Perception of Self and Others in Healthy Ageing

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Contents

Declaration

I declare that the present thesis has been composed by myself, that the work contained is my own except where explicitly stated otherwise. None of this work has been submitted in application for a degree or professional qualification in any other institution or university.

(Alessandra Girardi)

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Abstract

Processing information related to the self and inferring the mental state of another person is known to involve the ventromedial prefrontal cortex (VMPFC) in both younger and older adults (Stone et al., 2008; Kelley et al., 2002; Hynes et al., 2006; Ruby et al., 2009). According to the dorsolateral prefrontal (DLPF) theory of cognitive ageing, processing of the self should not be affected by healthy adult ageing as functions related to the VMPFC remain relatively preserved compared to functions related to the DLPF cortex (MacPherson et al., 2002). Similarly, no age difference should emerge in those tasks thought to tap functions of the VMPFC. The aim of this PhD is to investigate the effect of healthy adult ageing on the ability to process information related to the self and others. A series of experiments was designed to compare the performance of younger and older adults on tasks that investigate processing and retrieval of self-related information (e.g. behaviour prediction, personality judgement, mental state inferences, self-referential). The tasks differ in the extent to which they rely on cognitive effort. The results show that ageing does not affect self-related judgements. A further series of experiments designed to investigate affective and cognitive Theory of Mind (ToM) show that the affective performance, thought to rely on VMPFC activity, is not affected by age. In contrast, the performance of older participants differs from that of younger adults on cognitive ToM task, thought to involve DLPFC brain areas. A final experiment investigated the ability to make self versus other related judgments in a confabulating patient. The results show that the ability to reflect on the self but not on others was intact. In summary, the findings demonstrate that processing self-information and making ToM inferences remains intact in older individuals and is not overtly impaired by confabulation.

Chapter 1: Healthy adult ageing

1.1. Introduction

The prefrontal cortex (PFC) supports distinct cognitive functions such as executive functions (e.g. planning, monitoring, inhibition,), attention and memory functions (e.g. maintenance and manipulation of information; memory for the source of information) as well as emotional and social processing (Petrides & Milner, 1982; Cummings, 1993; Hornak, Rolls & Wade, 1996; Bechara, Damasio, Tranel & Anderson, 1998; Sarazin Pillon, Giannakopoulos, Rancurel, Samson & Dubois, 1998; Anderson & Tranel, 2002; Bird, Castelli, Malik, Frith & Husain, 2004). Evidence from morphological and functional studies shows that age affects the PFC more than other brain areas (Haug et al., 1983; Terry et al., 1987; Haug & Eggers, 1991; Raz, 1996; West, 1996). Therefore, the PFC theory of cognitive ageing claims that older adults perform more poorly on tasks traditionally associated to frontal lobes functions than younger adults (Mittenberg, Seidenburg, O'Leary & DiGiulio, 1989; Moscovitch & Wincour, 1995; West, 1996). Studies have shown that individuals show a decline in executive functions and memory as they become older (Salthouse 1990; 1996; Salthouse, Atkinson & Berish, 2003; Bryan & Luszcz, 2000; Band, Ridderinkhof & Segalowitz, 2002; Tisserand & Jolles, 2003; Anstey & Low, 2004).

Yet, not all functions supported by the PFC appear to deteriorate with age. For example, cognitive functions based on experience (e.g. social skills and emotion processing) are relatively spared in older individuals (Phillips, MacPherson & Della

Sala, 2002; Anstey et al. 2004; Glisky, 2007). These findings cannot be explained by the PFC theory of cognitive ageing, which would predict a decline in all functions thought to rely on the PFC.

The frontal lobes are not homogeneous and consist of distinct subregions including the ventromedial and the dorsolateral prefrontal cortex (VMPFC and DLPFC; Pandya & Yeterian, 1996; Rolls, 1996). Lesion studies have demonstrated that patients with VMPF lesions are impaired on tests of emotional and social information but have intact memory and executive functions (Eslinger & Damasio, 1985; Rolls, Hornak, Wade & McGrath, 1994; Bechara et al., 1998; Sarazin et al., 1998; Bird et al., 2004). In contrast, patients with DLPFC lesions are impaired on tests of memory and executive function (Sarazin et al., 1998; Berlin, Rolls & Kischka, 2004; Ptak & Schnider, 2004) but do not show impairments in social and emotional processing (Stone, Baron-Cohen & Knoght, 1998; Hornak, Bramham, Rolls, Morris, Doherty, Bullock et al., 2003; Shamay-Tsoory, Tomer & Aharon-Peretz 2005a; Shamay-Tsoory, Tomer, Berger, Goldsher & Aharon-Peretz, 2005b). In relation to cognitive ageing, research suggests that the DLPFC deteriorates, earlier and faster than VMPFC as people become older (West, 1996; Phillips et al., 2002). This led to the dorsolateral prefrontal theory of cognitive ageing as older adults have been found to perform more poorly on tasks tapping the DLPFC compared to healthy younger adults but not on tasks tapping the VMPFC brain areas (MacPherson et al., 2002; Phillips et al., 2002).

Tasks thought to rely on the VMPFC typically involve emotional and social processing. One such ability which has been shown to be associated with the VMPFC is the ability to understand another person's mental state (i.e. Theory of Mind, ToM; Hornak et al., 1996; Stone et al.,, 1998; Hynes, Baird & Grafton, 2006). Patients with lesions in the VMPFC have been shown to have impairments on both verbal and visual ToM tasks including understanding of another person's beliefs and emotions (Stone et al., 1998; Lough, Gregory & Hodges, 2001; Snowden, Gibbons, Blackshaw, Doubleday, Thompson, Craufurd et al., 2003; Shamay-Tsoory & Aharon-Peretz, 2007a) In order to make attributions about others, individuals need to be able to discriminate between the self and others (Georgieff & Jeannerod, 1998; Gallagher, 2000). Processing information about the self is known to activate the VMPFC (Kelley, Macrae, Wylan, Caglar, Inati & Heatherton, 2002; Heatherton, Wyland, Macrae, Demos, Denny & Kelley, 2006). Some studies showed that processing information in relation to another other person involves DLPFC and temporal activity (Ochsner, Beer, Robertson, Cooper, Gabrieli, Kihsltrom et al., 2005). If the VMPFC is relatively spared in an older population, the ability to process self-related information should not decrease with age (Ruby, Collette, D'Argembeau, Peters, Degueldre, Balteau et al., 2009). The following study will investigate whether there is age effect on self and other-related task thought to rely on distinct regions of the PFC.

1.2. Ageing and the frontal lobes

The prefrontal cortex (PFC) is one of the brain areas showing the greatest change in relation to healthy adult ageing (West, 1996). However, the frontal lobes are not homogeneous and evidence exists of specialisation and subdivision of the prefrontal cortex into the dorsolateral and ventromedial regions (DLPFC and VMPFC respectively; Pandya & Yeterian, 1996; Rolls, 1996). The DLPFC is located in the upper part of the frontal lobes and begins on the lateral convexity of the frontal lobe, anterior to the premotor area and has been identified as Brodmann's areas BA 9 and 46. The VMPFC, sometimes referred to as Orbito Frontal Cortex (OFC; Rolls et al., 1996) includes the lateral, middle and medial orbital gyrus and has been identified as Brodmann's areas (BA) 10,11,12,13,14 and 47 (Ongur, Ferry & Price, 2003). Brodmann (1909, cited in Phillips et al., 2002) originally identified the VMPFC with the areas 10, 11 and 47 and subsequently included the area 12 between areas 10 and 11 (1910). Beck (1949, cited in Phillips et al., 2002) included the areas 13 and 14 corresponding to the posterior orbital cortex. Petrides and Pandya (1994), to reconcile human and monkey studies, proposed to indicate the lateral VMPFC as area 47/12. The DLPFC and VMPFC differ phylogenetically and ontogenetically: the VMPFC is phylogenetically older than other areas of the brain and its development precedes that of the DLPFC, which instead continues to develop until the age of 12 years (Phillips et al., 2002). In addition, the two areas have different connections with other areas of the brain; the VMPFC is connected to the limbic system whereas the DLPFC to sensory-motor and parietal areas (Miller & Cohen, 2001). Figure 1.1 shows the distribution of the Brodmann's brain areas.

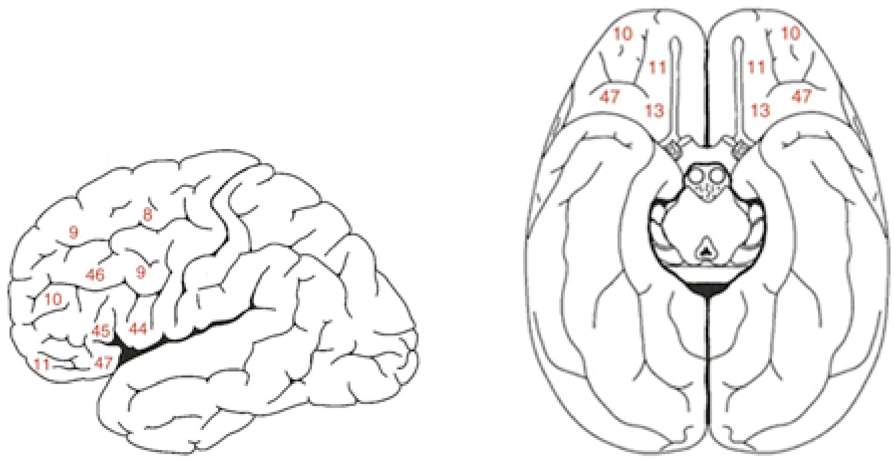

Figure 1.1. Lateral and orbital view of the prefrontal brain areas.

The DLPFC and the VMPFC can also be differentiated according to the functions that they support (Kringelbach & Rolls, 2004; Zald, 2007). The DLPFC is commonly associated with executive function and working memory (Petrides & Milner, 1982), such as the ability to retain information over a short period of time, selective attention and monitoring of responses (Bechara et al., 1998), whereas the VMPFC is thought to be involved in decision-making, emotional processing and social behaviour (Hornak et al., 1996; Rolls, 1996). Supporting this distinction, Sarazin et al. (1998) showed that cerebral metabolism changes in patients with DLPFC lesions were associated with poor performance on executive tasks; changes in the VMPFC, in contrast, were associated with behavioural and emotional deficits. Other neuroimaging studies show that working memory correlates with the activity in the DLPFC (Gerton, Brown, Meyer-Linderberg, Kohn, Holt, Olsen et al., 2004). An fMRI study of a delayed response task (which measures retention and retrieval of visual information after a delay) conducted with healthy participants reported activation in the DLPFC when the tasks required participants to organize and transform the items held in memory (Postle, Berger & D'Esposito, 1999). Unlike the DLPFC, the VMPFC area is related to decision-making skills, emotion recognition and social behaviour (Rolls, Hornak, Wade & McGrath, 1994; Hornak et al., 1996). For example, several studies have shown VMPFC involvement in emotion identification tasks such as rating facial expressions on the type of emotion, facial expression matching, remembering happy versus neutral faces, observation and imitation of facial emotional expressions (Dolan, Fletcher, Morris, Kapur, Deakin & Frith, 1996; Britton, Taylor, Sudheimer & Liberzon, 2006).

Lesion studies further support the view that different regions of the PFC support different cognitive functions. In fact, damage to distinct regions results in different cognitive and behavioural deficits (Eslinger & Damasio, 1985; Bechara et al., 1998 Sarazin et al., 1998). In particular, damage to the DLPFC is characterised by deficits related to attentional processes, difficulty shifting, planning, poor abstraction and reduced monitoring (Sarazin et al., 1998; Anderson & Tranel, 2002; Ptak et al., 2004); damage to the VMPFC, instead, results in reduced motivation, dishinibition, impulsivity and antisocial behaviour (Cummings, 1993; Rolls et al., 1994) as well as impaired decisions-making (Rolls et al., 1994; Miller et al., 2001). More recent patient studies that compared performance of VMPFC and DLPFC damaged patients on tasks thought to tap the VMPFC brain areas (e.g. faux pas, affective judgement of preference) considered the medial BA 8 and 9 as part of the VMPFC areas (Shamay-Tsoory, Tomer, Berger &

Aharon-Peretz, 2003; Shamay-Tsoory et al., 2005a;b; Shamay-Tsoory et al.,, 2007a). In the present study, Brodmann areas 10,11,12,13,14,47 will be referred to as VMPFC. Brain areas that include the medial BA 8 and 9 will be referred to as MPFC, in line with early neuroimaging studies that refer to these brain areas as MPFC (Happé, Ehlers, Fletcher, Frith, Johansson, Gillberg et al., 1996; Fletcher, Happé, Frith, Baker, Dolan, Frackowiak & Frith, 1995; Gallagher, Happé, Brunswick, Fletcher, Frith, & Frith, 2000).

Evidence suggests that the VMPFC and the DLPFC are differentially affected by healthy adult ageing (West, 1996; Phillips et al., 2002). It has been shown that neurons in the VMPFC shrink slower than neurons in other regions of the brain including other frontal areas, such as the BA 6 (Haug & Eggers, 1991). A post-mortem investigation showed a linear reduction in the weight, thickness and number of neurons in the DLPFC from the age of 30 years onwards (Terry, De Teresa & Hansen, 1987). Greater changes in the cerebral metabolism with age have also been reported in the DLPFC compared to the orbital areas (De Santi, de Leon, Convit, Tarshish, Rusinek, Tsuj et al., 1995). Marchal, Rioux, Petit-Taboue', Sette, Travere, Le Poec et al. (1992) did not find any age effects on VMPFC metabolism but did on the DLPFC. Similarly, Garraux, Salmon, Degueldre, Lemaire, Laureys & Franck (1999) found that age affected the metabolism of the DLPFC, while no age difference emerged in the VMPFC. Using structural MRI, Sowell, Peterson, Thompson, Welcome, Henkenius and Toga (2003) investigated grey matter density (GMD) changes in a sample of individuals age 7 to 87 and reported a rapid decline of the GMD in the dorsal frontal and the parietal areas with ageing. In contrast, other studies have shown that the OFC has greater structural changes with age compared to temporal and occipital areas (Resnick, Pham, Kraut, Zonderman & Davatzikos, 2003). In a volumetric MRI investigation, Salat, Kaye and Janowsky (2001) reported larger OFC in individuals aged 89 years compared to those aged 71 years. In a further structural MRI investigation with younger and older adults, Salat, Kaye and Janowsky (2002) showed that age was related to increase OFC volume and that larger OFC volume predicted poorer performance on a task thought to measure working memory abilities (the Self Order Pointing Task- SOPT and N-Back task). This evidence suggests that the preserved volume of the OFC in the face of degeneration of other PFC areas may reduce the communication among these brain regions leading to poorer performance.

Age has been showed to differentially affect performance on cognitive tests thought to measure functions that rely on the DLPFC and the VMPFC. MacPherson et al. (2002) investigated age effects on a series of tests thought to tap functions related to the DLPFC and the VMPFC. Tests of the DLPFC included the Wisconsin Card Sorting Test (WCST), the Self Ordered Pointing task (SOPT) and the Delayed Response task. The VMPFC functions were investigated using the Iowa Gambling task (IGT), the Faux Pas task (FP) and an emotion identification task. The results showed that older adults were impaired on all the DLPFC measures. In contrast, they performed as well as younger participants on the IGT and the FP.

Yet, other studies have shown impairment of older individuals on tasks thought to rely on VMPFC functions. Lamar and Resnick (2004) investigated younger and older adults' performance on a series of task thought to depend on the DLPFC (the SOPT, verbal fluency- VF, digit span backwards and months backwards) as well as on tasks measuring the VMPFC (the Iowa Gambling task- IGT, the Delayed Match to Sample-DMTS and the Delayed Non-Match to Sample-DNMTS task). The results showed that, similarly to MacPherson et al. (2002), older adults were impaired on the SOPT. However, they also performed poorly on the OFC measures (DMTS, and DNMTS) and that the difference between younger and older groups was more pronounced for the OFC than the DLPFC tasks. Lamar et al. (2004) claimed that the greater OFC impairment in their study may relate to the task demands, in that MacPherson et al. (2002) employed mainly social and emotional tasks that may not rely on the same monitoring demands as those required by the DMTS and the DNMTS, in which participants are required to determined whether a new item matches or not with a previously encountered item. Altogether these results indicate that social and emotional functions are relatively preserved in older individuals whereas cognitive functions supported by the dorsal region of the PFC decline as people become older.

Recent studies have demonstrated that processing information related to the self is associated with the MPFC, specifically the VMPFC (Kelley et al., 2002; Heatherton, et al., 2006). However, the affects of age on the construct of the self have not been extensively investigated in relation to the distinct brain areas that support self-processing. Recent neuroimaging studies have shown that performance on self-related tasks that do not require the explicit retrieval of past episodes (e.g. trait judgements) is not affected by age. However, it has been claimed that younger and older adults may rely on differential brain networks to perform the task (Ruby, et al., 2009; Feyers, Collette, D'Argembeau, Majerus, & Salmon, 2010). Specifically, during self-trait personality judgements, younger participants recruit brain areas (e.g. lingual gyrus) associated to autobiographical memory retrieval (Levine, Turner, Tisserand, Hevenor, Graham & McIntosh, 2004) and imaging actions performed by self and others (Cui, Jeter, Yang, Montague & Eagleman, 2007) suggesting that people may retrieve past experiences where they are shown to possess a given trait (Feyers et al., 2010). In contrast, older adults may rely on well-established knowledge of the self and others and recruit OFC areas involved in social understanding (Feyers et al., 2010). This finding suggests that an age effect might emerge in relation to specific components of the self (e.g. effortful cognitive processes-episodic retrieval) whereas no difference would emerge on tasks that rely on social knowledge and understanding.

The present study will investigate the processing of self and other-related information in younger and older adults. The age effect on cognitive functions supported by distinct frontal subregions will be investigated with a series of tasks thought to measure cognitive functions that depend on the VMPFC and DLPFC. Evidence indicates that processing self-related information and the understanding of another person's thoughts and feelings may rely on the involvement of the VMPFC as individuals project the self into the situation experienced by others in order to understand them (Frith & Frith, 2003). Therefore, older participants are expected to perform similarly to younger adults on tasks involving self-processing, providing further support for the dorsolateral prefrontal cortex theory of ageing. Further support for this view would come from evidence that patients with focal frontal damage of the VMPFC are impaired on tasks thought to measure VMPFC functions, including processing of the self. This issue will be investigated in the final experiment where a patient with VMPFC damage will be assessed on tasks tapping processing of the self.

Chapter 2. The Self

2.1. General Introduction

The sense of self can be generally defined as a collection of knowledge related to one's abilities, personality traits and attitudes, which guides our social interactions (Johnson, Baxter, Wilder, Pipe, Heiserman & Prigatano, 2002) and provides a sense of stability and continuity of personal experiences through the life span (Neisser, 1988). However, the self is not unitary: for example, it has been claimed that the self-concept includes different types of self-related information, such as the private self (i.e. internal and personal knowledge of the self) and the public self (i.e. externally expressed aspects of the self; Andersen, Glassman & Gold, 1998). Different types of self-related information are known to affect the way people make self-related judgments. In fact, it is known that individuals place different emphases on different types of self-knowledge when making self-related judgements and consider private thoughts/feelings more informative in defining the self than overt behaviours (Andersen & Ross, 1984). Support for this view comes from the results of an early investigation where participants were instructed to rate how well another person would know them if s/he had the opportunity to know all their private thoughts/feelings or the opportunity to observe their behaviours for a day or over several months (Andersen & Ross, 1984). They then had to rate the extent to which private thoughts/feelings and behaviours were diagnostic of their self. Participants were also asked to indicate how well they would know another person if they knew all his/her private thoughts/feelings or had the opportunity to watch their behaviours for a day or over several months. The results showed that information pertaining to the private self was more informative than overt behaviours for both the self and others, although the difference in informativeness between private thought and overt behaviour was greater for the self than for others. Participants also believed that access to one day of private thoughts would be more informative of their own self than several months of behaviour observation. In contrast, several months of behaviour observation of another person would be as informative as access to their inner thoughts for a day. The results of this study, therefore, indicate that private thoughts/feelings are more important than overt behaviours in defining the self but not another person.

The judgements that individuals express in relation to the self are affected by the self-related motivations, which refer to the internal states that guide self-evaluation. Three main types of motivations have been described: self-enhancement, self-assessment and self-verification (Sedikides & Strube, 1995).

Self-enhancement

Self-enhancement is the tendency for people to enhance or maintain a positive self-view (Sedikides et al., 1995). There are behaviours such as the tendency to consider themselves better than the average of other people that have been explained in terms of self-enhancement (Alicke, 1985). There is evidence indicating that individuals process self-related knowledge in a way that helps them to maintain a positive self-view. For example, people may compare themselves with worse individuals. For example, Wood et al. (1999) showed that when individuals are forced to compare their own abilities with another person, they choose to compare their strengths rather than their weakness. People may also compare themselves with a worse past self. Wilson and Ross (2001) instructed their participants to describe general aspects of themselves in the past and at the present time and found that the current self was described more positively than the older self. These studies indicate that different types of comparisons are made in order help individuals to enhance the view of the self that they possess.

