.	
LIAR	Unkind or unpleasant
MEAN	Causing pain or grief intentionally
HONEST	Someone who tells lies
KIND	Free from fraud or deception
CRUEL	Only concerned with oneself without regard for others
LOYAL	Of a sympathetic or helpful nature
SELFISH	Marked by genuineness
SINCERE	Faithful to a person or cause

Appendix O: Consent Statement by Relative: Individuals with AD

STATEMENT BY RELATIVE/FRIEND/WHANAU

The Recognition of Facial Expressions

Principal Investigator Tracey McLellan

Participant's Name ____

I have read and I understand the information sheet for people taking part in the study examining the recognition of facial expressions. I have had the opportunity to discuss this study. I am satisfied with the answers I have been given.

I believe that relative/friend would have chosen and consented to participate in this study if he/she had been able to understand the information that I have received and understood.

I understand that taking part in this study is voluntary and that my relative/friend may withdraw from the study at any time if he/she wishes. This will not affect his/her continuing health care.

I understand that his/her participation in this study is confidential and that no material which could identify him/her will be used in any reports on this study.

I understand the compensation provisions for this study.

I know who to contact if my relative/friend has any side effects to the study or if anything occurs which I think he/she would consider a reason to withdraw from the study.

This study has been given ethical approval by the Upper South A Regional Ethics Committee. This means that the Committee may check at any time that the study is following appropriate ethical procedures.

I believe my relative/friend would agree to an auditor appointed by the Ethics committee, or the regulatory authority or their approved representative approved by the Upper South A Ethics Committee reviewing my relative's/friend's relevant medical records for the sole purpose of checking the accuracy of the information recorded for the study.

I/my relative/friend would like a copy of the results of the study. **YES/NO**

I believe my relative/friend would agree to his/her GP being informed of his/her participation in this study **YES/NO**

Name:__________________________Signed:__________________________Date ____________

Relationship to Participant:_________________ Address for results:___________________________

Statement by Principle Investigator

I Tracey McLellan declare that this study is in the potential health interest of the group of patients of which __________________________ is a member and that participation in this study is not adverse to his/her interests.

Signed: _______________________________ Date ____________________________