Self-assessment

Self-assessment is the accurate assessment of the self in order to reduce uncertainty (Trope, 1980) and relates to the concept of diagnosticity (i.e. the ability of a given test to accurately measure characteristics of the self, such as one's personality and attitudes). A series of investigations has shown that people rate highly diagnostic tests as highly informative (Strube & Roemmele, 1985) and are more willing to perform them (Strube, Lott, Le-Xuan-Hy, Oxenberg, & Deichmann, 1986). Furthermore, diagnosticity may affect task performance under conditions of uncertainty. Support for this view comes from an early investigation where participants were told that that they were about to perform a mental flexibility task involving the presentation of a word they were instructed to find three words interrelated with that word in content or form. Participants were provided with feedback on their performance that indicated that they had a low, intermediate or high level of mental flexibility (low uncertainty condition) or that all the levels were equally probable (high uncertainty condition). Participants then performed a different mental flexibility task and were informed that its diagnosticity was high or low. The results showed that performance on the second task improved as the level of diagnosticity of the task increased and the effect was stronger for those in the high uncertainty condition. These results indicate that the effort invested in processing information depends on the prior knowledge that individuals possess about their ability (e.g. uncertainty), supporting the view that people look for evidence to confirm the view of the self that they possess.

Self-verification

Self-verification is the tendency to maintain the concept of the self that one possesses, even if it is negative (Swann, Pelham & Krull, 1989; Swann, Stein-Seroussi & Giesler, 1992). The verification motive typically emerges in the preference for interaction with partners who confirm the self-view that one possesses (Swann et al., 1989; 1992). For example, participants with a positive self-view have been shown to choose partners who see them favourably while those with a negative self-concept choose partners who see them unfavourably (Swann et al., 1992). Further support for self-verification motives comes from studies which show that individuals pay more attention to information that confirms their self-view. In one study (Swann & Read, 1981), participants who described themselves as likeable or dislikeable were selected. When they were shown a description of what another person thought of them, likeable individuals spent more time reading statements that expressed favourable appraisal of them while dislikeable participants spent more time reading unfavourable statements. These studies, therefore, show that people typically look for evidence that support the view they possess of the self.

2.2. Self and memory

In addition to self-judgements, the self-representation is known to affect the retrieval of self-relevant past knowledge. Autobiographical memory (i.e. recollection of personal past information) contributes to the formation of self-identity by providing individuals with a sense of continuity between their past and their current self. This continuity might emerge through the construction of self-narratives or stories that people tell about themselves (McAdams, 2001) where individuals connect the view of the self with specific events. The connections between the self and events can be explanatory in nature, such that the event is explained or illustrated as an example of a self-feature (stability). Connections may also refer to a change, in that the event is described as the cause of a change in the self-view or can be revealing, in that they may reveal a pre-existing but unrecognised self-feature. Studies that investigated the formation of self-event connections in younger and older adults showed that older individuals produced more self-event explanatory connections than younger adults while the connections reported by younger participants referred to changes (McLean, 2008). The age difference in the self-event connections may be related to older adults developing a preference for stability than for change (Brown, Asher & Cialdini, 2005), which authors interpreted as being determined by the stronger motivation of older participants to avoid inconsistency, which in turn may lead to emotional upsetting. These results are consistent with the socioemotional selectivity theory (Carstensen et al., 1999), which proposes that motives shift from the desire of self-knowledge in younger people to the desire of emotional stability in older adults, supporting the view that self-related goals change as people become older (Conway & Holmes 2004a). However, distinct self-components may affect memory retrieval, such as the type of self-concept that individuals possess, self-related motivations and self-related goals.

Types of self-concept and memory

As previously discussed, the self consists of both private and public self-knowledge. In terms of memory, private and public information affects the retrieval of one's own and others' thoughts and behaviours. For example, individuals are known to retrieve more private than public self-information when instructed to describe the self, giving strength to the notion that the self-concept relies more on private knowledge than observable behaviours (Anderson et al., 1998). In this study, the researchers instructed their participants to describe the self, a significant other person and a non-significant other in terms of private and public features. Participants in the self condition listed more sentences for the private than the public self and listed more private sentences for the self than others giving strength to the notion that the self concept relies more on private knowledge than observable behaviours. In contrast, although the difference was not significant, they produced more public than private sentences when describing others and were faster in producing public sentences for others than for the self. The number of public sentences did not differ between the self and significant others, indicating that although they have more private knowledge for the self than both significant and non-significant others, they have a similar amount of knowledge of the self and the significant other's overt behaviours. These results indicate that the self-concept relies more on private knowledge than observable behaviours and that private self-information is more easily accessible than observable behaviours. The informativeness of private thoughts/feelings, however, depends on the amount of knowledge that individuals possess in relation to the person being judged. This view is supported by a study that employed a verb-sentence paradigm. For example, Johnson, Robinson and Mitchell (2004) presented the participants with sentences describing actions or mental states and instructed them to indicate the extent to which a verb was an expression of the actor's self. Sentences described either a specific situation ("Megan is bored by Beth"; "Megan pesters Beth") or a general tendency of the target (e.g. "Megan is a person who tends to be bored by other people"; "Megan is a person who tends to pester other people"). The results showed that actions were considered more diagnostic of the actor's self for a single example (Semin & Marsman, 1994) whereas mental states which encompass different situations were better indicators of the actor's self (Johnson et al., 2004). These results highlight the role played by the amount of knowledge that one possesses when making judgments.

Self-motivations and memory

Self-motivations are also known to affect the retrieval of self-related information from memory. For example, self-enhancement motives increase the retrieval of positive information in relation to the self (Skowronsky, Betz, Thompson & Shannon, 1991; Sedikides & Green, 2000; D'Argembeau, Comblain & Van Der Linden, 2003; 2005a; D'Argembeau & Van Der Linden, 2008). Support for this view comes from studies that have investigated memory for self-related behaviours and trait attributes. For example, Skowronsky et al. (1991) asked students to keep a diary of events that happened to them and to a close relative/friend. When then presented with diary entries and asked to indicate how well they remembered the events, students showed higher memory for pleasant than unpleasant self-events. In contrast to the self-events, the valence did not affect memory for others-related events. Similarly, higher memory has been reported for positive than negative words previously encoded in relation to the self, whereas no difference emerged for positive and negative traits encoded in relation to another person (D'Argembeau et al., 2005a), suggesting that the need to enhance differentially affects the retrieval of self- and other-related information. In another study, Swann et al. (1981) investigated the affect of self-verification on memory retrieval. In this study the participants described as likeable/dislikeable listened to a tape recording of what another person thought of them. When then asked to remember as many statements as possible, participants with a positive self-view recalled more positive than negative statements and those with a negative self concept recalled more negative than positive statements. These studies indicate that self-related motives affect the way people process and retrieve self-related information as well as their overt behaviour (e.g. choice of a partner).

The self-enhancement, self-assessment and self-verification motives may operate together in guiding the behaviour (Sedikides et al., 1995). However, which motivation predominates may depend on several factors, included the centrality of the information (i.e. whether the information is central to defining the self identity; Sedikides et al., 2000), the diagnosticity of the information provided (Green & Sedikides, 2004) and its perceived modifiability (whether the information is perceived stable or modifiable;

Trope, Gervey & Bolger, 2003). For example, self-enhancement predominates when the attributes are important (central to the definition of the person), negative and highly diagnostic (Sedikides et al., 2000; Green et al., 2004). Supporting this conclusion, Sedikides et al. (2000) presented their participants with sentences (e.g. It's amazing how "light" life sometimes is"; I do not mind visiting places where I have never been before) and instructed them to indicate the extent to which they agreed with each sentence. Participants in the self-test were provided with feedback in the form of behaviours that they themselves were likely to show. Participants in the other condition were instead shown behaviours that another person was likely to show. Finally, participants were instructed to recall as many behaviours as possible. Participants in the self-test recalled fewer central negative behaviours than those in the other person condition and recalled fewer central negative than central positive behaviours. In contrast, those in the other person condition recalled an equal number of positive and negative behaviours. No difference for the self and others emerged for the peripheral traits. Altogether these results suggest that people process more positive information about the self than others when the trait is central (i.e. negative information about a central attribute would threaten the positive view of the self and so it would be less well remembered). In contrast, a negative peripheral attribute is considered less threatening and individuals would not need to remember it less well than the positive information. These studies indicate that different types of motivation affect how information about the self is processed. The findings further indicate that the prevalence of one motivation over others depends on the importance of the specific attributes in describing the self (e.g.

centrality) as well asthe belief that attributes are stable or change over time (e.g. modifiability) and the extent to which manifesting a specific behaviour implies the possession of an underlying trait attribute.

Self-goals and memory

A further type of knowledge related to the self, self-goals, appears to affect memory retrieval. As previously discussed, the self consists of different components and when individuals experience a discrepancy between different representations of the self, they behave in order to get closer to their desired state (i.e. a self-related goal; Higgins, 1987; Higgins, Roney, Crowe & Hymes; Conway & Pleydell-Pearce, 2000; Conway & Holmes, 2004a; Conway, 2005). For example, the self-concept may include distinct types of selves: 1) the 'actual' self, that is a representation of the features that one believes they possess; 2) the 'ideal' self, that is a representation of the features that one would like to possess (e.g. hopes, aspiration, wishes); and 3) the 'ought' self, that is a representation of the features that one believes they should possess (the one that the individual should be according to other people, such as sense of duties and responsibilities), (Higgins, 1987). The ideal self is related to desired positive outcomes (e.g. love obtained); in contrast, the ought self is related to negative outcomes (e.g. criticism). Support for this claim comes from a subsequent investigation in which Higgins and Tykocinski (1992) investigated whether activation of the ideal/ought self would determine a greater sensitivity to positive/negative outcomes. The researchers selected participants who possessed a high discrepancy between the actual and ideal self or the actual and the ought self. Their participants were asked to list the attributes that they possessed, that they would like to possess (hopes and wishes) and that they ought to have (what they believe to be their duties). They then read an essay about a person's life, which contained events that described the presence or absence of positive and negative outcomes and were instructed to reproduce the essay word for word. The results showed that those with a high actual-ideal self-discrepancy had a better memory for events describing the presence or absence of positive outcomes indicating that the ideal self is accompanied by greater sensitivity to positive outcomes. In contrast, those with a high actual-ought discrepancy remembered better events for the presence/absence of negative outcomes. These results indicate that the type of discrepancy people possess affects memory retrieval by enhancing the retrieval of events that are consistent with the self-concept those individuals possess. Further support for the view that self-related goals affect memory retrieval comes from a study conducted by Moffitt and Singer (1994). The researchers asked participants to list their current goals (e.g. things that they tried to achieve or avoid), to recall memories from different life-periods and to rate their emotional reaction to those memories. Individuals who listed more attainment goals recalled more memories related to achievements and felt more positively about their memories, supporting their current listed goals of achievement. Participants who instead listed more avoidance goals recalled more memories related to non-attainment and those memories were rated as being more negative, supporting their current goal of avoidance. These results indicate that the goals that individuals possess affect the content of memory retrieved. In a different study, Gardner et al. (2000) investigated the extent to which the need to belong may affect the way individuals process social information. Participants were instructed to interact with four other people and received either approval or rejection clues from others. Participants then read a diary containing social and individual events. The results of a subsequent memory task showed that participants in the rejection condition had better memory for social activities, suggesting that the unfulfilled need for social acceptance would selectively increase the retention of the information related to their goals of social acceptance. The results of these studies indicate that the self-concept guides the retrieval of memories that are important for supporting self-related goals.

Altogether, these studies show that the self has a powerful effect on the way self-related knowledge is encoded and retrieved and that individuals possess more knowledge in relation to the self than for others. The amount of knowledge that individuals possess (e.g. examples of situations when they manifested a trait) determines the type of information retrieved (abstract or specific). The self-knowledge can be either abstract and semantic or episodic and detailed (Klein et al., 1989; 1992a;b; 1993a;b; Conway, 2005). A series of investigations claim that when individuals possess extended knowledge of examples of when they manifested attributes, skills and behaviours, self-information is abstract (Klein et al., 1989; 1992a;b; 1993a;b; Scherman et al., 1994; Schell et al., 1996). This type of abstract semantic self-knowledge is context-independent so that individuals can make self-judgements without retrieving the specific temporal and contextual details of when they manifested a trait attribute. In contrast to semantic self-knowledge, when people do not possess enough examples to abstract the information, their judgements will rely on retrieval of episodic self-related information, which requires the retrieval of specific temporal and contextual details (Klein et al., 1992a). Evidence exists which indicates that semantic and episodic self-knowledge rely on different brain areas (Levine, Turner, Tisserand, Hevenor, Graham & McIntosh, 2004) and are independently affected by ageing, with older adults performing significantly more poorly than younger adults on tasks that rely on episodic retrieval (Spencer & Raz, 1995), whereas their performance on semantic tasks is relatively preserved (Adams et al., 1997). Therefore, it can be expected different components of the self would be differentially affected by age. In line with this view, the ability to make self-related judgments appears not to be affected by age when participants are instructed to make self-descriptive judgements on a series of personality trait adjectives (Ruby et al., 2009; Feyers et al., 2010). The intact performance of older adults on this type of task may relate to the brain areas involved. Specifically, making self-judgements relies on the activation of the ventromedial prefrontal cortex (VMPFC; Kelley et al., 2002), which is known to be less affected by ageing than other brain areas, such as the dorsolateral prefrontal cortex (DLPFC; MacPherson et al., 2002; Phillips et al., 2002). As previously discussed (Chapter 1), the DLPFC is involved when the task requires greater mental effort (e.g. episodic retrieval; Gilboa, 2004). These results suggest that the performance on tasks that rely on the DLPFC would be affected by ageing to a greater extent than tasks that rely on the VMPFC region.

2.2.1. Episodic and semantic-self knowledge

The above studies show that the concept of the self is related to two memory systems: the episodic knowledge of past events, related to temporal and contextual information, and the semantic knowledge of self related attributes, beliefs and thoughts, which does not require retrieval of specific temporal and contextual information (Klein et al., 1989; Klein, Loftus, Trafton & Fuhrman, 1992a; Klein, Loftus & Plog, 1992b; Klein, Loftus & Sherman 1993a; Klein & Loftus, 1993b; Schell, Klein & Babey, 1996; Conway, Singer & Tagini, 2004b; Conway, 2005). The following section will discuss neuroimaging and patient studies which show that these two types of memory retrieval rely on the activity of distinct brain areas and can be independently affected by brain damage.

2.2.1.1 Autobiographical episodic memory and semantic self-knowledge

The relationship between the self-concept, goals and autobiographical memories is described by the Self Memory System (SMS) model developed by Conway et al. (2000; Conway, 2005). The model includes the working self (see also Markus, 1977; Markus and Kunda, 1986) and self related knowledge.

2.2.1.1.1. Working self

In Markus's view, different aspects of the self can be activated by different situations in relation to the individual's goals. It was assumed that when receiving information that may threaten the self-concept, people make every effort to reaffirm their self-view. Therefore, if a person was told s/he is extremely similar to someone else, s/he would experience a threat to her/his self view as being unique and, as a result, s/he would try to reaffirm her/his self view. In order to investigate the effect of contextual changes on the self-concept, Markus et al. (1986) presented four participants at a time (three confederates and a subject) with images of different items (e.g. three colours, three cartoons) and instructed them to indicate which item they liked best. In the similarity condition, the three confederates chose as their favourite the same item chosen by the participant. In the uniqueness condition, confederates disagreed with the participant's choice and agreed with one other. Participants were then presented with attributes related to uniqueness (e.g. original, unique), similarity (normal, follower) and unrelated to either concepts and were instructed to indicate whether the attributes described them. The results showed that the two conditions did not differ in the number of neutral, uniqueness- and similarity- related words that they considered as self descriptive, indicating that in both groups both concepts were considered important. However, a difference emerged in the accessibility of these concepts: those in the similarity condition were faster in responding to uniqueness words while those in the uniqueness group were faster in responding to similarity items. These results indicate that a different self-view can be triggered by changing situations and will affect the way information is processed. The concept of the working self in Conway's model guides memory retrieval according to the current self-related goals (Conway & Tacchi, 1996; Conway et al., 2004a).

2.2.1.1.2. Self related knowledge

In the SMS, self-related knowledge is organised on a continuum that ranges from general to more detailed autobiographical memories. Three types of autobiographical memories are included in the SMS: lifetime periods, knowledge of general events and event-specific knowledge (ESK).

Lifetime periods refer to long periods of time (i.e. years) and represent general knowledge of people, locations, activities and plans (e.g. when I was at school). This knowledge is the highest level of abstraction of self-related autobiographical memories. The lifetime period emerged from the clustering of general events. In order to investigate how personal memories are organised, Conway and Bekerian (1987) employed a priming task where participants were presented with a prime word that referred to a semantic category (e.g. furniture, sports) or to a lifetime periods (e.g. school days; when I worked at…). The prime was followed by a cue (an exemplar of the previously presented semantic category (e.g. desk) or a personal event that occurred during a life time period (e.g. going to London) to which participants were instructed to retrieve a personal experience. The time taken to generate a memory was used as a measure of the facilitating effect of the prime cue on retrieval. The results showed that retrieval of personal memory was facilitated when participants were primed with a lifetime period but not with a semantic category. This study suggests that autobiographical memories may be hierarchically organised in terms of abstracted personal knowledge (e.g. life time periods).

The general events category of autobiographical memory refers to more specific knowledge of repeated events over a period of months and weeks and can be accessed through knowledge of lifetime periods. It has been claimed that general events are clustered on the basis of temporal proximity and causality (i.e. one event causes another event). Support for this claim comes from a study that employed an event cueing procedure (Brown and Schopflocher, 1998). In one condition, the important event condition, participants listed some personal events. A different group of participants was assigned to a word condition, in which they were instructed to retrieve memories in response to a concrete noun. The memories generated were then used as cues for a second memory retrieval task where participants were then presented with pairs of events that included the cuing events (the first memory generated) and the cued events (the second memory generated) and were asked to indicate how the events were related: whether they involved the same features (e.g. people, locations), whether one caused the other, or whether both were part of a larger story. The results showed that both groups often generated events that belonged to the same cluster, that the important events group generated more clusters and that the events retrieved were more likely to be temporally proximated and causally related compared to memories generated by the word-cue group. The results indicate that personal past events are grouped together on the basis of temporal proximity and causality in order to form broad clusters of events.

General events knowledge allows access to the more event-specific knowledge (ESK) that consists of memories of specific and detailed events. Haque and Conway (2001) presented their participants with cue-words and instructed them to remember a personal event related to the word. Some words were followed by a probe (the word "Report") where they were instructed to report all that crossed their mind during retrieval. Probes were presented after 2, 5 or 30 seconds. Memories were classified as describing lifetime periods, general events or ESK. The results showed that after 2 seconds most protocols were classified as lifetime periods, after 5 seconds as general events and memories reported after 30 seconds were mostly described as specific episodes. These results suggest that memory retrieval is a cognitively effortful process in that past personal memories are constructed by first accessing abstract knowledge followed by more detailed information at a later stage. Specifically, memories of different events (life time period, general and specific events) are retrieved and accessed in cycles, from abstract to more detailed information and that more time is required to retrieve more detailed memories (e.g. event specific knowledge).

The relationship between the self, its goals and autobiographical memory is reciprocal: the self determines constraints on what can be retrieved from memory, and these constraints should be consistent within the self. For example, it has been shown that the type of memory retrieved (general or specific) depends on self-related goals: general rather then specific events are retrieved to define the self in that general events describe aspects that are "typical" of the self. Support to this idea, comes from a study (Brunot et al., 2004) in which participants were made believe that either introversion or extraversion was related to academic success. Participants were then asked to retrieve personal pat behaviours in relation to trait dimensions (e.g. lazy-industrious). The results showed that those who believe that introversion would lead to success recalled more general introverted memories compared to extroverted success participants who instead recalled more general extraverted memories than introversion-success participants. The authors concluded that the general memories are selectively recalled and help to maintain the desired self-perception. In turn, autobiographical knowledge determines the creation of self-identity. McAdams, Diamond, de St. Aubin and Mansfield (1997) investigated the creation of self-narratives in relation to the psychosocial states described by Erikson (1997; infancy/childhood, adolescence, early adulthood, middle/old age). As has been discussed earlier in this chapter, the old age is thought to be characterised by the specific generativity goal (i.e. commitment in guiding the next generation). In their study, McAdams et al. (1997) compared the self-narratives of high and low generative elder individuals and found that the memories retrieved sustained the current view of the self (i.e. memories of concern for others) and also affected the goals for the future (i.e. goals for the future that would benefit society). These results support the view that memories are retrieved in order to support the current self-view (Conway et al., 2005) as well as to plan future self-related goals. However, the memories retrieved to sustain the self need to correspond to real past events. In order to investigate this claim, Sanitoso, Kunda and Fong (1990) selected participants who were either extremely introverted or extraverted and led them to believe that either introversion or extraversion was important for academic/professional success. The results of a subsequent descriptive task, where for each trait they indicated whether it was self descriptive, showed that the extraverted individuals rated themselves as more extraverted than introverted individuals in both the introversion and extraversion conditions indicating that their ratings were constrained by prior knowledge of self as extraverted. This study indicates that the process of retrieving is not entirely guided by self-related goals. The events recalled need to be consistent with the actual facts.

2.2.1.1.3. Neuroimaging and patient studies

As previously discussed, in the SMS models (Conway et al., 2000; 2005) memories are organized from general to detailed episodes. It has been shown that autobiographical memories are retrieved through a process named generative retrieval (Conway, Turk, Miller, Logan, Nebes, Meltzer et al., 1999; Conway, Pleydell-Pearce & Whitecross, 2001). The memories retrieved in response to a cue word (e.g. train) are then evaluated by the working self to determine whether they are consistent with the self-goals. This process is thought to rely on the left frontal areas which are important for implementing control process during the retrieval of autobiographical memories (Conway et al., 1999; 2000; 2001). More detailed memories, instead, would be stored in posterior brain areas, thought to be activated when memories are accessed and maintained. In an EEG investigation, Conway et al. (2001) instructed their participants to retrieve personal memories in response to a series of cue words (e.g. restaurant, train, beach). They found initial strong activity in the left frontal areas at cue presentation, which they interpreted as the early phase of autobiographical memory retrieval. Once the memories were retrieved, there was a shift to activity in more posterior temporal and occipital areas where the memory knowledge is thought to be stored. To further corroborate the location of autobiographical memories, Conway et al. (1999)

investigated changes in the regional cerebral flow (rCBF) during a semantic and an autobiographical memory task and found that the left middle and inferior frontal areas were more active during the autobiographical than the semantic retrieval. Activation during autobiographical retrieval involved also temporal and parietal areas. Semantic retrieval showed instead right lateralised activation, particularly in the temporal, parietal and occipital lobes. These results provide support for the view that autobiographical memories are retrieved in cycles and that the retrieval of personal past memories and of semantic knowledge rely on different brain areas. The generative retrieval can be bypassed when the cues provided are very specific so as to determine a direct access to specific memory without the need to retrieve general memories. To test this proposal, Fink, Markowitsch, Reinkemeier, Bruckbauer, Kessler and Heiss (1996) presented their participants with very specific cues that provided details of a personal or another person's experience and were asked to imagine what have happened. The contrast between the personal and the impersonal memories did not show the same frontal activation reported in Conway et al. (1999; 2001); instead Fink et al. (1996) found extensive right frontal and temporal lobe activation. This is possibly because they used very specific cues that activated specific memories stored in more posterior brain regions.

The above studies compared areas of brain activation associated with personal episodic memory and knowledge not related to the self. Personal memory, however, may also be semantic in nature and refer to daily repeated events (e.g. making a cup of tea) that are time and context independent. It has been shown that personal semantic and personal episodic knowledge rely on different brain areas (Levine, Turner, Tisserand, Hevenor, Graham & McIntosh, 2004). In Levine et al.'s (2004) fMRI study, participants were presented with four types of information: personal episodic (PE) that referred to specific personal events; personal semantic (PS) that referred to repeated personal events; personal episodes of another person (OE) and general semantic (GS) knowledge. The fMRI results showed that personal memories (episodic and semantic) relied on a common brain network which included the anterior MPFC, thought to be associated specifically with processing of the self (Kelley et al., 2002), the DLPFC, associated with monitoring and manipulation of the information retrieved, the premotor cortex as well as temporal and parietal areas. Differences between the two types of personal memories emerged in the extent to which the MPFC was activated: the MPFC was more activated by PE than PS. Further differences between the two personal conditions emerged where PE was related to activation of the temporal lobe and diencephalic structures. In contrast, PS was related to activation in the thalamic and pulvinar nuclei connected to the lateral temporal and parietal cortex. These results indicate that PE and PS are partially dissociable. The greater activation of the MPFC in relation to PE compared to PS was due to the greater self involvement during episodic memory, which related to daily activities, such as making a cup of tea (e.g. I take the teapot with the broken lid and rinse that out with warm water and then I put enough tea bags in it).

Patient studies have provided further evidence that episodic and personal semantic autobiographical memory can be dissociated. For example, Levine, Black, Cabeza, Sinden, McIntosh, Tulving et al. (1998) reported the case of a retrograde amnesic following a closed-head injury. The patient was unable to remember any specific episodes that happened before the injury; however he could recollect some personal semantic information, such as the destinations of his holidays, indicating that personal episodic and semantic knowledge are dissociable.

2.2.1.2. Autobiographical episodic memory and trait self knowledge

In the SMS model, Conway et al. (2000) described the relationship between the self and episodic and general self-knowledge. However, there is a third group of general context independent information related to traits, attitudes, beliefs and values of the self, known as the Conceptual Self (Conway et al., 2004b). The conceptual self-knowledge is assessed by asking participants to make judgements without the explicit instruction to recall a past memory. In one early study, Rogers, Kuiper and Kirker (1977), participants were presented with trait words and asked to indicate whether each trait was self-descriptive, if it was printed in capital letters, if it rhymed with another word or if the presented word had the same meaning as another word. In a subsequent surprise memory task, participants recalled as many of the trait words as possible. The words encoded in relation to the self were better remembered than those encoded on the basis of their semantic, phonological and physical features. This enhanced memory for information encoded with reference to the self is known as the Self Referential Effect (SRE). Since Rogers and colleagues' work, several studies have developed different paradigms to investigate the role played by the self on retrieval processes and have shown that both episodic and semantic memory determine a robust SRE (Ferguson, Rule

& Carlson, 1983; Brown, Keenan & Potts, 1986; Miall, 1986; Reeder, McCormick & Esselman, 1987; Klein et al., 1989; Craik, Moroz, Moscovitch, Stuss, Winocur, Tulving et al., 1999; Kelley et al., 2002; Macrae, Moran, Heatherton, Banfield & Kelley, 2004; D'Argembeau et al., 2005a; Heatherton, Wyland, Macrae, Demos, Denny & Kelley, 2006). The SRE will be further discussed in Chapter 6.

Autobiographical tasks often require participants to recall past experiences in response to verbal cues. Miall (1986) presented phrases (e.g. catching the train, pleased with money) and asked participants to recall an experience of him/herself or a friend in the situations described and then to recall the phrases previously presented. Phrases encoded in relation to the self or a friend were remembered better than the control condition (deciding how commonly each phrase might be used in ordinary conversations). Klein et al. (1989) presented their participants with a series of trait adjectives and for each trait they were asked to decide if the word was self-descriptive or to recall a memory related to the word. The results showed that both the descriptive and the memory task determined better recall of traits then the semantic task and that no difference emerged between the descriptive and the memory task. These studies showed that the SRE occurs during both autobiographical retrieval and when participants are asked to make self-judgements without being instructed to recall past episodes. The SRE will be discussed in more detail in chapter 6, which focuses on the SRE in healthy adult ageing. The memory advantage provided by encoding information in relation to the self, however, appears to reduce when compared to information encoded in relation to a close other person.

2.2.1.2.1. Self and Close Others

Intimate others have been postulated to be integrated into the representation of the self and to share common characteristics and neural activation with the self (Aron, Aron, Tudor & Nelson, 1991; Smith, Coats & Walling, 1999; Mashek, Aron & Boncimino, 2003; Schmitz, Kawara-Baccus & Johnson, 2004). Support to this proposal comes from a study that investigated the inclusion effect for close others in response latency based paradigm (Aron et al., 1991). Participants first made trait judgements about the self, the partner and a TV character and then were presented with the same traits. For each trait, they indicated whether it was self-descriptive or not. The results showed that participants were faster for traits that were common to the self and a partner (either true/descriptive or false/not descriptive of both targets) while they were slower for traits that differed between the self and partner (traits that were true for a partner, but false for the self) suggesting that greater confusion emerges as a consequence of the inclusion of a close other into the self concept. A more recent study employed an episodic memory paradigm that required participants to recall the circumstances under which they acquired the information (Mashek et al., 2003). Participants rated traits for the self, a partner and two strangers, and then, in a subsequent memory test, they indicated for each trait who they had rated it for. The results showed more confusion between the self and a partner than either the self or a partner with strangers. Altogether these finding indicate that the concept of the self that individuals possess may extend to include important others and including others into the self-representation might lead to confusion between the self and others.

2.2.1.2.2. Representation of episodic and abstract self-knowledge

The way individuals decide whether a trait is self descriptive has been explained using both the exemplar and the abstraction models. In the exemplar model, in order to decide whether a trait describes the self, individuals need to retrieve specific behavioural exemplars of the trait (Bellezza, 1984). In the abstraction model, traits are abstracted from the behavioural instances (Klein et al., 1989). These two types of self-knowledge (i.e. context related and abstract) have been shown to be independent (Klein et al., 1989; 1992a;b; 1993a;b; Schell et al., 1996). This topic will be further discussed in detail in Chapter 3. However, episodic and semantic trait self knowledge systems may interact so that memories of specific behavioural exemplars are retrieved in order to make self related semantic judgements. Klein et al. (1992a) developed the mixed model, according to which both exemplar and abstract knowledge play a role helping people whether a trait is self-descriptive. In order to make trait judgements about a person, one needs to have access to a sufficient amount of behavioural exemplars to allow for abstraction of general trait knowledge. However, when one does not have sufficient experience of a target person (i.e. few behavioural exemplars), their judgements may rely more on retrieval of specific events (Klein et al., 1992a; 1993b; Sherman & Klein, 1994; Schell et al., 1996). This hypothesis was tested using a facilitation paradigm (Klein et al., 1992a) which requires participants to perform two tasks in sequence and postulates that the second task will be facilitated and performed faster if the initial task makes available the information necessary to perform the second task. Klein et al. (1992a) presented their participants with trait adjectives and they had to either provide a definition of the word, to rate the trait as descriptive of their mother or to recall a specific episode that would be an example of the trait showed by their mother. The second task required participants to either perform a descriptive trait judgement in relation to their mother or to retrieve a past episode. Finally, they were presented with the same trait adjectives and asked to rate the degree they were representative of their mother (high, medium or low). The results showed that, for highly representative traits, the descriptive task was no more facilitating than a definition task on memory recall, which in turn was no more facilitating than a definition task on a subsequent descriptive task. Instead, for medium and low representative traits, the descriptive task facilitated memory retrieval and the autobiographical task facilitated the descriptive task more than a definition task, suggesting that memories of past behaviours are used to make judgements about information for which individuals do not possess extensive knowledge. Episodic and trait self-knowledge will be further discussed in Chapter 3.

2.2.1.2.3. Neuroimaging and patient studies

Recent reviews on the neuroimaging investigations of self-related information have shown the involvement of a brain network that includes the medial prefrontal frontal cortex (MPFC), DLPFC, ACC and PCC, temporal and parietal lobes (Gillihan et al., 2005; Northoff, Heinzel, de Greck, Bermpohl, Dobrowolny & Panksepp, 2006; Lieberman, 2007). Despite this spread of activation, the processing of the self in tasks that do not require access to autobiographical memory, such as trait judgement, is specifically associated with the medial prefrontal cortex (MPFC), in particular the ventromedial prefrontal cortex (VMPFC), (Kelley et al., 2002). The role played by the VMPFC has emerged in several neuroimaging studies that employed different paradigms. One such paradigm investigates self-reflection, which is the ability to reflect on one's own state. In a PET study, Kjaer, Nowak and Lou (2002) asked their participants to reflect on their own personality traits and the traits of the Danish Queen (distant other person). The results showed that reflection of self-traits activated the precuneus, the temporoparietal area and the OFC compared to reflection of the Queen. In a more recent fMRI investigation, Lombardo, Chakrabarti, Bullmore, Wheelwright, Sadek, Suckling et al. (2010a) instructed their participants to indicate the extent to which a target person (the self or the British Queen) agreed with statements that focused on mental features (e.g. How likely are you/is the British Queen to think that keeping a diary is important) and found that activation of the VMPFC (BA 10/11) was activated to a greater extent for the self than other related judgements providing further support to the role played by the VMPFC in processing self relate information.

As described previously, in trait attribution tasks, participants are presented with a series of trait adjectives and are scanned while they indicate for each trait whether it is self-descriptive or descriptive of another person. In an fMRI study, Kelley et al. (2002) asked their participants to indicate whether trait words were self-descriptive, whether they were descriptive of President George Bush or whether they were printed in upper case letters. The results of a surprise recognition task showed the classic SRE effect, with participants recognising more self-related words than words encoded in relation to Bush or the case judgement. Moreover, the results showed that a region of the VMPFC

(BA 10) was specifically activated during the self-condition. However, this result contrasts with a previous study by Craick et al. (1999) that did not find any differential brain activity between self and a famous but not-close other person. Kelley et al. (2002) pointed out that Craick's et al. study employed a blocked design procedure whereas Kelley's study trials were randomly intermixed. The VMPFC is also specifically related to the retrieval of self-relevant information. Macrae et al. (2004) investigated brain activation related to subsequent remembered and forgotten items for self and non-self descriptiveness items and found greater activation of the VMPFC (BA 10) for self relevant traits that were then remembered. These results indicate the central role played by the VMPFC in making self-related judgements as well as in retrieving information that is relevant to the self-concept. Despite these evidences, another area of the PFC, the DMPFC appears to be involved in making self-judgements. It has been proposed that these two areas of the MPFC play a different role in self-processing (Northoff & Bermpohl. 2004; Northoff et al., 2006). The VMPFC is considered to represent stimuli as self-referential (Kjaer et al., 2002; Kelley et al., 2002; Macrae et al., 2004; Lombardo et al., 2010a; D'Argembeau Collette, Van der Linden, Laureys, Del Fiore, Degueldre et al., 2005b) while the DMPFC is involved in the evaluation of self-referential material, when inferring others' beliefs and intentions and when taking another person's perspective of the self (Ochsner et al., 2005; Happé, Ehlers, Fletcher, Frith, Johansson, Gillberg et al., 1996; Frith & Frith 2003; D'Argembeau et al., 2005b; D'Argembeau, Ruby, Collette, Degueldre, Balteau, Luxen et al., 2007).

The difference between semantic traits and episodic self-knowledge is further supported by patient studies. Tulving (1993) described patient KC whose episodic memory was impaired following a motorcycle accident. Despite severe retrograde amnesia, he was able to accurately describe his current personality. In a further series of investigations, Klein and colleagues showed that the ability to process self-related information is intact in patients with episodic as well as semantic memory deficits, suggesting that self-knowledge is separate from both episodic as well as general and personal semantic knowledge (Klein Loftus & Kihlstrom, 1996; Klein, Chan & Loftus, 1999; Klein, Rozendal & Cosmides, 2002a; Klein, Cosmides, Costabile & Mei, 2002b). For example, Klein et al. (1996) reported the case of a college student WG who sustained a head injury. The patient could not recall events that happened in the 6-7 months before the accident. Despite amnesia for episodic events, WG showed intact self-knowledge. Similarly, an autistic patient RJ with a severe episodic memory deficit did not show any impairment in his rating of the semantic self (Klein et al., 1999). The authors claimed that RJ may have never developed the ability to store episodic information and therefore suggest that episodic knowledge is not necessary for either semantic self-judgements or the development of self-trait knowledge. Moreover, patient DB who suffered brain anoxia was impaired on both personal episodic and personal semantic memory (although less so than in terms of episodic memory). Despite these deficits, his self-concept was still intact (Klein et al., 2002a). In a further study, Klein et al. (2002b) showed that semantic trait knowledge is a system separate from the general semantic memory system. The same previously tested autistic patient RJ (Klein et al.,

1999) was assessed in terms of non-personal semantic memory. Three semantic categories were investigated: animals, inanimate objects and food. RJ and healthy controls were presented with a series of questions for each category where they were instructed to indicate the extent to which the subject of the sentence possessed a given attribute (e.g. Is a horse a large animal?) by choosing their answer from three options: not at all, somewhat and definitely. The results showed that RJ performed poorer compared to healthy controls. Based on the results of the above studies, Klein et al. (2002a;b) claimed that the semantic memory system might consist of different components, one of which is specialised for processing traits in relation to the self-concept.

The studies discussed in this section showed that the self-knowledge refers to detailed autobiographical memory as well as to an abstract self-related knowledge (e.g. self related trait knowledge). The ability to decide whether a trait is self-descriptive appears to rely on VMPFC functioning (Kelley et al., 2002) and as discussed in Chapter 1, MacPherson, Phillips and Della Sala (2002) showed that the VMPFC is less affected by ageing than other brain areas, such as the DLPFC. In line with this view, the ability to process the self should not decrease with age.

2.3. Ageing self

People typically face physical, psychological and social changes as they become older (Brandtstädter & Greve, 1994). These changes have been associated with negative beliefs that individuals hold about the aging process (Sneed & Krauss Whitbourne,

2005) and which negatively affect their well being (Levy, Hausdorff, Hencke & Wei, 2000; Levy, Slade, Kunkel & Kasl, 2002a; Levy, Slade, Kunkel & Kasl, 2002b; Steverink Westerhof, Bode & Dittman-Kohli, 2001), health-promoting behaviours (Levy & Myers, 2004) as well as cognitive functioning (i.e. memory; Levy, 1996). Improving cognitive functioning, such as memory performance might enhance the view of the ageing-self that individuals possess as well as their well being and health related behaviours. Therefore it appears to be important to determine what aspects of the self are less affected by healthy adult ageing.

Changes in self-identity emerge in older adults in relation to personality dimensions: some traits appear to reduce with age (i.e. extraversion and openness to experience; Roberts, Walton & Viechtbauer, 2006) while others increase as people become older (i.e. agreeableness and consciousness; Srivastava, John, Gosling & Potter, 2003). It has been reported that the self-representation that individuals possess changes as people age and shifts from a representation that focuses on in-groups and social acceptability to more complex representations in terms of individual qualities and traits (Labouvie-Vief, Chiodo, Goguen, Diehl & Orwoll, 1995).

Age-related changes also emerge in terms of self-related goals and motivations. As previously discussed, research has shown that there are two ways to reach a desired end state: by moving towards positive outcomes or by avoiding negative outcomes (Higgins et al., 1994). Older adults are thought to show changes in the way they get closer to a desired goal. For example, Freund and Ebner (2005) reported that older adults are biased towards the avoidance of negative outcomes (e.g. cognitive functions), whereas younger adults are more oriented towards achieving positive outcomes. In terms of specific goals, older adults are oriented towards the development and maintenance of deep relationships, positive feelings and well being (Carstensen, Isaacowitz & Charles, 1999; Sneed et al., 2005) Self-related goals are thought to be age specific (Conway et al., 2004a). Humans are thought to develop across five psychosocial states: infancy and childhood; adolescence; early adulthood; middle age; and old age, where each stage is thought to be characterised by different self-related goals (Erikson, 1997, cited in Conway et al., 2004a). For example, early adulthood is centred on identity developments versus identity confusion, whereas old age is centred on generativity versus stagnation (i.e. being concerned about others' welfare and taking care of others), suggesting that self-related goals change as people become older.

As the self is thought to guide the encoding of self-relevant information (relevant to goal attainment), and determines what memories will be retrieved (consistent with the current self view that one possesses; Conway et al., 2000; 2005), it might be expected that the most accessible memories of the past are those related to the self-goals typical of young adulthood. This would suggest that specific types of information (e.g. self consistent) are more easily accessible than information less important in defining the self-concept. In order to investigate whether goals are age specific, Conway et al. (2004a) instructed older adults to recall memories belonging to different periods of their life (childhood, young adult, middle age, and old age). The content of the memories retrieved was classified according to the psychosocial states proposed by Erikson (e.g. identity search; early adulthood). The results showed that the content of the memories retrieved referred to an age that corresponds with the stages described by Erikson, indicating that goals change as people become older.

In terms of motivations that guide evaluations of the self, evidence indicates that despite a decline in physical, psychological and social functions, older adults hold a positive view of their ageing self (Demo, 1992; Brandtstädter et al., 1994). For example, the level of neuroticism appears to reduce with age suggesting that older adults might become less anxious as they age (Sneed et al., 2005). Furthermore, the positive self-perception of ageing has been shown to relate to well being and longevity (Levy et al., 2002a;b). The positive self view held by older adults has been associated with the ability of older individuals to adjust their goals, expectations, motivations and emotional reactions to more achievable levels leading to "successful ageing", rather than pursuing goals that can no longer be achieved due to the physical and the cognitive changes typical of the older adult (Brandtstädter et al., 1994; Sneed et al., 2005). The positive self-view of older adults has been claimed to emerge because of the tendency of older participants to preferentially process positive information (Carstensen et al. 1999; Mather & Carstensen, 2003). It is possible that this effect is due to the effect of age on those brain areas involved in emotion processing. In fact, it is known that emotion recognition relies on VMPFC brain areas (Hornak et al., 1996). The VMPFC is thought to be relatively spared in older adults (e.g. VMPFC; Phillips, MacPherson & Della Sala, 2002) and some neuroimaging studies have reported that the involvement of these brain areas during emotion recognition tasks increases as people become older (Fischer, Sandblom, Gavazzeni, Fransson, Wright & Backman, 2005; Ruffman Henry, Livingstone & Phillips, 2008).

The VMPFC brain areas have also been reported to be involved in processing self-related information (Kelley, Macrae, Wyland, Caglar, Inati & Heatherton, 2002) and no age effect emerges in terms of accuracy and VMPFC activity when participants are instructed to make personality trait judgements of the self (Ruby et al., 2009; Feyers et al., 2010). The present study will investigate the performance of younger and older adults on a series of tasks that differ in the extent to which they rely upon different types of memory and the involvement of different frontal brain areas.

2.3.1. Ageing self, memory and theory of mind

As discussed earlier, people face several changes as they become older (Sneed et al., 2005) and negative beliefs about the ageing process are associated with poor memory performance (Levy, 1996), poor health-related outcomes and depression (Levy et al., 2000; 2002a; Gattuso, 2001). It appears, therefore, important to determine which aspects of self-processing are affected less by ageing in order to help maintain or improve well being and cognitive functioning. Furthermore, as the discussed evidence shows, processing self and other related information depends on the PFC brain areas (Kelley et al., 2002; Heatherton et al., 2006). This suggests that damage to the PFC would affect the ability to process self and other-related information. However, the self consists of different components (e.g. semantic and episodic self-knowledge) that depend on the activity of distinct brain areas: processing semantic self-related knowledge relies mainly on VMPFC activity whereas episodic retrieval of self-information requires DLPFC as well as temporal lobes activity (Kelley et al., 2002; Gilboa, 2004; Levine et al., 2004), suggesting that different component of the self/other processing might be differentially affected by ageing. As discussed in chapter 1, the VMPFC and the DLPFC areas can be differentially affected by brain damage (e.g. Sarazin et al., 1998). Therefore, the investigation of processing of the self and others in older adults will help discriminate which aspects of the self and others decline as consequence of frontal lobe damage and which components are instead affected by healthy ageing.

The current study will investigate the performance of younger and older adults on a series of tasks that differ in the extent to which they rely on episodic and semantic memory and that are thought to involve activation of distinct brain areas (Chapter 3 and 4). Older participants are expected to perform as well as younger adults on tasks thought to rely on semantic self knowledge whereas age differences may emerge on tasks that require greater cognitive effort (e.g. episodic retrieval).

The ability to make self-judgements appears not to decrease with age (Ruby et al., 2009; Feyers et al., 2010). This may be due to the fact that processing self-related information relies on the VMPFC which deteriorates more slowly than the DLPFC in healthy adult ageing (MacPherson et al., 2002). Participants will perform a series of tasks thought to measure cognitive functions traditionally associated with the VMPFC and DLPFC brain areas (i.e. the affective and cognitive components of Theory of Mind respectively; Chapter 5). Theory of Mind (ToM) is the ability to understand what another person thinks or feels. ToM and processing of the self may rely on a common brain network that involves the MPFC as individuals may rely on self-related knowledge to understand others (Frith & Frith, 2003). On the basis of this view, older participants are expected to perform as well as younger adults on all self-related task as well as on tasks tapping VMPFC functions (i.e. affective ToM). In contrast, age differences might emerge on task thought to measure functions associated to DLPFC brain areas (i.e. cognitive ToM).

As the self consists of different components that are supported by different brain areas, the performance on self-related tasks thought depend on effortful episodic are expected to be affected by ageing. This possibility will be investigated in series of experiments that test the memory performance of younger and older participants for information encoded in relation to self and others. It has been shown that encoding information in relation to self leads to higher memory performance (self referential effect, SRE) than encoding information in a shallow manner (e.g. structural) or in relation to another person (Rogers et al., 1977; Brown et al., 1986; Kelley et al., 2002) in both younger and older adults (Gutchess, Kensinger, Yoon & Schacter et al., 2007a; Glisky & Marquine, 2009). The SRE has been further shown to emerged in younger individuals when participants are not instructed to make an explicit evaluation of the trait (Cloutier & Macrae, 2008; Cunningham, Turk, Macdonald & Macrae, 2008; the SRE will be further discuss in Chapter 6). In Chapter 6 the relationship between the self and memory retrieval will be investigated in two tasks that do not explicitly require the processing of information related to the self or another person. Both younger and older participants would be expected to show higher memory performance for self related materials compared to another person encoding condition in that older adults benefit of strategies based on self related information (Derwinger, Stigsdotter Neely, MacDonald & Backman, 2005) and in that the ability to process the self information does not decrease with age (Ruby, Collette, D'Argembeau, Peters, Degueldre, Balteau et al., 2009). However, older individuals have been often reported to perform poorer than younger adults on episodic memory tasks that require to retrieve detailed temporal and contextual information (Levine, 2004), such as when they performed a recognition task on a list of words that includes previously encountered and new words (Schacter, Koustaal & Norman, 1997). Therefore, older participants are expected to show a general poorer memory across self and non-self conditions compared to younger adults.

Finally, due to the involvement of the VMPFC when making self-judgements, it might be expected that brain damage to the medial region of the PFC would determine deficits in processing self-related information. Indeed, Conway and Tacchi (1996) proposed that damage to the frontal areas affects the self-memory system. As a result, the self-concept would be disconnected from the episodic retrieval of past events and would contribute to the content of confabulating memories. A final experiment (Chapter 7) will investigate whether the ability to process self-related information would be affected by brain damage to the brain areas involved in self-processing in confabulating patients.

Chapter 3. Behavioural and Personality Judgements

3.1. General introduction

The self-representation that individuals hold emerges through and is supported by the memory of past episodes (Sanitoso et al., 1990; McAdams et al., 1997; Conway, 2005). This aspect of the self-concept might be particularly relevant in the older population. As people become older they face several physical, psychological and social changes (Sneed et al., 2005). Successful ageing (Brandtstädter et al., 1994) occurs when older adults adapt their goals and motivations to their current skills and abilities in order to set more achievable goals. This view of the ageing self requires that older adults detect self-related changes compared to the past and accurately rate their current self. Furthermore, retrieval of past self-related information is also involved in making self-enhancing comparisons, as discussed in Chapter 1 (Wilson et al., 2001). During adolescence and early/middle adulthood, social comparison is important for the formation of the self-concept. Older individuals, instead, make more comparisons with a past self rather than making a social comparison, possibly due to their reduced social interactions (caused by retirements and death) in older years (Demo, 1992). It appears therefore important that older individuals retrieve accurate past self-information.

As previously discussed, the self relies on two memory systems: the episodic and semantic systems (Klein et al., 1989; 1992a;b; 1993a;b; Conway, 2005). Older individuals perform more poorly than younger adults on episodic memory tasks (Levine, 2004), such as when they perform a recognition memory task involving both previously encountered and new words (Schacter, Koustaal & Norman, 1997). In contrast to younger individuals, older adults rely to a greater extent on semantic self-knowledge when instructed to report self-relevant past events (Levine, Svoboda, Hay, Winocour & Moscovitch, 2002; Piolino, Desgranges, Benali & Eustache, 2002; Spencer & Raz, 1995) and their performance on semantic tasks appears to be relatively intact (Carstensen et al., 1994; Adams et al., 1997). These results suggest that older adults might rely more on semantic self-knowledge even when the tasks require episodic retrieval.

The aim of the following experiments is to investigate the ability of younger and older adults to make self-related judgements on tasks that differ in the extent to which they rely on episodic and semantic memory retrieval. Participants will perform two tasks where they will make self/other judgements at the present time and in the past. In the first task, the behaviour prediction task, participants will indicate their own and a close other person's possible emotional reactions to a series of social situations. The task has been used previously to investigate the neural correlates of the ability to make judgements taking a third person perspective in a group of younger adults (Ruby & Decety, 2004) as well as anosognosia for self-related changes in a group of patients with frontal variant frontotemporal dementia (fvFTD; Ruby, et al., 2007). This type of judgement has been shown to rely upon episodic knowledge (Ruby et al., 2007). In the current study, the behaviour judgement task will be used to investigate the ability to make self/other related judgements on the basis of episodic retrieval in both younger and older participants. The second task, the personality judgement task, has been previously employed to investigate the neural correlates of the concept of the self in younger and older adults as well as in patient with Alzheimer's Disease (AD: Ruby et al., 2009). This type of judgement is known to rely on semantic memory retrieval (Klein et al., 1989; 1992a;b; 1993a;b). In the present study, the personality judgement task will be used to investigate the ability to make semantic judgements.

Several measures will be computed for both the behavioural and the personality tasks. The inclusion of the same measures in both tasks will allow us to determine whether differences emerge in the processing of episodic and semantic self-related information. The ability of participants to make accurate behaviour/personality judgements will be determined by asking a close relative or a friend to judge the participant's behaviour and personality. Older adults are expected to be as good as younger participants in making self/other judgements in both the episodic and the semantic tasks as they rely on their well established knowledge of the self and others, without the need to rely on detailed episodic retrieval (Ruby et al., 2009). Participants will be also instructed to make judgements about their own past behaviour and personality. Judgements related to the past have been included to determine whether participants report a behavioural/personality change. Their responses will be compared to those provided by the relative/friend regarding the participant's behaviour/personality in the past. This comparison allows us to determine whether, in the case of change, participants update their view of the self to the present time. As the ability to update self-related knowledge has been associated with OBF (which occupies the ventral surface of the PFC; Rolls et al., 1996) brain activity (Salmon, Perani, Herholz, Kalbe, Holthoff, Delbeuck et al., 2006; Schnider, Treyer & Buck, 2000), older participants are expected to accurately detect the change and update their self-representation. Furthermore, to measure accurate episodic retrieval, the comparison between the participant's and relative/friend's responses allows us to determine whether individuals rely on old memories of self-related behaviour/personality that differ from those reported by their relative/friend. This type of comparison also allows us to determine whether a discrepancy between judgements made by the self and the relative/friend emerge in relation to observable behaviours (i.e. the behaviour prediction task) or in relation to self-related attributes (i.e. the personality judgement task). In line with this view, it has been suggested that others' judgements may be more accurate when rating overt behaviours (e.g. "talkative" as indicator of extraversion) while self-judgements may be more accurate in rating less visible behaviours (e.g. emotional reaction; Spain, Eaton & Funder, 2000). Furthermore, Vazire and Mehl (2008) demonstrated that self-ratings show greater accuracy for behaviours such as "Arguing" while others' ratings were more accurate in "Talking one to one" and "Spending time with another". This difference may relate to the fact that negative behaviours are less expressed than positive behaviours as positive behaviours are more desirable and do not need to be hidden (Spain et al., 2000). This evidence indicates that participants are better in judging the self-covert and negative behaviours than are others. However, since older participants might have known their relative/friend for long time, they might also have expressed their "private" self more often than younger adults. This type of knowledge might lead to a discrepancy between the ratings made by the self and others in older participants.

Age differences might emerge in relation to the episodic retrieval deficits typically associated with healthy ageing. For example, older adults have been shown to provide stereotypical responses when they are required to retrieve specific past information, suggesting that they fill in the gap in their memory by relying on stereotypical knowledge of how people typically behave (Mather, Johnson & De Leonardis, 1999; Mueller, Wonderlich & Dugan, 1986). Furthermore, Nickerson (1999) claimed that self-related knowledge helps to fill in the gaps when one has little knowledge in relation to a close other person. This evidence suggests that older adults might compensate for their difficulties in retrieving episodic knowledge of the self and a close other by providing the same response in relation to the self and another person. In contrast, stereotypical responses might not emerge when the task relies on abstract and semantic knowledge of both the self and others.

3.2. Experiment 1a: Behaviour Prediction Task

3.2.1. Introduction

The concept of the self has been shown to emerge from past memories and to affect memory retrieval (Sanitoso et al., 1990; Skowronsky et al., 1991; McAdams et al., 1997; Sedikides et al., 2000; Conway et al., 2000; 2005; D'Argembeau et al., 2003; 2005a; 2008). Two main memory systems are associated with the construction and maintenance of the concept of the self: episodic memory, related to retrieval of past events and their contextual information, and semantic autobiographical memory, which is context independent (Conway et al., 2000). Semantic memory may contain 1) abstract information, such as "I am friendly" or "I was born in New York" (Klein, German, Cosmides & Gabriel, 2004b), 2) events repeated over weeks and months (e.g. evening hikes to meadows; Conway et al., 2000) or 3) routine events (e.g. making coffee; Levine et al., 2004).

As previously described, individuals are able to make abstract judgements, such as deciding whether a trait is self-descriptive or not, without accessing specific past episodes (Klein et al., 1989). For example, when one possesses sufficient behavioural exemplars depicting a target attribute, individuals refer to abstract knowledge rather than to specific past events (Klein et al., 1992a; 1993b).

Yet, others studies have shown that knowledge becomes more abstract over time and less based on behavioural exemplars (Sherman et al., 1994) and that when one does not possess sufficient experience to abstract semantic information, the episodic and the semantic memory systems interact so that specific behavioural exemplars are retrieved in order to make a judgement (Klein et al, 1993b; Schell et al., 1996). For example, Klein et al. (1993b) controlled the amount of self-experience (high and low experience) that individuals had acquired at college by selecting 1st year and 4th year students. Participants performed a facilitation task in relation to the time they spent at college. In this task, participants perform an initial task followed by a second task. The paradigm relies on the logic that if performing an initial task makes available the information, which is required to perform a subsequent task, performance on the second task will be facilitated (faster RTs). In the Klein et al. (1993b) study, participants were presented with a series of traits and instructed to perform one of two possible tasks: a) a memory task (i.e. to remember a specific situation when they demonstrated that trait) or b) a defining task (i.e. to provide a definition of the trait word). Then participants performed either a descriptive task (i.e. to indicate whether the word was self descriptive or not), or a defining task. Klein et al. reasoned that if the memory task and the descriptive task rely on different type information, no facilitation effect (in terms of response times) should emerge on the subsequent descriptive task. The results support this view: a facilitation effect emerged only for the 1st year students indicating that specific behavioural memories are retrieved when individuals do not possess enough knowledge for the abstraction of information to occur. In contrast, 4th year students had enough behavioural exemplars of that trait that allowed them to abstract the trait knowledge from the specific episode and therefore did not need to retrieve specific instances when they showed that trait. Therefore, these results suggest that when individuals possess an extensive knowledge of examples when they manifested a trait, they do not need to retrieve specific episodic memory; they decide whether a trait is self-descriptive on the basis of abstract self-knowledge.

In the current study, participants will perform self-related tasks that rely on either the retrieval of past information (behaviour prediction) or on semantic (trait descriptiveness) self-knowledge. Both tasks have been shown to rely on VMPFC involvement suggesting that the performance of older participants should be comparable to that of younger adults, as the VMPFC is relatively spared in older individuals (Phillips et al., 2002). However, older individuals are known to perform more poorly than younger adults on episodic tasks (Spencer et al., 1995). An age effect in the ability to accurately make behavioural predictions might indicate that older adults rely on episodic memory retrieval to perform the task. Such an age effect might be due to the involvement of the DLPFC during the retrieval of episodic memories, which has been associated with greater cognitive effort (Gilboa, 2004).

Support for the view that different PFC brain regions are involved in retrieving different types of self knowledge comes from neuroimaging investigations during the retrieval of personal past events and self-descriptive judgments under high or low experience conditions. In terms of memory retrieval, one study showed that the retrieval of personal semantic memory represented by contextually independent repeated events, is functionally separate from the retrieval of personal episodic memory (Levine et al., 2004). In this fMRI study, the researchers instructed participants to retrieve specific past episodes or semantic events repeated over time. The results showed that both episodic and semantic retrieval activated the VMPFC, which has been associated with the processing of self-related information (Kelley et al., 2002). Although both tasks explicitly required retrieval of past memories, they showed differential brain activity in relation to the extent to which they required the retrieval of contextual dependant (episodic) or independent (semantic) information. Activation during personal episodic retrieval was related to activity in the temporal lobe and diencephalic structures, while personal semantic memory was related to activation in the ventrolateral and pulvinar nuclei connected to the lateral temporal and parietal cortex. These findings indicate that when individuals recall past information, the retrieval of personal semantic and episodic memories are dissociable and rely on separate brain networks. Neuroimaging studies also support the involvement of memory retrieval in judgement tasks that requires to indicate whether the presented information is true or not, without the need to retrieval specific past episodes. For example, In a PET study, Maguire and Mummery (1999) investigated brain activation in relation to episodic/semantic memory for self-related and non-self related information. Participants were scanned while they heard sentences, which they had to say were true or false. Four types of events were presented: a) episodic autobiographical events (context-specific and personally-relevant): "you were Mike's best man at his wedding"; b) semantic autobiographical facts (not context-dependant; personally-relevant): "Ray is the youngest of your brothers"; c) memory for public events (context-specific not personally relevant): "Zola Budd tripped with Mary Decker"; and d) memory for general semantic events (not context-specific and not personally-relevant): "presenter Chris Evans has red hair". Making judgements about personal events that do not require explicit retrieval relies on the MPFC, the temporal pole, the hippocampus and the temporo-parietal junction. The results suggest that deciding whether a past event is true or not, requires some form of memory retrieval (although the limited time allowed for each sentence may have not evoked a full detailed memory, Levine et al., 2004). In a different study Johnson et al. (2002) presented participants with statements regarding their attitudes (e.g. I get angry easily) and semantic sentences (e.g. We need water to live); in a yes/no decision task they were asked to decide whether the sentence was true or not. Participants were allowed only 2 seconds to respond aimed at preventing them from retrieving specific episodes. The results showed that the self statements were specifically related to activation of the anterior medial prefrontal cortex (BA 9 and 10) as well as the posterior cingulate cortex (PCC) which has been suggested to integrate current self referential information into a broader emotional and autobiographical context (Northoff et al., 2004).

The need to retrieve episodic information also emerges in terms of self-descriptive judgements and is associated with activation of brain areas related to cognitive effort (e.g. DLPFC). For example, in an fMRI investigation, Lieberman, Jarcho and Satpute (2004) recruited participants who were athletes or actors. They were presented with words related to athletics (e.g. agile, muscular) and acting (e.g. artist, dramatic) and asked to make like me/not like me judgements. The results showed greater activation of the VMPFC in relation to judgements for high experience traits and activation of the DLPFC for low experience traits. Since Klein found that judgements are based on abstract information when one possess several behavioural exemplars, the results of the Lieberman et al. (2004) study indicate that judgements based on self related abstract information rely on the VMPFC. In contrast, the DLPFC activation which has been associated to retrieval of contextual information (Gilboa, 2004) would be mainly involved in making judgements based on behavioural exemplars.

As for the retrieval of personal past episodes (Levine et al., 2004), making self-descriptive judgments might involve the temporal lobes. For example, it has been shown that making judgements about both the self and another person (Ochsner et al., 2005) and taking the 3rd person perspective (D'argembeau et al., 2007) are associated with temporal lobe activation suggesting that past experiences are retrieved in order to assist in the judgement process (D'Argembeau et al., 2007). However, the temporal areas were involved to a greater extent when making judgements about another person than the self (Ochsner et al., 2005), indicating that making judgements about others and taking a different perspective requires greater effortful retrieval than making judgments about the self. In line with the view that these tasks require greater cognitive effort than making self-descriptive judgements, a recent review showed that episodic memory retrieval involves DLPFC activation, typically associated with effortful and monitoring processes (Gilboa, 2004).

In summary, the above results suggest that when individuals are asked to make self-related judgements without being instructed to retrieve any specific past episodes, they will rely on MPFC activation which has been associated with self processing (Kelley et al., 2002). The brain areas involved in memory retrieval -the temporal pole, hippocampus, the temporo-parietal junction and dorsal frontal brain areas- may be recruited according to the extent to which the information refers to specific context or information for which individuals do not have an extensive knowledge. Since healthy ageing affects the DLPFC brain areas to a greater extent than the VMPFC ones (MacPherson et al., 2002), it might be expected that older individuals will be less accurate in making self-judgements when they need to rely on episodic retrieval, which involves activity of the DLPFC (Gilboa, 2004).

In terms of brain damage, lesion studies further support the view that processing self-related information relies on the VMPFC. For example, Ruby et al. (2007) investigated the performance of patients with frontal variant frontotemporal dementia (fvFTD) and healthy controls on a behavioural task that required them to indicate their own and others' behavioural reactions in social situations. The fvFTD patients performed poorly compared to healthy controls in predicting their relative's behavioural reactions. The impaired performance of the fvFTD patients was attributed to deficits in taking their relative's perspective following atrophy in the VMPFC brain areas that has been reported to be involved in predicting behaviours of a close other person (Ruby & Decety, 2004). Therefore, the patients could not update their current self-concept on the basis of how others may see them. In addition, they based their self-evaluation on old, incorrect memories. In the same study, a PET investigation of the patients' performance showed that the self-related behavioural judgements correlated with temporal lobe activation, suggesting that performance on the behaviour prediction task relies on autobiographical memory retrieval. However, in contrast with this result, a recent study showed that the self-concept could be preserved despite a loss of episodic memory. For example, Rathbone, Moulin and Conway (2009) reported the case of a patient who suffered retrograde amnesia following a bicycle accident. The patients could not retrieve episodic personal events. Despite the severe amnesia, her self was sustained by semantic self–related knowledge, suggesting that semantic self-knowledge might be sufficient to maintain an accurate self-representation.

In terms of healthy adult ageing, studies have shown that older adults are impaired in terms of specific episodic recollection (Spencer & Raz, 1995); in contrast context independent memories are preserved (Adams et al., 1997). Furthermore, in terms of brain activity, Maguire and Frith (2003) showed that no difference emerged between younger and older adults in terms of performance during the retrieval of personal semantic memories. However, older adults showed greater temporal activation compared younger participants during retrieval of personal episodic events, suggesting that the higher temporal activity in the older group may relate to the increase in contextual dependant information necessary to perform these conditions (Maguire & Frith (2003). In line with the view that age affects the retrieval of episodic events, it has been reported that the personal episodic memories retrieved by older adults are more semantic and less detailed than those retrieved by younger participants (Piolino, et al., 2002). For example, Levine et al. (2002) asked younger and older participants to recall 5 life events and scored the reports for episodic and semantic content. The results showed that younger participants reported more episodic details while older adults reported more semantic details. These studies indicate that older individuals might not need to retrieve episodic events when processing self-related information. In contrast, older adults rely on well-established knowledge of the self.

It also has been shown that the content of memories retrieved by older individuals relates to emotional events more than the memories of younger adults. Carstensen et al. (1994) instructed participants aged 20-83 years to read a narrative and to recall as much as they could from the passage. The proportion of recalled emotional information, as opposed to neutral information, increased with age. Furthermore, in a source memory paradigm that required individuals to recall perceived and imagined events and to indicate whether each event was perceived or imagined, younger people recalled more sensory and perceptual details, whereas older adults recalled a greater number of feelings and evaluative statements (Hashtroudi, Johnson, & Chrosniak, 1990). Carstensen et al. (1999) proposed that as people approach the end of life, goals associated with emotional meaning and well being become more salient whereas goals associated with acquiring knowledge for future use are less important (i.e. the socioemotional selectivity theory).

The following experiment (Experiment 1a) will investigate the ability to make behavioural predictions in relation to the self and another person, both in the present time and the past. The performance on the behaviour prediction task will be compared to that on the personality judgements task (Experiment 1b). Because of the involvement of the VMPFC when processing self-related knowledge, it can be expected that older participants will be as accurate as younger adults when making both behavioural and personality judgements. In fact, as described above, younger individuals rely on episodic retrieval and inferential reasoning (Ruby et al, 2009) whereas older adults show a tendency to retrieve more semantic and emotional information compared to younger adults when retrieving past information (Hashtroudi et al., 1990; Carstensen et al., 1994; Piolino et al., 2002; Levine et al., 2002). These studies suggest that older participants might not need to retrieve episodic information when making behaviour predictions. Furthermore, the sentences employed describe situations designed to elicit an emotional reaction in social situations (Ruby et al., 2004; 2007). Based on the above evidence and on the VMPFC involvement in processing the self, older adults are expected to perform as well as younger individuals on behavioural judgements as they might base their judgements on well-established knowledge of both the self and others (Ruby et al., 2009). An age effect might instead indicate that, in order to make behavioural predictions, older individuals rely on the retrieval of specific past episodes, which requires greater effort and involves both DLPFC and temporal brain areas, supporting the view that the self consists of different components (Klein et al., 1989; 1992a;b; 1993a;b; Conway, 2005) which are differentially affected by ageing.

3.2.2. Pilot study

The behavioural task was based on a task developed by Ruby et al. (2004; 2007). A pilot study was conducted to determine whether making judgements about the self or another person's behaviour at the present time and in the past (5 years before) involves the same cognitive demands, as it may be that it is simply more difficult to make judgements about another person's behaviour. To determine whether the two types of judgements were similar in terms of their cognitive demand, participants performed the behaviour prediction task under single and dual task conditions with the secondary task being a response time task. A second aim of the pilot study was to reduce the number of behavioural situations to be employed in the actual experiment.

3.2.2.1. Methods

3.2.2.1.1. Participants

Ten younger participants, eight females and two males (age range: 22-31 years; μ = 26.3; SD = 3.0) and six older adults, four females and two males (age range: 62-78 years; μ = 67.0, SD =5.93) were recruited for the pilot study. Younger participants were undergraduate and postgraduate student at the University of Edinburgh. Older participants were volunteers at the Department of Psychology and were paid for their participation. The study was approved by the Philosophy, Psychology and Language Sciences Research Ethics Committee at the University of Edinburgh. Participants were first asked to read the information sheet that explained the aim of the task. All participants agreed to take part to the study and signed the consent forms (Appendix 1, 2 and 3).

3.2.2.1.2. Materials

3.2.2.1.2.1. Behaviour prediction task

The materials consisted of 60 sentences describing social situations. Each sentence was followed by a triplet of adjectives describing possible emotional reactions. Six triplets of adjectives were used, each repeated ten times ("shocked, indifferent, sympathizer"; "panicked, bothered, calm"; "angry, upset, resigned"; "suspicious, carefree, excited"; "impressed, proud, detached"; "irritated, embarrassed, relaxed"). The participants' task was to indicate how they themselves or a close other person would react (would have reacted) in the situation described at the present time (in the past). All participants were specifically instructed to choose one of the adjectives provided. The stimuli were provided by Perrine Ruby (personal communication). There were 240 trials across four within-subjects conditions (60 sentences x 4 conditions). Because the number of trials was very high, the sentences were randomly divided into two sets (A and B) of 30 different sentences each. Ten younger participants performed the behavioural task with the sentences included in set A. Both sets were administered to the six older participants.

3.2.2.1.2.2. Response time task

The secondary task used in the dual task paradigm consisted of the presentation of a 22 KHz neutral sound to both ears through earphones. The sound was presented at random delays of 500, 1000, and 1500 milliseconds. The participants' task was to say "yes" out loud into a microphone every time they heard the neutral sound played through the earphones. The time taken to respond to the sound was recorded. The response time task was performed in six blocks, each lasting 1 minute.

3.2.2.1.2.3. Behaviour prediction questionnaire

A relative or friend of the older participants was asked to fill in a questionnaire in relation to self and the participant. The questionnaire consisted of the same social situation items in the same four conditions used in the participants' computer-based version of the behaviour prediction task. As the aim of the pilot was to select a set of sentences to be used in further ageing investigations, the questionnaire was administered only to the older participant's relative/friends, in order to identify the sentences that older participants and their relative/friend rated in a similar way. A relative/friend of the participant was instructed to predict their own and the participant's behavioural reaction to each situation, both at the present time and five years ago. The questionnaire included the same sentences presented to the participants. The questionnaire was posted to the relative/friend before the participants attended the testing session. They were instructed to fill in the questionnaire at their own pace and to return it in a sealed stamped addressed envelope.

3.2.2.1.3. Procedure

Participants performed the behaviour and the response time task under single condition, with the tasks being counterbalanced across participants. The dual task condition was performed after the single-task condition. During the behaviour prediction task, participants were presented with sentences one at a time on a computer screen. Sentences were displayed in black on a white background. After 2 seconds, the triplet of adjectives appeared under the sentences. Each adjective matched a label on the keyboard. Participants were instructed to indicate as fast as possible how they or their relative/friend would react (would have reacted) in each situation at the present time (in the past) by pressing the corresponding button. The response time (RTs) and the judgement were recorded. In the dual task condition, participants performed the behaviour prediction task and the response time task at the same time; the response tine task run continuously. Since performing both sets under dual task condition would have taken long time, the 10 younger participants performed the secondary task together with set A while the 6 older participants performed the dual task condition using Set B. Both groups performed the dual task condition in order to determine whether judgements of self/other at the present and in the past were similar in terms of their cognitive demands in both age groups.

3.2.2.1.4. Scoring

In order to obtain measures of the accuracy to rate one's own and another person's behaviour, the responses provided in by the relative/friend were compared to the responses provided by older participants. Each scenario was scored 1 point when the responses matched (exact congruency) or 0 points when they differed (no congruency).

3.2.2.1.5. Analysis

The data were analysed separately for sets A and B. The mean overall time taken to perform the single task was computed for each condition (i.e. self now/before, relative/friend now/before). The response task was repeated six times under single task conditions and the mean RTs over the six repetitions was computed. The mean RT for the single task condition was then subtracted from the RTs when the response time task was performed under dual task conditions.

3.2.2.2. Results

3.2.2.2.1. Overall time taken under single task condition.

The overall time taken to perform each condition of both sets under single task condition was computed for older adults (Table 3.1). The data were not normally distributed and, thus, analysed with the non-parametric Friedman test. The results showed no significant difference in performing each condition of set A [$\chi 2$ (3) = 3.0, p = .39, w = .37] and B in older adults [$\chi 2$ (3) = 3.0, p = .39, w = .37], indicating that the two sets of questions were of comparable difficulty.

Table 3.1. Overall time taken in each condition for both sets in older group.

	Set A	Set B
	Mean (SD)	*Mean (SD)*
Self Now	46240.66 (11610.47)	30951.66 (15870.80)
Other Now	53387.66 (11995.93)	48026.16 (13589.98)
Self Before	45289.00 (11400.00)	35241.00 (12515.36)
Other Before	50724.67 (18835.35)	47197.33 (9661.00)

3.2.2.2.2. Dual task performance set A

The mean RT difference between the performance on the secondary task alone and under dual task conditions in younger participants for each behavioural condition is displayed in Table 3.2. The ANOVA analysis for repeated measures showed no significant difference between the four conditions [F (3,27) = .827, p = .49, η_p^2 = .084], indicating that the questions asked did not differ in terms of their cognitive demands.

Table 3.2. RT difference (ms) between the single and dual task conditions for the secondary task using set A for younger adults.

	Mean	SD
Self Now	128.26	89.23
Other Now	159.01	113.65
Self Before	152.88	92.90
Other Before	185.27	77.98

3.2.2.2.3. Dual task performance set B

The mean RT differences between the performance of the response task alone and under dual task conditions in the older participants for each behavioural condition is displayed in Table 3.3. The data were not normally distributed and therefore analysed with the non-parametric Friedman analysis. There was no significant difference between the conditions [$\chi 2$ (3) = 1.4, .706, p = .70, w = .07], indicating that the questions asked did not differ in term of their cognitive demands.

Table 3.3. RT difference (ms) between single and dual task conditions for the secondary task using set B for the older adults.

	Mean	SD
Self Now	369.37	228.82
Other Now	355.32	244.31
Self Before	263.79	136.64
Other Before	383.15	131.63

3.2.2.2.4. Question selection

The responses provided by the older participants that matched with the responses provided by their relative/friend were considered. One participant was excluded from the item selection analysis, as a behavioural questionnaire filled in by a relative/friend was not obtained. The questions that had matching responses between the participant and their relative/friend for at least 4 out of 5 participants were selected. Eight behavioural situations were selected: four from each set. The overall time taken to perform each behavioural condition for the selected question was computed (Table 3.4.). Friedman analysis showed no significant difference across the four conditions [$\chi 2$ (3) = 3.0, p = .39, w = .37].

Table 3.4. Overall time taken to perform each condition in the older group for the selected questions.

	Mean	SD
Self Now	11139.50	5409.35
Other Now	14610.33	3934.75
Self Before	9766.17	3350.38
Other Before	13246.83	3497.12

3.2.3. Experiment 1a: Episodic self-knowledge

3.2.3.1. Methods

3.2.3.1.1. Participants

Thirty younger and thirty older adults took part in this study; none had taken part in the pilot study. Participants were administered the Addenbrooke's Cognitive Examination-Revised (ACE-R, Mioshi, Dawson, Mitchell, Arnold & Hodges, 2006). The ACE-R is a brief cognitive battery for the assessment of attention/orientation, memory, verbal fluency, language and visuospatial abilities. The two groups did not differ on the ACE-R performance [t (58) = -.315, p = .75, d = .08]. The Wechsler Abbreviated Scale of Intelligence (WASI: Wechsler, 1999) was used as a measure of the level of general intelligence. Participants performed the vocabulary and the reasoning subscales and an IQ score was obtained by the sum of the scores of the two subscales.

The two groups did not significantly differ in their IQ [t (58) = -1.10, p = .27, d = .28] or their level of education [t (58) = -1.31, p = .19, d = .34].

Both groups were administered the Self -Ordered Pointing Task (SOPT, Petrides & Milner, 1982) and the Verbal Fluency task (VF, Spreen & Strauss, 1998) as measures of frontal executive abilities. The SOPT is a supra-span short-term visual memory task used to assess working memory and monitoring abilities. Participants were presented with an array of 12 black and white abstract images and were instructed to choose an item they had not seen before. The position of the items changed after each presentation and participants were instructed to select a different item. As the item position changed, participants needed to remember which item they had previously selected and not simply the item's position. The array was presented 12 times to allow participants the opportunity to select each item once. The task was performed three times. The number of items repeatedly selected was considered to be an error.

In the VF task, participants were asked to generate as many words as possible beginning with the letters F, A and S. One minute was allowed for each letter. The total number of words produced across the three letters was computed.

Both groups were also administered the Rey Auditory Verbal Learning Task (RAVLT; Rey, 1958; Schmidt, 1996). The RAVLT is an episodic memory task used to assess learning of a list of words across five presentations. Participants were read a list of 15 words at the rate of 1 word per second. The same list of words was read five times.

At the end of each presentation, participants were instructed to recall as many words as possible in any order. After the 5^{th} repetition, a different list of words was read and participants were instructed to recall as many words as possible from the new list only. Immediately after recall of the new list, participants were asked to recall as many words as possible from the first list only. After 30 minutes, during which participants were engaged in other cognitive tasks, they were instructed to recall as many words as possible from the first list only. Finally, they were administered a word recognition task. Participants were presented with a list of 50 words that included 15 words of the first list and 35 foils. Their task was to indicate which words they had studied during presentation of the first list. Delayed recall and recognition were recorded after 30 minutes. Table 3.5 provides the demographic characteristics and the performance on the background neuropsychological measures of the two groups.

Table 3.5. Demographic data and performance on the neuropsychological tests of the younger and older groups.

	Younger *(M: 4; F: 26)* *Mean (SD)*	Older *(M: 9; F: 21)* *Mean (SD)*
Age	19.37 (1.4)	69.77 (6.6)
Years of Full-Time Education	13.67 (1.8)	14.37 (2.2)
ACE-R (max = 100)	95.90 (2.5)	96.13 (3.1)
WASI Full Scale IQ	116.5 (6.5)	118.43 (6.9)
SOPT Errors (mean)	4.97 (2.3)	9.40 (2.6)
VF (total words)	44.38 (13.2)	50.23 (12.9)
RAVLT Recall (max =15)	12.97 (2.5)	10.40 (3.3)
RAVLT Recognition (max = 15)	14.33 (1.1)	12.80 (1.7)

Younger and older participants did not significantly differ in terms of VF task performance [t (52) = -1.63, p = .10*,* d = .44]. However, the older adults performed significantly more poorly than the younger individuals on the SOPT. In particular, older participants made more errors than younger participants [t (58) = -6.92, p = 000, d = 1.8]. The older group also showed reduced memory compared to younger adults on both the delayed free recall [t (58) = 3.33, p = .001, d = .87] and recognition memory task [t (58) = 4.10, p = .000, d = 1.06] as measured with the RAVLT.

3.2.3.1.2. Materials

3.2.3.1.2.1. Participants task

Participants were presented with the sentences describing possible real life situations selected using the pilot study (e.g. you catch someone listening at your door). The same set of 8 sentences was used in each condition. Under each sentence, after 2 seconds, a triplet of adjectives was also presented describing possible emotional reactions to the situation. Four triplets of adjectives were used, each repeated twice (angry/upset/resigned; irritated/embarrassed/relaxed; shocked/indifferent/sympathetic; suspicious/carefree/excited). Participants performed 4 tasks the order of which were counterbalanced across participants:

- S1_Now: Judging their own behaviour now (e.g. you are burgled. You are: angry/upset/resigned).

- S1_Before: Judging their own behaviour 5 years ago (e.g. Five years ago you were burgled. You were: angry/upset/resigned).

- S2_Now: Judging their relative/friend's behaviour now (e.g. your relative/friend is burgled. Your relative/friend is: angry/upset/resigned).

- S2_Before: Judging their relative/friend's behaviour 5 years ago (e.g. Five years ago your relative/friend was burgled. Your relative friend was: angry/upset/resigned).

A control sentence was also included in each condition that referred to facts where only one response could be correct. The control sentences were added to ensure participants read and could understand the sentences (e.g. You are: man, woman, child).

3.2.3.1.2.2. Relatives/Friends questionnaire

The participants' relative/friends were asked to fill in a questionnaire, which consisted of the same conditions used in the participants' computer version of the behaviour prediction task. The relative/friend was instructed to predict their own and the participant's behavioural reaction to each situation at the present time and five years ago. The relatives/friends performed 4 tasks:

- R1_Now: Judging their own personality now (e.g. you are burgled. You are: angry/upset/resigned).
- R1_Before: Judging their own personality 5 years ago (e.g. Five years ago you were burgled. You were: angry/upset/resigned).
- R2_Now: Judging the relative/friend's personality (i.e. the participant) now (e.g. your relative/friend is burgled. Your relative/friend is: angry/upset/resigned).
- R2__Before: Judging the relative/friend's personality (i.e. the participant) 5 years ago (e.g. Five years ago your relative/friend was burgled. Your relative/friend was: angry/upset/resigned).

The questionnaire was posted to the relative/friend before the participants attended the testing session. They were instructed to fill in the questionnaire at their own pace and to return it in a sealed envelope.

3.2.3.1.3. Procedure

During the behaviour prediction task, participants sat in front of a computer screen and the instructions were presented on a computer screen at the beginning of each condition to explain what type of judgement they were going to be asked to make, followed by an example. One sentence at a time was presented in the middle of the screen. After 2 seconds, the triplet of adjectives appeared underneath the sentence, and both the sentence and the adjective remained visible on the screen until a response was made. Responses provided by participants and response times (RTs) were recorded.

Each participant indicated how s/he and her/his relative/friend would react in each situation at the present time and 5 years ago by choosing one of the adjectives presented below the sentence. The order of the sentences was randomised across participants. To respond, participants pressed one of three buttons on the keyboard, each corresponding to the adjective position in the triplet.

3.2.3.1.4. Scoring

In order to obtain measures of the ability to rate one's own and another person's behaviour, the responses provided in each condition were compared between subjects (i.e. responses given by participants were compared with responses given by their relative/friend) and within subjects (i.e. responses given by participants for one condition were compared with the responses given by participants for another condition and responses given by the relative/friend in one condition were compared with responses given by the relative/friend in another condition). Each scenario was scored 1 point when the comparisons revealed the responses matched (exact congruency) or 0 points when they differed (no congruency). As there were 8 sentences in each condition, the congruency scores ranged from 0 (no congruency) to 8 (maximum congruency).

The responses provided by the participants and relatives/friends were compared to obtain 7 measures.

- Self-Perceived Change: Obtained by comparing the responses given by participants about their own behaviour at the present time (S1_Now) and in the past (S1_Before).

- Other-Perceived Change (relative/friend): Obtained by comparing the responses given by the relative/friend about the participant’s behaviour at the present time (R2_Now) and in the past (R2_Before).

- Self-Awareness: Obtained by comparing the responses given by participants about their own current behaviour (S1_Now) and those given by their relative/friend about the participant’s behaviour (R2_Now).

- Other Awareness: Obtained by comparing responses given by participants about their relative/friend's behaviour (S2_Now) and responses given by their relative/friend about their own behaviour (R1_Now).

- Participant Stereotypical Ratings: Provided a measure of the congruency between ratings of the self and other as perceived by the participants to determine whether the participant simply responds in the same way for both themselves and their relative. It was obtained by comparing responses given by participants about their own behaviour at the present time (S1_Now) and their relative/friend's behaviour (S2_Now).

- Relative/Friend Stereotypical Ratings: Provided a measure of the congruency between the participant and the relative/friend's current behaviour according to the relative/friend (R1_Now and R2_Now). Again, this was to ensure that the relative/friend was not simply providing the same responses for themselves and their relative/friend.

- Reliance on past behaviour: Obtained by comparing responses given by the participant about their own behaviour at the present time (S1_Now) with those given by their relative/friend about the participant's behaviour in the past (R2_Before).

3.2.3.1.5. Analysis

Congruency scores and response times (RTs) were analysed separately. Scores for the congruency measures for the younger and older groups were analysed using either ANOVA or t-tests:

- Congruency scores for Self Perceived Change and Other Perceived Change for the two age groups were compared using a 2 (age group: young vs. older adults as between factor) x 2 (judgement condition: self perceived change vs. other perceived change as within factor) mixed-model ANOVA.

- A 2 (age group as between factor) x 2 (stereotypical ratings: participant vs. relative/friend as within factor) mixed-model ANOVA was conducted to compare the stereotypical ratings for the participant and relative/friend.

- Reliance on the past was analysed using an independent samples t-test with age group as the independent variable.

The RTs of the participants in each behavioural condition were entered into a 2 (age group: young vs. old adults as between factor) x 4 (judgement condition: S1_Now, S1_Before, S2_Now, S2_Before as within factor) mixed-model ANOVA.

3.2.3.2. Results

3.2.3.2.1. Behavioural judgement results

3.2.3.2.1.1. Behavioural Change

Table 3.6 shows the means and standard deviations for the measures of behavioural change in younger and older participants.

Table 3.6. Means and standard deviations (SD) for Self and Other Perceived Change

	Younger	Older
	Mean (SD)	*Mean (SD)*
Self Perceived Change (max = 8)	5.07 (1.4)	6.87 (1.6)
Other Perceived Change (max = 8)	6.13 (1.3)	7.33 (1.1)

The behavioural change analysis showed a significant main effect of judgement condition [F (1,58) = 10.91, p = .002, η_p^2 = .15] with higher congruency scores for Other Perceived Change compared to Self Perceived Change. This suggests that participants report greater changes in their own behaviour (less congruency between now and before) than those reported by the relative/friend about the participant's behaviour. The results also demonstrated a main effect of age group [F (1,58) = 31.12, p = .000, η_p^2 = .34], with higher congruency scores for older than younger participants, suggesting that older adults change less over time than younger adults. The age group x judgement condition interaction was not significant [F (1,58) = 1.67, p = .20, η_p^2 = .028].

3.2.3.2.1.2. Behavioural Awareness

The ANOVA conducted to investigate awareness of the self and others did not reveal any significant main effects of condition [F (1,58) = .028, p = .86, η_p^2 = .001], age group [F (1,58) = .011, p = .91, η_p^2 = .001] or interaction [F (1,58) = .028, p = .86, η_p^2 = .001]. The means and standard deviations are displayed in Table 3.7.

Table 3.7. Means and standard deviations (SD) for Self and Other Awareness

	Younger	Older
	Mean (SD)	*Mean (SD)*
Self-Awareness (max = 8)	5.43 (1.65)	5.43 (1.16)
Other Awareness (max = 8)	5.50 (1.69)	5.43 (1.27)

3.2.3.2.1.3. Stereotypical ratings for the participant's behaviour and the relative/friend's behaviour

The higher the stereotypical rating, the more congruence there was between the responses provided to describe someone's own and their relative/friend's behaviour. For example, 0 = no congruence between the responses provided to describe both their own and their relative/friend's behaviour and 8 = the same responses were given to describe both their own and relative/friend's behaviour. The means and standard deviations for the stereotypical ratings are displayed in Table 3.8.

Table 3.8. Means and standard deviations (SD) for stereotypical ratings for participants and relative/friend's personality

	Younger	Older
	Mean (SD)	*Mean (SD)*
Participant Stereotypical Ratings (max = 8)	4.87 (1.38)	5.47 (1.19)
Relative/Friend Stereotypical Ratings (max = 8)	5.17 (1.59)	5.97 (1.56)

The analysis showed a significant main effect of age group with higher congruency scores for older compared to younger participants [F (1,58) = 5.49, p = .02, η_p^2 = .087], suggesting that there was more similarity between the responses provided to describe the self and the relative/friend in older adults. The main effect of stereotypical rating and the age group x stereotypical rating interaction were not significant [F (1, 58) = 3.20, p = .07, η_p^2= .05; F (1,58) = .20, p = .65, η_p^2 = .003].

3.2.3.2.1.4. Reliance on the Past

An independent samples t-test showed that Reliance on the Past did not significantly differ [t (58) = -.250, p = *.80, d* = .06] between younger (μ = 5.20; SD = 1.7) and older participants (μ = 5.30; SD = 1.3).

3.2.3.2.2. Response Times

The RTs for the four behavioural measures are provided in Table 3.9.

Table 3.9. Means and standard deviations (SD) for the response times on the 4 conditions completed by the younger and older participants

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
S1_Now	1371.03 (377.7)	2396.21 (787.4)
S1_Before	1344.69 (372.5)	2403.35 (698.4)
S2_Now	1472.76 (512.5)	2795.81 (765.6)
S2_Before	2038.67 (828.6)	3875.47 (1675.8)

S1 = judging own behaviour
S2 = judging relative/friend's behaviour

The results showed a significant main effect of judgement condition [F (3,138) = 19.84, p = .000, η_p^2 = .30]. Post-hoc paired samples t-tests showed faster RTs when making judgements about the self than the relative/friend, both for current and past behaviour [t (59) = -2.73, p = .008, d = .23; t (47) = - 6.66, p = .000, d = .80, respectively] The analysis also showed faster RTs when making judgements about the relative/friend's behaviour at the present time compared to the past [t (47) = -4.48, p = .000, d = .60]. No significant differences emerged when making judgements about the current and past self [t (59) = .377, p = .70, d = .04]. The results also showed a significant main effect of group [F (1,46) = 55.94, p = .000, η_p^2 = .54] with faster RTs in younger participants. The interaction was not significant [F (3,138) = 2.67, $p = .06$, $\eta_p^2 = .05$].

3.2.4. Discussion

In the present study, younger and older adults were required to indicate how they and their relative/friend would react in possible real-life situation at the present time and in the past by choosing one of the provided adjectives describing emotional reactions. Their responses were compared with those given by the participant's relative/friend in order to obtain congruency scores of the ability to rate one's own and another person's behaviour. The results demonstrated that rating one's own and another person's behaviour does not change with age, as both groups showed similar congruency scores between the ratings made by the participants themselves and those made by their relative/friend regarding the participant's and the relative/friend's behaviour. However, an age effect was found in terms of the reported behavioural change, as older adults showed higher congruency between their past and present behaviour suggesting that they changed less than younger participants. Higher congruency scores emerged also in the stereotypical ratings made by older adults compared to younger participants meaning that older adults tended to provide the same response for self and others more often than younger participants.

Response latencies have been used as a measure of the accessibility to information (i.e. how easily stored information can be brought into awareness; Markus et al., 1986). Both younger and older participants were significantly faster to respond to behavioural situations related to the self compared to another person, which is in line with previous studies that have shown faster RTs for self-related information in younger and older adults (Craik et al., 1999; Kelley et al., 2002; Gutchess et al., 2007a), suggesting that information related to the self is more easily available than information related to another, even in a task thought to rely on autobiographical memory retrieval. In addition, both groups showed no difference in RTs when making judgements about the self at the present time compared to the past, suggesting that little change was perceived to have occurred over 5 years. The RT results were not characterised by a significant group x condition interaction, suggesting that the advantage for processing information about the self over another person is similar in both groups (Gutchess et al., 2007a).

Despite the advantage in RTs when making self-related judgements over judgements related to another person, there is not an advantage in rating self-behaviour over the accuracy to rate the relative/friend's behaviour. Both groups performed similarly in rating their own as well as their relative/friend's behaviour. This was indicated by the similar congruency scores in both groups between participant and relative/friend's ratings of the participant's and the relative/friend's current behaviour, suggesting that age does not affect the ability to rate oneself or others' behaviour.

Older participants obtained higher congruency scores between their current and past behaviour than younger adults (i.e. older participates rated their own behaviour as more similar to their past behaviour and report fewer changes than younger adults did). This result would suggest that overall older adults perceived themselves to have changed less than younger adults. Greater consistency between current and past behaviour in older participants may emerge due to a tendency of older adults to show a preference for consistency and stability compared to younger adults (Brown et al., 2005; McLean et al., 2008). Brown et al. (2005) tested the preference for consistency in older population: they used a scale, which presented sentences (e.g. "I am uncomfortable holding two beliefs that are inconsistent''; ''I want my close friends to be predictable") and asked them to rate the extent to which they agreed with each sentence. The results showed a linear pattern of increase in the preference for consistency as a function of age with a sub-sample of older adults (above 50 years) reporting higher preference scores than the participants in the other two age categories. Further support for the preference for consistency in the older population comes from the previously described self-narratives (i.e. what people tell others about themselves). The self-narratives allow individuals to integrate the past and the current self-concept to provide a sense of unity (McAdams, 2001). Studies of past memories reported by younger and older adults showed that older participants reported more themes of consistency and stability while younger participants reported more stories representing change (MacLean et al., 2008).

The current results also revealed that the congruency between a participant's current and past behaviour is higher when rated by a relative/friend than by the participant him/herself in both the younger and older groups, indicating that participants perceived more behavioural changes than those reported by their relative/friends. This difference in the behavioural change reported might be due to a tendency for individuals to depict themselves in a more positive light and overestimate their skills (e.g. self-judgements can be biased positively to maintain or enhance a positive self-view in order to maintain self-esteem; John & Robins, 1994). Support for the view that memory retrieved is positively biased for the self but not others, comes from a study that investigated memory for trait attributes (D'Argembeau et al., 2005a) as well as memory for past events (D'Argembeau et al., 2008).

The discrepancy between judgements rated by the self and others may also depend on the type of judgements made. As previously discussed, others' judgements are accurate when rating overt behaviours while self judgements are more accurate in rating less visible traits, such as emotional reactions (Spain, Eaton & Funder, 2000). As the present behavioural prediction task assessed reactions to social situations, it taps more observable behaviours, which are more easily assessed by others compared to the self.

The results also showed that older adults reported higher stereotypical ratings between the self and others than younger adults. Two possible explanations may account for these results. The first explanation is that the self-concept can extend to include close others (i.e. a partner, friend, relative; Aron et al., 1991). This overlap may result in greater confusion between those representations. This would affect both performance on trait judgements (Aron et al., 1991; Smith et al., 1999) and memory tasks (Mashek et al., 2003). Further support of the inclusion of others into the self representation comes from studies of the self referential effect (SRE) which refer to an advantage for the encoding and subsequent retrieval of items related to the self than information encoded in reference to semantic or phonological features. It has been shown that the advantage provided by the self can also be found for encoding information in relation to a close other person, such as one's mother (Symons et al., 1997) suggesting that there might be an overlap between the self and a close other person. The perceived similarity between the self and close others is thought to be beneficial for relationships, in that it increases the satisfaction and positively predicts a relationship's outcome: married couples who perceive higher similarity between the self and others report greater feelings of being understood (Murray, Holmes, Bellavia, Griffin & Dolderman, 2002). Because of the many years that older adults have known their relative/friend; it might be that they feel greater similarity with their relative/friend than younger participants would.

The inclusion of another person into the self-representation is mainly determined by a sense of closeness (i.e. the extensive knowledge that one may gain in long-lasting relationships; Mashek et al., 2003; Symons et al., 1997). Therefore, the longer time spent together may affect the similarity between self and other. Supporting this view, Anderson, Keltner and John (2003) found that people become more emotionally similar over time. In their study, couples dating for one year and roommates were involved in a discussion about positive or negative events and then they rated each event for both positive and negative emotions. Similarity was calculated by computing the correlations between the emotional responses to the discussion provided by both partners in the couple. The results showed that correlations increased from .30 to .56 in 6 months in romantic partners. While no correlation emerged among roommates' emotional responses when they had lived together for two weeks, authors reported higher correlation in 9 months (.55). It may be that similarity differentially affects the performance of older and younger adults. For example, Mashek et al. (2003) investigated the overlap in younger adults and found that the overlap was greater for friends/partners than for parents, suggesting that it may be that friends are less familiar but closer than their relatives in young adults. In the present task, the person filling the questionnaire for the young participants was often a relative, who is highly familiar but probably less close than a friend or a partner so little overlap emerged (Mashek et al., 2003). In contrast, the person filling in the questionnaires in the older group was always a person that the participant felt close to (spouse, friend, child) and that they had known for a long time, providing a sense of familiarity. This combination of greater closeness and familiarity may have led to a greater similarity between the self and others in the older group.

Another explanation for the higher stereotypical ratings for the self and others in older adults may be due to the fact that participants may rely on the recollection of past episodes. Ruby et al. (2007) found that the assessment of one's own behaviour was related to activation in the temporal lobes, as it involved memory recollection, which is typically reduced in older participants (Levine et al., 2004). It may be therefore that in light of their reduced memory abilities, older adults would rely more than younger adults on stereotypical ratings. This stereotypical effect may depend on the type of situation described: some of them were general (e.g. "You fall sick") and may not require recollection of a specific past events. Other situations may be more specific (e.g. You have a collision in your car). Not all participants may have experienced such a situation in their lives and so would rely on memories of similar events to respond. This is further supported by the results of Klein and colleagues (Klein et al., 1992a;b; 1993a;b; 1996; Klein, Cosmides, Tooby & Chance, 2001) which have shown that episodic recollection of events is necessary when individuals are asked to make judgements about information they do not have an extensive knowledge of. Therefore, older adults may have retrieved memories of events similar to those provided because they did not have direct experience of such a situation (you have a collision in your car). Consistent with this is the previously described tendency of older participants to show a preference for consistency. It may be that due to a lack of memory details for the event described, older adults attribute to their relative/friend responses similar to those they had provided for themselves. However this explanation contrasts with their intact ability to achieve high congruency between their ratings of themselves and others and those ratings provided by their relative/friend. If judgements provided by older participants when rating their relative/friend were based on more stereotypical ratings than younger adults, they would show lower accuracy in rating either themselves or their relative/friend. However, the older group performed as well as younger adults suggesting that there is a greater overlap between older participants and their relative/friend.

3.2.5. Conclusion

In conclusion, the results of the behaviour prediction task support the advantage for self-related information, which is expressed through faster decision times when participants rate behavioural reactions regarding the self, compared to a close other. However, the response time advantage was not accompanied by better performance in rating the self compared to others as participants rated their relative/friend's behaviour as well as they rated their own behaviour. The ability to rate the self and another person's behaviour does not decrease with age. However, there is a greater overlap (similarity perceived) between the self and a partner in older adults. These results might indicate that older adults rely on well-established knowledge of the self without the need to retrieve specific episodes. However, the greater similarity perceived might indicate that when the task requires the retrieval of episodic events, older adults provide the same (stereotypical) response about both the self and others. This ffect may emerge as a consequence of the older adults' difficulty in retrieving episodic information.

3.3. Experiment 1b: Personality Judgement Task

3.3.1. Introduction

Conway et al. (2000; 2005) developed the Self Memory System (SMS) model, which delineates the relationship between the self and memory. In this model, self-related knowledge is organised from general to more detailed episodic memories for past events. However, general self-knowledge also contains conceptual knowledge (Conway et al., 2004b), which refers to self-related beliefs, values and attributes and corresponds to abstract trait self knowledge described by Klein et al. (Klein et al., 1989; 1992a;b; 1993; Conway et al., 2004b). Different paradigms have been employed to show that self-knowledge for traits is independent from episodic self knowledge:

1- The facilitation-priming task, described in Chapter 1, has been employed in a series of studies to investigate whether autobiographical memory is required to perform trait judgement tasks (Klein et al., 1989; 1992a; 1993a;b; 2001; Sherman et al., 1994; Shell et al., 1996; Babey, Queller & Klein, 1998). The results of these studies suggest that autobiographical retrieval does not use the same type of information conveyed by conceptual knowledge and vice versa indicating that the two tasks rely on separate memory systems.

2- Joint performance. Another form of evidence supporting the dissociation between episodic memory and abstract trait self knowledge derives from the idea that if the processes underlying two different tasks make different types of information available to an individual, the simultaneous performance of both tasks should increase memory retrieval of the information presented. Klein et al. (1989, Experiment 4) compared the memory performance of participants who undertook only one task (repeated condition) with those who performed two tasks (combined condition). Participants were presented with a series of traits and instructed to perform: a) a descriptive task (i.e. whether the trait is self-descriptive), b) a memory task (i.e. retrieve a past episode related to a trait). or c) a semantic task (i.e. provide a definition of the word). In a subsequent memory task, those in the combined condition recalled more words than those in the repeated condition indicating that the two tasks provided two qualitatively different types of self-related information.

3- Encoding specificity. Klein et al. (1992b) employed a methodology based on the encoding specificity principle, which is the idea that memory performance increases when participants perform the same task at encoding and recognition. During the study phase of the task, participants performed a descriptive, a memory or a definition task on a series of trait words. Two weeks later they were presented with a list of traits, half seen during the study phase and half new words; again they performed a descriptive, a memory or definition task. Then participants were asked to perform recognition judgements and decide whether they had seen the traits during the previous study phase or not. The results showed higher memory performance when participants performed the same task at encoding and recognition. However, for those participants who performed the memory task at encoding, memory performance was not higher when they performed a descriptive task at retrieval compared to the semantic task. Similarly, when they performed a descriptive task at encoding, they did not show better memory at retrieval when they performed an autobiographical memory task at retrieval compared to the semantic task, suggesting that the information made available by the memory task and the descriptive task are qualitatively different.

4- Reverse association. Klein, Babey and Sherman (1997) employed the method of reverse association to further provide evidence of independence between episodic memory and abstract self-knowledge. In this paradigm, two tasks assumed to rely upon different types of information, such as the descriptive and the memory task, are separately performed. Both tasks are performed under the same conditions; for example, participants might be presented with traits that vary in respect to their descriptiveness of the participant (i.e. high, medium and low descriptive traits). The results of the two tasks are then plotted against each other for the three levels of descriptiveness. It is assumed that if the relationship between the two tasks is linear across all conditions (i.e. increasing or decreasing for all trait descriptiveness), the tasks are thought to rely on the same type of information. Klein et al. (1997) instructed their participants to perform either a descriptive or a memory task using a series of traits that represented different levels of descriptiveness and plotted the performance on the descriptive task in terms of RTs against the performance on the memory task in terms of RTs across three levels of trait-descriptiveness (high, medium and low). The results demonstrated that the relationship between the two tasks was non linear (not always increasing or decreasing), suggesting that the two tasks rely on different types of information.

All four paradigms described above suggest that two different memory systems underlie the ability to make trait self-judgements and to recall behavioural examples from which the trait can be abstracted. As previously discussed in Chapter 2, several neuroimaging studies have shown that self related information processing involves the VMPFC (Kelley et al., 2002; Macrae et al., 2004; Heatherton et al., 2006). The same area has been shown to be activated in studies that presented participants with episodic and personal semantic information (e.g. facts related to the self) but not regarding information related to another person or processing of non-personal semantic knowledge (e.g. historical facts; Levine et al., 2004).

Further support for the view that self-knowledge related to traits may not require access to episodic memory comes from lesion studies. In fact, single case studies of brain damaged patients show that the ability to make trait judgements about the current self concept is preserved despite deficits in recalling general semantic knowledge (Klein et al., 2002b), personal semantic information (Klein et al., 2002a), specific past episodes (Tulving, 1993; Klein et al., 1996; 2002a) and even when the patient has never developed the ability to store episodic information (Klein et al., 1999) or the patient's personality has changed since lesion onset (Tulving, 1993). Trait self-judgements are also preserved despite deficits in making judgements about other people (Klein et al., 2002a; Klein, Cosmides, Murray & Tooby, 2004a). These results suggest that traits are stored independently from episodic memory, from general semantic memory and also from personal semantic knowledge.

Some evidence of decline in processing self-related information, however, emerges in frontotemporal dementia patients (FTD, Ruby et al., 2007) and individuals with Alzheimer's Disease (Klein, Cosmides & Costabile 2003; Ruby et al., 2009). Furthermore, Ruby et al. (2007) showed that the ability to make self-trait judgements is independent from the ability to make behavioural self-related judgements. A group of FTD patients with reduced metabolism in the OFC cortex and the temporal areas and healthy controls were instructed to make judgements about their own and a relative's behavioural reactions in social situations and on personality traits. The group's performance on the two tasks differed. In the behavioural judgement task, the FTD patients did not report changes since the onset of dementia, suggesting that they based their judgements on memories of a past self. In addition, the FTD patients failed to predict their relative's current behaviour, suggesting a deficit in perspective taking abilities, which has been associated with the function of the VMPFC and temporal lobe (Ruby et al., 2004). The results cannot be attributed to a deficit in understanding the task: patients' responses were not random in that they were consistent in their responses when rating their own behaviour at the present time and in the past and also provided different responses for the self and others, suggesting that their impairment was due to a deficit in making accurate judgements. In contrast to the behaviour task, FTD patients correctly rated their relative's personality. In addition, their current self concept matched with their pre-morbid personality as described by their relative, indicating that they recalled accurate past memories but did not update their self concept to the present time, which is in line with a previous study that found an association between OFC dysfunction and deficits in updating the view of the self (Salmon et al., 2006) and the FTD patients' reduced perspective taking abilities. The self-concept may derive also from what other individuals think of us (Wilson & Dunn, 2004). Therefore, as a consequence of perspective taking deficits, FTD patients might be unable to use others' beliefs about themselves to update their current self-view. These results suggest that the behavioural judgement deficit is due to the retrieval of incorrect memories, while the personality judgement deficit is due to updating and perspective taking impairments. In addition, although patients performed poorly on both tasks, a PET investigation of the FTD patients' cerebral metabolism showed that only their performance on the behavioural task correlated with activity in the temporal areas, which are thought to be involved in memory retrieval, while no correlation emerged for the personality task. Therefore, the results indicate that deficits on the behaviour prediction and the personality judgement tasks depend on different cognitive mechanisms (e.g. memory retrieval and updating, rspectively) thought to relate to the involvement of different brain areas (temporal and OBF).

In terms of ageing, recent evidence has shown that self-semantic knowledge can be used to maintain a coherent sense of the self (Rathbone et al., 2009). As semantic memory is less affected by ageing than episodic memory (Spencer & Raz, 1995) and because traits are semantic in nature and do not require effortful memory retrieval, then older adults should be able to make as accurate self judgements as younger participants. The neuroimaging studies conducted to examine age effects on the concept of the self report a similar VMPFC activation for self processing in both younger and older adults (Gutchess et al., 2007a; Gutchess, Kensinger & Schacter, 2010; Ruby et al., 2009; Feyers et al., 2010). In a recent fMRI study, Ruby et al. (2009) instructed younger and older participants to indicate the extent to which trait attributes described the self or a well known other person (a relative or a friend). The results showed that older adults performed as accurately as younger participants when compared with a relative's ratings and that both groups activated the VMPFC. However, younger participants showed greater activation of the dorsal prefrontal cortex (DMPFC) and the precuneus, which are thought to be involved in monitoring and inferential processes and memory retrieval (D'Argembeau et al., 2005b; 2007; Feyers et al., 2010). This suggests that the two may groups use different strategies to perform a self/other assessment task, with younger adults responding on the basis of inferential and reasoning processes (i.e. activation of the DMPFC) and episodic memory retrieval (i.e. activation of the precuneus), while older adults rely on their well established knowledge of both the self and others (i.e. VMPFC and lingual gyrus).

In a more recent investigation, Feyers et al. (2010) employed the same self/other trait attribution paradigm and also found that both younger and older adults recruited the VMPFC during self-judgements. However, the VMPFC interacted differently with other brain areas in the two groups, such that co-activation between the VMPFC and lingual gyrus was specific to the younger group. The lingual gyrus reported also in Ruby et al (2009) has been related to visual imagery during retrieval (Levine et al., 2004). Therefore, despite the fact that the younger adults were not asked to retrieve any personal memories, they may have relied on episodic memory retrieval and imagery of past experience more than older participants. In contrast, older adults showed greater co-activation of the VMPFC with the OFC, which is associated with social abilities and emotional perspective taking (Stone, Baron-Cohen & Knight, 1998; Hynes, Baird & Grafton, 2006). These studies also indicate that the lingual gyrus, associated to visual imagery during retrieval, emerged in both younger (Feyers et al., 2010) and older adults (Ruby et al., 2009). This result suggests that older participants might also rely on retrieval of visual information, although they rely less then younger participants on inferential processes mediated by the DLPFC.

Further support for differential strategies employed by younger and older adults in processing self-related information comes from Gutchess et al. (2010). Younger and older adults were presented with a series of traits and instructed to indicate for each trait if it was descriptive of the self, Albert Einstein or if it was printed in upper case letters. After the encoding stage, participants performed a surprise recognition task. The fMRI analysis showed that both groups activated the MPFC while performing the judgement task. However, such activation in younger participants was associated with a subsequent forgetting effect for the self-related items and a remembering effect for the other related items. In other words, greater activation of the MPFC was associated with increased forgetting of self-traits but better memory for other traits. In contrast, older adults showed greater remembering for self-related traits and forgetting for other related traits when the same area was activated. Further analysis contrasted the self-remembered and the other-remembered traits and found that the VMPFC differentiated between the self and other remembered traits in older participants, while the ACC and temporal lobe activation differentiated between the self and other remembered traits in younger participants.

The aim of the following experiment is to investigate the performance of the same younger and older participants on a task thought to rely on semantic self-related knowledge. In order to allow comparison of the results between the self-episodic task (behavioural judgement) and the current self-semantic task, the same measures were computed for the behavioural judgement task. Older adults are expected to perform well on all conditions as they rely on the well-established knowledge of both the self and other traits, which reduces the need to retrieve behavioural instances of when the target person (self or other) possesses a trait. However, if an age effect emerged, it might indicate that older participants need to rely on retrieval of past instances when traits emerge.

3.3.2. Pilot study

The personality judgement task was based on a task developed by D'Argembeau et al. (2007) and Ruby et al. (2007). As for the previous experiments, a pilot study was conducted to determine whether making different trait judgements requires the same cognitive demands. Participants performed the personality judgement task under single and dual task condition. A second aim of the pilot study was to select a pool of traits to be used in the actual experiment.

3.3.2.1. Methods

3.3.2.1.1. Participants

The same participants who were recruited for the pilot behavioural task performed the pilot personality judgement task (see section 3.2.2.1.1). The order of the two pilot tasks was randomised across participants.

3.3.2.1.2. Materials

3.3.2.1.2.1. Personality judgements task

The material consisted of 20 traits adjectives, half positive and half negative presented across five judgement conditions (20 adjectives per condition = 100). The traits were selected from the NEO-Personality Inventory Revised (NE0-PI-R, Costa & McCrae, 1992). The participant's task was to indicate how well each adjective described the self (e.g. Are you aggressive?) or a close other person (Is your relative/friend aggressive?). Both judgements were made for the present time and for the past (5 years before). In contrast to the previous behavioural task, a further condition was included where participants were instructed to take their relative/friend's perspective when judging the self at the present time (e.g. According to your friend, are you aggressive?). This condition was included to investigate whether participants discriminate between their own and another person's perspective. Judgements were made on a 4-point scale (1: not at all; 2: a little; 3: quite; 4: definitely).

3.3.2.1.2.2. Response time task

The secondary task was the same response time task employed during the previous pilot behavioural task.

3.3.2.1.2.3. Personality judgements questionnaire

The older participants' relatives/friends were asked to fill in a questionnaire that consisted of the same judgements used in the participants' computer version of the personality prediction task. Since one aim of the pilot was to select a set of sentences to be used in a further ageing investigations, the questionnaire were administered only to the older participant's relative/friends in order to identify the sentences that older participants and their relative/friend rated in a similar way. The relative/friend was instructed to indicate how well each adjective described themselves and the participant's personality both at the present time and five years ago. The questionnaire was posted to the relative/friend before the participants attended the testing session. The relative/friends were instructed to fill in the questionnaire at their own pace and to return it in a sealed stamped addressed envelope.

3.3.2.1.3. Procedure

In the single condition, younger participants completed the personality judgement task and the response time task, with the tasks order being counterbalanced across participants. The dual task condition was performed after the single conditions. Older participants were recruited in order to select a set of traits to be used in a further ageing study and did not perform the dual task.

During the personality judgement task, participants were shown one adjective at a time presented in the middle of a computer screen. After 2 seconds, the four-point scale (1: not at all; 2: a little; 3: quite; 4: definitely) appeared underneath the adjective, and both the scale and the adjective remained visible on the screen until a response was made. Response times (RTs) and responses were recorded.

In the dual task paradigm, participants performed the personality judgement task and the response time task simultaneously. The sound of the response time task was performed throughout the test. Ten younger participants performed the personality judgement task while they were performing the response task.

3.3.2.1.4. Scoring

The four responses were grouped into two matching categories by combining "not at all" with "a little" responses (responses 1 and 2) and "quite" with "definitely" responses (responses 3 and 4). In order to obtain measures of the ability to rate one's own and another person's personality, the responses provided in each condition were compared between subjects (i.e. responses given by participants were compared with responses given by their relative/friend).

3.3.2.1.5. Analysis

Since older participants did not perform a dual task condition for the personality judgement task, the mean overall time taken to perform each single task was computed self now/before, relative/friend now/before. The response time task was performed six times under single task conditions. The mean RT for the six repetitions of the secondary task was computed and subtracted from the RTs when the task was performed under dual task conditions.

3.3.2.2. Results

3.3.2.2.1. Overall time taken under single task condition.

The overall time taken to perform each condition of both sets under single task condition was computed for older adults (Table 3.10). Data were not normally distributed and thus were analysed with the non-parametric Friedman test. The results showed no significant difference [$\chi 2$ (5) = 9.8, p = .08, w = .39].

Table 3.10. Overall time taken in each condition for both sets in older group

	Mean	SD
1st Self Now	29725.33	6591.19
1st Other Now	36193.50	10276.71
1st Self Before	27680.16	4378.09
1st Other Before	34834.00	13436.47
3rd Self Now	25407.34	13144.85

3.3.2.2.2. Dual task performance

The mean RT difference between the performance on the secondary task alone and under dual task conditions for each personality condition is displayed in Table 3.11. The result of a repeated measure ANOVA showed no significant difference [F (4,36) = 1.25, p = .30, η_p^2 = .12].

Table 3.11. RT differences (ms) between single and dual task performance on the secondary task

	Mean	SD
Self Now	173.87	128.58
Self Before	213.73	103.45
Other Now	182.37	121.85
Other Before	188.30	128.48
3rd Person Perspective on Self Now	207.19	103.54

3.3.2.2.3. Question selection

The items' responses provided by the older participants that matched with the responses provided by their relative/friend were considered (e.g. a response of 1 provided by the participant was considered matching with a response of 1 or 2 provided by the relative/friend). The questions that obtained matched responses on at least 5 out of 6 participants were selected resulting in 10 personality traits being selected. The overall time taken to perform each personality judgements for the selected questions only was computed for both younger and older participants (Table 3.12).

Table 3.12. Overall time taken (ms) to perform each condition for the selected personality traits in the younger and older groups.

	Younger Mean (SD)	Older Mean (SD)
Self Now	7900.3 (3182.4)	15237.3 (1858.8)
Self Before	9872.6 (5424.9)	16687.3 (6573.0)
Other Now	7240.3 (3896.2)	12570.3 (1591.0)
Other Before	10268.9 (6168.2)	15720.5 (6603.6)
3rd Person Perspective on Self Now	8638.0 (4778.2)	16162.0 (1733.9)

The data were not normally distributed and thus were analysed with non-parametric tests. The Mann-Whitney results (all values corrected for multiple comparisons, $p < .01$) showed that younger participants took significantly less time to make personality judgements about the self at the present time taking both the first [U =2.00, z = -3.03, *p = .002, r* = - .75] and the 3rd person perspective [U = 6.00, z = -2.60, p = .009, *r* = .65]. No other comparisons were significant in term of self-judgements in the past [U = 11.00, z = -2.06, *p* = .03*, r* = -.51] and judgements of others both at the present time [U = 9.00, z = -2.27, *p* = .02*, r* = -.56] and in the past [U = 14.00, z = -1.73, *p* = .08*, r* = -.43]. These results of the pilot study indicate that the judgement condition were of comparable difficulty.

3.3.3. Experiment 1b: semantic self-knowledge

3.3.3.1. Methods

3.3.3.1.1. Participants

The same thirty younger and thirty older adults who were tested in the behavioural task (Experiment 1a) took part in this study. The task order was counterbalanced across participants.

3.3.3.1.2. Materials

3.3.3.1.2.1. Participants task

In a 2 (self vs. other) x 2 (1^{st} vs. 3^{rd} perspective) x 2 (present vs. past) design, participants were required to judge how well a given adjective described themselves or their relative/friend at the present time and five years ago (1: not at all; 2: a little; 3: quite; 4: definitely). Participants were also assessed on their ability to take their relative/friend's perspective when judging their own or their relative/friend's personality now. The sentences were written in black ink on a white background and were presented in the middle of the screen. Judgements were made on a four point Likert scale by pressing the corresponding button on the computer keyboard. Overall participants made 6 judgements, which were counterbalanced across conditions:

- S1_Now: Judging their own personality now (e.g. Are you sociable?)

- S1_Before: Judging their own personality 5 years before (e.g. Were you sociable 5 years ago?)

- S2_Now: Judging their relative/friend's personality now (e.g. Is your relative/friend sociable?)

- S2__Before: Judging their relative/friend's personality 5 years before (e.g. Was your relative/friend sociable 5 years ago?)

- 3rd_Self: Taking the relative/friends' perspective to judge the participants' own personality now (e.g. According to your relative/friend, are you sociable?)

- 3rd_Other: Taking the relative/friends' perspective to judge the relative/friends' personality now (e.g. According to your relative/friend, is s/he sociable?)

3.3.3.1.2.1.2. Relative/Friend's Questionnaire

The participant's relative/friend was asked to fill in a questionnaire, which consisted of 4 of the 6 judgements used in the participants' computer version of the personality-rating task. The relative/friend was instructed to assess their own personality and the participant's personality at the present time and five years before. The responses were used to determine whether younger and older participants were similarly accurate in making self and other related judgements. The third perspective conditions were included to determine whether younger and older differed in their ability to take another person perspective and were administered to their relative/friend.

The relatives/friends performed 4 conditions:

- R1_Now: Judging their own personality now (e.g. Are you sociable?)

- R1_Before: Judging their own personality 5 years before (e.g. Were you sociable 5 years ago?)

- R2_Now: Judging the relative/friend's personality (i.e. the participant) now (e.g. Is your relative/friend sociable?)

- R2__Before: Judging the relative/friend's personality (i.e. the participant) 5 years before (e.g. Was your relative/friend sociable 5 years ago?)

The questionnaire was posted to the relative/friend before the participants attended the testing session. They were instructed to fill in the questionnaire at their own pace and to return it in a sealed stamped addressed envelope.

3.3.3.1.3. *Procedure*

Participants sat in front of a computer screen and the instructions were given at the beginning of each condition to explain what type of judgement they were going to be asked to make, followed by an example. One sentence at a time was presented in the middle of the screen. After 2 seconds the four-point scale appeared underneath the sentence, and both the scale and the sentence remained visible on the screen until a response was made. Response times (RTs) and responses provided were recorded.

The same set of 10 personality traits, five positive and five negative, was used in each condition. A control sentence was also added to the personality task which referred to facts wherein a single response could be correct (e.g. Is the examiner a man?). The control sentences were added to ensure participants read and could understand the sentences.

3.3.3.1.4. Scoring

In order to obtain measures of the ability to rate one's own and another person's personality, the responses provided in each condition were compared between raters (i.e. responses given by participants were compared with responses given by their relative/friend) and within subjects (i.e. responses given by participants for one condition were compared with the responses given by participants for another condition and responses given by the relative/friend in one condition were compared with responses given by the relative/friend in another condition). The four responses were then grouped into two categories by combining "not at all" with "a little" responses (responses 1 and 2) and "quite" with "definitely" responses (responses 3 and 4). Consequently, responses were scored according to the degree of consistency between the responses given: 2 = exact congruency (e.g. 2 and 2), 1 = modest congruency (e.g. 1 and 2, 3 and 4) or 0 = no congruency (e.g. 1 and 3). The final congruency scores ranged from 0 = no congruency to 20 = maximum congruency (2 points x 10 traits).

Responses given by the participants and relatives/friends were compared to obtain 9 measures:

- Self Perceived Change: Obtained by comparing the responses given by participants about their own personality at the present time (S1_Now) and in the past (S1_Before).

- Other Perceived Change (relative/friend): Obtained by comparing the responses given by the relative/friend about the participant's personality at the present time (R2_Now) and in the past (R2_Before).

- Self Awareness: Obtained by comparing the responses given by participants about their own current personality (S1_Now) and those given by their relative/friend about the participant's personality (R2_Now).

- Other Awareness: Obtained by comparing responses given by participants about their relative/friend's personality (S2_Now) and responses given by their relative/friend about their own personality (R1_Now).

- Different Perspectives of Own Personality: Obtained by combining responses given by the participant about the self when taking the relative/friend's perspective (3rd_Self) and responses given by the relative/friend about the participant's personality taking their own perspective (R2_Now).

- Different Perspectives of Relative/Friend's Personality: Obtained by combining responses given by the participant about their relative/friend's personality when taking the relative/friend's perspective (3rd_Other) and responses given by the relative/friend about their own personality taking their own perspective (R1_Now).

- Participant Stereotypical Ratings: Provided a measure of the congruency between ratings of the self and other as perceived by the participants to determine whether the participant simply responds in the same way for both themselves and their relative. It was obtained by comparing responses given by participants about their own personality at the present time (S1_Now) and their relative/friend's personality (S2_Now).

- Relative/Friend Stereotypical Ratings: Provided a measure of the congruency between the participant and the relative/friend's current personality according to the relative/friend (R1_Now and R2_Now). Again, this was to ensure that the relative/friend was not simply providing the same responses for themselves and their relative/friend.

- Reliance on past personality: Obtained by comparing responses given by the participant about their own personality at the present time (S1_Now) with those given by their relative/friend about the participant's personality in the past (R2_Before).

3.3.3.1.5. Analysis

Congruency scores and response times (RTs) were analysed separately. Scores for the congruency measures for the younger and older groups were analysed using either ANOVA or t-tests:

- Congruency scores for Self Perceived Change and Other Perceived Change for the two age groups were compared using a 2 (age group: young vs. older adults) x 2 (judgement condition: self vs. other perceived change) mixed-model ANOVA.

- Congruency scores for Self Awareness and Other Awareness across the Different Perspectives for the Own and Relative/Friend's Personality for both age groups were compared using a 2 (age group: young vs. older adults) x 2 (awareness: self vs. other) x 2 (perspective: 1st vs. 3rd) mixed-model ANOVA.

- A 2 (age group) x 2 (stereotypical ratings: participant vs. relative/friend) mixed-model ANOVA was conducted to compare the stereotypical ratings for the participant and relative/friend.

- Reliance on the past was analysed using an independent samples t-test.

The RTs of the participants in each personality condition were entered into a 2 (group: young vs. old adults) x 6 (conditions: S1_Now, S1_Before, S2_Now, S2_Before, 3rd_Self, 3rd_Other) mixed-model ANOVA.

3.3.3.2. Results

3.3.3.2.1. Personality judgement results

3.3.3.2.1.1. Personality Change

Table 3.13 shows the means and standard deviations for the measures of perceived personality change in younger and older participants.

Table 3.13. Means and standard deviations (SD) for Self and Other Perceived Change

	Younger	Older
	Mean (SD)	*Mean (SD)*
Self Perceived Change (max =20)	11.33 (3.3)	15.40 (3.0)
Other Perceived Change (max = 20)	14.40 (3.0)	17.13 (2.9)

The results showed a significant main effect of judgement condition [F (1,58) = 18.42, p = .000, η_p^2 = .24] with higher congruency scores for the change perceived by others compared to the self perceived change, suggesting that participants report higher changes in their own personality than those reported by the relative/friend on the participant's personality. There was also a main effect of age group [F (1,58) = 35.12, p = .000, η_p^2 = .37] with higher congruency scores for older than younger participants, suggesting that older adults change less over time than younger adults. The interaction was not significant [F (1,58) = 1.42, p = .23, η_p^2 = .02].

3.3.3.2.1.2. Awareness and Perspective Taking

A separate 2 group (young vs. old) x 2 awareness (self vs. other) x 2 perspective (first vs. third) mixed-model ANOVA was conducted to investigate awareness of the self and others and no significant results emerged. The means and standard deviations are displayed in Table 3.14.

Table 3.14. Means and standard deviations (SD) for Self and Other Personality Awareness taking the first and third person perspective

	Younger	Older
	Mean (SD)	*Mean (SD)*
Self Awareness (max =20)	13.17 (3.4)	12.10 (3.8)
Other Awareness (max = 20)	12.43 (2.8)	13.23 (2.8)
Different Perspectives of Own Personality (max = 20)	12.97 (3.1)	12.33 (3.3)
Different Perspectives of Relative/Friend's Personality (max = 20)	12.73 (2.8)	13.17 (2.8)

The results did not reveal any significant main effects of target person and perspective [F (1,58) = 2.91, p = .59, η_p^2 = .005; F (1,58) = .082, p = .77, η_p^2 = .001, respectively], group [F (1,58) = .040, p = .84, η_p^2 = .001] or interactions [target x group: F (1,58) = 2.5, p = .11, η_p^2 = .04; perspective x group: F (1,58) = .005, p = .94, η_p^2 = .001; target x perspective: F (1,58) = .050, p = .82, η_p^2 = .001; target x perspective x group: F (1, 58) = .79, p = .87, η_p^2 = .01].

3.3.3.2.1.3. Stereotypical ratings for the participant's personality and the relative/friend's personality

The higher the stereotypical rating, the more congruence there was between the responses provided to describe someone's own and their relative/friend's personality. For example, 0 = no congruence between their responses provided to describe both their own and their relative/friend's personality and 20 = the same responses were given to describe both their own and relative/friend's personality. The two measures of stereotypical ratings for the participant and the relative/friend's personality were entered in a 2 (age group: younger vs. older) x 2 (target: self vs. relative/friend) mixed-model ANOVA. No significant main effect of condition [F (1,58) = 2.46, p = .12, η_p^2 = .04], age group [F (1,58) = .51, p = .47, η_p^2 = .009] or interaction [F (1,58) = .73, p = .39, η_p^2 = .01] was found. The means and standard deviations are displayed in Table 3.15.

Table 3.15. Means and standard deviations (SD) for stereotypical ratings for participants and relative/friend's personality

	Younger	Older
	Mean (SD)	*Mean (SD)*
Participant Stereotypical Ratings (max = 20)	12.70 (3.2)	12.67 (3.4)
Relative/Friend Stereotypical Ratings (max = 20)	11.33 (3.4)	12.24 (3.0)

3.3.3.2.1.4. Reliance on the Past

An independent sample t-test showed that Reliance on the Past did not significantly differ between younger (μ = 11.77; SD = 3.2) and older participants (μ = 12.80; SD = 3.6), [t (58) = -1.17, p = .24, d = .30].

3.3.3.2.2. Response Times

The response times for the younger group in the 3rd_Self condition were not normally distributed. Visual inspection of the means using a box plot showed that one younger participant was an outlier and, therefore, s/he was removed from the analysis. The response times for the six judgements were then entered in a 2 (age group: younger vs. older) x 6 (judgement: S1_Now, S1_Before, S2_Now, S2_Before, 3rd_Self, 3rd_Other) mixed-model ANOVA. The means and standard deviations for RTs are displayed in Table 3.16.

Table 3.16. Means and standard deviations (SD) for the response times on the 6 conditions completed by the younger and older participants

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
S1_Now	626.6 (262.8)	1743.9 (569.3)
S1_Before	681.9 (222.7)	1654.1 (494.9)
S2_Now	566.1 (232.3)	1598.2 (447.4)
S2_Before	921.8 (413.3)	1974.9 (646.2)
3rd_Self	615.2 (200.6)	1699.2 (584.3)
3rd_Other	873.4 (259.2)	2465.1 (856.7)

The results showed a significant main effect of judgement condition [F (5, 285) = 25.80, p = .000, η_p^2 = .31]. Since multiple post-hoc comparisons were conducted, the results were Bonferroni corrected (p < .008). Post-hoc paired samples t-tests showed faster RTs when making judgements about a relative/friend's personality (S2_Now) compared to the self at the present time (S1_Now), [*t* (59) = -3.06, *p* = .003, *d* = .20], when making judgements about a relative/friend's personality at the present time (S2_Now) compared to the past (S2_Before), [*t* (59) = - 6.74, *p* =. 000, *d* = .59], as well as when making judgements taking the first person perspective (S2_Now) compared to the third perspective for others (3rd_Other), [*t* (59) = -8.04, *p* = .000, *d* = .71] and for the 3rd perspective judgement about the self (3rd_Self) compared to the relative/friend (3rd_Other), [*t* (58) = -6.43, *p* = .000, *d* = .45]. No significant differences emerged in making judgements about the participant's own current and past personality [*t* (59) = .336, *p* = .73, *d* = .025] nor when taking different perspectives to rate the self [*t* (59) = -.557, *p* = .59, *d* = .025]. The results also showed a significant main effect of group [*F* (1,57) = 149.88, *p* = .000, η_p^2 = .72] with faster RTs in younger participants.

The interaction age group x judgement condition was also significant [*F* (5, 285) = 6.54, *p* = .000, η_p^2 = .10]. Post-hoc t-tests showed that both younger and older groups were faster in making judgements about the relative/friend's current (S2_Now) than past personality (S2_Before), [*t* (29) = - 5,99, *p* = .000, *d* = .99; *t* (29) = - 4.25, *p* = .000, *d* = .65, respectively] and judgements about the relative/friend's personality when taking a first (S2_Now) than a third person perspective (3rd_Other), [*t* (29) = - 7.13, *p* = .000, *d* = 1.24; *t* (29) = -7.27, *p* = .000, *d* = 1.16]. Both groups also showed an advantage when taking the third perspective to rate the self (3rd_Self) than the relative/friend (3rd_Other), [*t* (28) = - 6.48, *p* = .000, *d* = 1.09; *t* (29) = - 5.49, *p* = .000, *d* = 1.01, respectively]. However, both groups showed similar latencies when making current (S1_Now) and past (S1_before), [*t* (29) = -.1.53, *p* = .13*,* *d* = .22; *t* (29) = .944, *p* = *.35,* *d* = .16] judgements about the self taking the first perspective and when making judgements on their current personality taking the first (S1_Now) and the third (3^{rd}_Self) perspective, [*t* (29) = -.894, *p* = .37*,* *d* = .04; *t* (29) = .479*,* *p* = .63*,* *d* = .07]. Older participants showed faster RTs when making personality judgements about their relative/friend (S2_Now) compared to the self (S1_Now), [*t* (29) = 3.01, *p* = .005, *d* = .28], while no difference emerged in younger adults [*t* (29) = 1.14, *p* = .26, *d* = .24].

This pattern of results suggests that there is an advantage in making personality judgements in relation to the relative/friend's current personality (i.e. judgements about others are faster for the relative/friend's current personality compared to their past personality and when the relative/friend is judged taking a first person perspective compared to a third person perspective). Faster RTs for self-assessment compared to others emerged when participants took a third person perspective.

3.3.4. Discussion

Younger and older adults were required to make trait judgements regarding the self and others, at the present time and in the past, taking either their own or their relative/friend's perspective. Their responses were compared with those given by the participant's relative/friend to obtain congruency scores for the ability to rate one's own and another person's behaviour. The ability to rate self and others' personality taking either the self or a different person perspective did not show any effect of healthy adult ageing. This finding is in line with the view that self-judgements rely on the VMPFC

(Kelley et al., 2002; Macrae et al., 2004; Heatherton et al., 2006; Ruby et al., 2009; Feyers et al., 2010), which is thought to be less affected by ageing than other frontal regions (Phillips et al., 2002).

The results of response latencies (RTs) showed that, similarly to the behavioural task, participants were faster in making judgements about the relative/friend's personality now than in the past. They also showed an advantage for making self than other related judgements when taking a third person perspective and no difference emerged for judgements made about the self at the present and in the past. However, participants were faster in making relative/friend judgements than self-related trait judgements taking their own perspective. This result was qualified by an age group x judgement condition interaction, which showed that older participants were significantly faster in making relative/friend judgements than self-related judgements. The RT advantage in making judgements about the relative/friend may relate to the type of knowledge that individuals retrieve when making personality judgements. In a series of investigations, Klein et al. (1989; 1992a;b; 1993a;b; 1997) showed that making trait judgements does not require retrieval of specific past memories, suggesting that the trait and the behavioural exemplars are independently stored. However, Babey et al. (1998) and Klein et al. (2001) showed that when people retrieve a trait, they might also retrieve memories that represent instances when the individual manifested the opposite trait (e.g. She is happy unless when she is at a funeral). The availability of behavioural examples for the opposite trait has been also shown to affect the type of response provided during a trait judgement task. Klein et al. (2004a) suggested that when individuals possess an extensive knowledge of a target person, their judgements may not be clear-cut so they know when one does not manifest the trait. Therefore, when individuals are asked to indicate the extent to which a trait adjective describes a target person by choosing one of three available responses (not at all, somewhat, definitely), they often choose the "somewhat" response, suggesting that the knowledge they possess allows them to make more accurate judgements of a trait's descriptiveness. Similarly, Pronin and Ross (2006) showed that individuals are likely to based self- but not other-related judgements on situational variability. The researchers presented participants with a list of trait adjectives and instructed them to indicate for each trait whether it was descriptive of the self/close other by choosing one of three options: yes, no or "depends on situation". The authors found that participants responded more often "depends on situation" when making judgements about the self than a close-other person. It is plausible that when participants have better knowledge of the self rather than of another person, participants take longer to decide the extent to which a trait is self-descriptive. This effect would not emerge in younger participants who instead rely more than older adults on inferential processes when making personality judgements, due to their less well-established knowledge of both the self and others (Ruby et al., 2009; Feyers et al., 2010).

The younger and older participants also showed a similar ability to rate their relative/friend's personality and to take another person's perspective regarding both the self and others (Ruby et al., 2009). The ability to make self-related judgements may require the ability to consider what another person may think of us (D'Argembeau et al., 2007). It has been proposed that the processing of self related information and the ability to infer other peoples' mental states and thoughts, known as Theory of Mind (ToM), may overlap, in that individuals infer other peoples' mental states by imagining how they would feel in a similar situation (i.e. they would project themselves into the situation; Nickerson, 1999). Recent neuroimaging studies instead showed that the self and the ability to take another person perspective rely on different neural substrates. For example, D'Argembeau et al., (2007), in an fMRI investigation, instructed young participants to make trait judgements about the self and a well known other person taking either their own or the other person's perspective. The neuroimaging results showed that taking the first perspective about the self activated the ventral (BA 10) and dorsal (BA 9) MPFC, whereas the third person perspective on the self showed more posterior frontal activation (BA 6). This posterior frontal activation has been previously reported in neuroimaging studies that assessed the ability to take another person perspective on conceptual and emotional issues (Ruby & Decety, 2003; 2004). Activation of other brain regions during the third person perspective included left frontal temporal and parietal involvement, related to autobiographical memory and perspective taking respectively (Fink et al., 1996; Conway et al., 1999; Ruby et al., 2003; 2004). In addition, the DMPFC (BA 9) showed increased activation for self compared to other related judgements when taking a third person perspective. These findings suggest that making judgements on others are more cognitively demanding in terms of cognitive efforts and memory retrieval. In a more recent study, Ruby et al. (2009) showed that younger participants recruit the DMPFC and the lingual gyrus during the third perspective condition to a greater extent than older adults indicating that they would rely more on inferential and memory process while older adults would rely more on their well established knowledge of the self and others. The results of the present study showed that younger and older participants performed similarly when taking the perspective of another person to rate both the self and others. This suggests that the ability to take into consideration what another person think is preserved in older adults.

The results of the current investigation also showed that, in contrast to the behaviour prediction task, older adults do not report higher stereotypical responses when judging the self and others compared to younger adults. Similarly, Anderson et al. (2003) reported that emotional responses but not personality traits become more similar over time. These results demonstrate that older adults provide the same responses for the self and a close other only on a task that requires episodic retrieval. The personality task instructed participants to indicate on a 4-point scale the extent to which a trait is descriptive of either the self or a relative/friend. The type of response required may have allowed participants to make a more fine-grained distinction between the self and others. In contrast, the behaviour prediction task presented participants with a pre-determined triplet of adjectives that may have forced them to choose a response close, but not specific, to their own and their friend/relative's real reaction.

3.3.5. Conclusion

In conclusion, the results of the personality judgement task showed that older individuals do not show any difference compared to younger participants when making self and other related judgements and that both groups similarly can take into consideration what another person may think of them.

3.4. General Conclusion of Chapter 3

The self is the representation of attributes, beliefs, wishes and past episodes that individuals possess. Despite physical, psychological and social changes that individuals face as they become older (Brandtstädter et al., 1994; Sneed et al., 2005), the ability to process self-related information appears not to decrease with age (Ruby et al., 2009). This might be due to the specific involvement of the VMPFC brain area in processing self-related information (Kelley et al., 2002). It has been claimed that this region of the PFC is less affected by age than other brain areas (i.e. DLPFC) and that the older individuals would perform relatively well on tasks thought to rely on VMPFC functions (Phillips et al., 2002; MacPherson et al., 2002).

However, self-knowledge relies on two memory systems: the episodic and semantic memory storage systems. Evidence exists showing greater decline of episodic than semantic memory performance in the older population (Spencer et al., 1995) and that older adults might compensate for memory deficits by relying on stereotypical knowledge more than younger adults (Mueller et al., 1986; Mather et al., 1999). These studies suggest that age differences in processing self-related information might emerge when the task relies on episodic rather than semantic self-knowledge. In the current study younger and older adults performed two self-related tasks that differed in the extent to which they relied on episodic or semantic retrieval. The results showed that older participants were as accurate as younger adults in making both episodic and semantic self-related judgements. However, age differences emerged on the behaviour task, where older participants made higher stereotypical ratings than younger individuals, suggesting that they might compensate for their memory deficit by providing the same response for the self and a close-other on the task that required episodic but not semantic retrieval. These results indicate that the ability to process self-related information is modulated by the task requirements. Furthermore, the results also indicate that the type of information on the basis of which participants made their judgments might differ in the two age groups. Older but not younger adults took longer to make self than other judgments. Therefore, it may be that older adult relied on well-established knowledge of the self while younger participants relied on inferential and reasoning processes to a greater extent than older individuals.

Chapter 4. Experiment 2: Self and Theory of Mind.

4.1 Introduction

In the previous two experiments, participants took the perspective of a close other person who is known to be included in their representation of the self (Aron et al., 1991). This ability to take another person's perspective is not affected by ageing. Taking another person perspective has been shown to recruit DMPFC to a greater extent than taking the first person perspective (Ruby et al., 2009), suggesting that greater mental effort is required to discriminate between the self and others' perspectives (D'Argembeau et al., 2007). Yet, some studies did not find differential activation of the MPFC between the self and a close other (Schmitz et al., 2004; Ochsner et al., 2005). Therefore, it might be that taking the perspective of a distant-other person would require greater mental effort (Ochsner et al., 2005) than taking the perspective of a close-other. Furthermore, taking the perspective of a non-close other person is known to involve the regions of the temporal lobes typically associated with memory retrieval (Ochsner et al., 2005). Therefore, an age effect would be expected on those tasks thought to require greater cognitive effort.

The ability to consider what another person may think or feel is known as Theory of Mind (ToM; Premack & Woodruff, 1978). Participants typically are presented with a series of short stories, cartoons or photographs and are instructed to infer the mental state of the main character (Happé et al., 1996; Fletcher et al., 1995; Gallagher et al., 2000). The performance on ToM stories is compared to the performance on stories that do not require inferring another person's mental state (non-ToM or physical stories), in which participants are asked a question related to a physical details of the story presented). Reduced ability in understanding another person's mental state has been reported in patients with autism, Asperger's Syndrome and schizophrenia (Baron-Cohen, Ring, Moriarty, Schmitz, Costa & Ell, 1994; Baron-Cohen, Ring, Wheelwright, Bullmore & Brammer, 1999; Happé et al., 1996; Shamay-Tsoory, Aharon-Peretz & Levkovitz, 2007b), following damage that involved the VMPFC (Stone et a., 1998), in patients with frontal-variant frontotemporal dementia (fvFTD; Lough, Gregory & Hodges, 2001; Gregory, Lough, Stone, Erzinclioglu, Martin, Baron-Cohen et al., 2002; Snowden et al., 2003).

Neuroimaging studies investigating the brain regions associated with understanding another person's mental states indicate that it involves activation of temporal brain areas as well as MPFC. The specific involvement of temporal areas has been associated to retrieval of past experiences that would help to interpret the situation described in the ToM stories (Frith & Frith, 2003). In terms of frontal areas, different regions of the PFC have been associated with ToM tasks. Early studies reported activity of the MPFC (BA 8 and 9). For example, the first study that investigated the brain regions that are activated during the presentation of ToM stories compared to physical stories (Fletcher et al., 1995) using PET found specific activation of the left medial frontal gyrus (BA 8) extending into BA 9 for the ToM stories. A number of PET and fMRI studies have replicated the MPFC activation associated with ToM (Happé et al., 1996; Gallagher et al., 2000; Vogeley, Bussfeld, Newen, Herrmannm, Happé, Falkai et al., 2001). For example, Happé et al. (1996) showed that healthy adults activated the frontal area on the border between BA 8 and 9 and to a lesser extent a more inferior frontal area, BA 9/10. Similarly, Gallagher et al. (2000) showed greater MPFC activation (BA 8/9) specific to ToM compared to the physical stories. Yet, more recently, Gobbini, Koralek, Bryan, Montgomery and Haxby (2007) reported activation in the same areas as the previous studies mentioned above (BA 8 and 9), but also found activation in the frontal pole (BA 10) and a more ventrolateral brain region (BA 47).

These studies indicate that making ToM inferences involves both dorsal and ventral region of the PFC. It may bes that ToM consists of different components that rely on the involvement of different brain areas. For example, the Happé's ToM stories are thought to measure cognitive aspects of ToM processing (cognitive ToM; Hynes et al., 2006). In contrast, other stories commonly used, such as the Faux Pas, are thought to measure affective ToM (Kalbe, Grabemhorst, Brand, Kessler, Hilker & Markowitsch 2007). Supporting this distinction, Hynes et al. (2006) investigated brain activation for affective and cognitive ToM with fMRI and found that activation of the medial orbital frontal areas (BA 11, 25 and orbital 47) associated to the affective stories whereas the cognitive stories were associated to the activation of more lateral and anterior portion of the ventral PFC (BA 10 and 47/10). Overall, these studies suggest that both the DLPFC (Fletcher et al., 1995; Happé et al., 1996; Gallagher et al., 2000) and the VMPFC (Hynes et al., 2006; Gobbini et al., 2007) are involved in inferring other people's mental states. More specifically, the DLPFC is involved in understanding another person's mental state, thoughts or beliefs. The VMPFC is instead involved in understanding another person's emotional/affective state.

The central role played by the MPFC in performing ToM tasks emerges also in patient studies. Damage to the MPFC in lesion studies is also known to produce deficits in performing the ToM stories task. Although not many studies exist that have looked at the effects of well-defined brain damage on performance on the ToM stories, some evidence emerges in studies that have investigated ToM in patients with Asperger Syndrome and fvFTD. In a PET study, Happé et al. (1996) compared the brain activation of healthy adults to patients with Asperger Syndrome on the ToM and physical stories (in which participants need to understand a physical elements of the story, without the need to infer a character's mental state). The PET results showed differences in the brain activity. Both patients and healthy controls activated the temporal pole and the angular gyrus. However, while healthy adults activated the MPFC, BA 8/9, Asperger's patients showed more ventral activation of MPFC, BA 9/10. This ventral area was also activated in controls, although much less than BA 8/9. The greater activation of BA 9/10 in patients was interpreted as indicating that patients relied more on reasoning processes to infer mental states. This result is in line with a previous PET investigation in normal volunteers, which indicated that mentalising (e.g. understanding another person's mental state) was specifically associated with activation of the left MPFC, on the border between BA 8 and 9 (Fletcher et al., 1995; Gallagher et al., 2000; Gobbini et al., 2007).

Some support for the role played by the VMPFC in task performance has emerged in studies that investigate ToM in patients with fvFTD. Snowden et al. (2003) investigated performance on the ToM stories in healthy adults and fvFTD patients whose atrophy predominantly included the OFC. The results showed that the fvFTD were impaired compared to controls on the ToM stories. However it must be taken into account that the fvFTD group included OFC damage in 9 patients while a widespread frontal lobe change characterised the brain damage in the remaining 4 patients, suggesting that other brain areas might be involved in the ToM performance. In line with this view, Bird, Castelli, Malik, Frith and Husain (2004) reported ceiling performance on the ToM stories in a patient with fvFTD whose damage extended from the OFC to the corpus callosum and included the anterior cingulate gyrus as well as the middle and superior frontal gyrus, suggesting that the middle areas of the frontal lobes might not be crucial when performing the task.

It has been claimed that making ToM inferences and processing self-related information involve a common brain network (Frith et al., 2003; Happé, 2003). In fact, some studies suggest that processing of the self and the ability to infer other peoples' mental states may overlap because individuals infer others peoples' mental states by imagining how they would feel in a similar situation (the simulation theory; Gallese & Goldman, 1998; Nickerson, 1999). A contrasting view (the theory-theory; Perner, Gschaider, Kuhberger & Schrofner, 1999) states that the ability to infer others' mental states develops separately from self-knowledge. To determine whether the self and ToM abilities rely on a common or a different brain network, Vogeley et al. (2001) developed a paradigm to separately investigate the brain activity associated with mentalising about the self and mentalising about others. Participants were instructed to read a series of short stories and to infer the mental state of a character in the story. The ToM stories were those used by Fletcher et al. (1995) and Happé et al. (1996). Vogeley et al. (2001) developed two further types of stories: the self stories where the self perspective of the participant was included in the story as one of the characters and the Self + ToM stories where participants were instructed to report on their own behaviour or mental state taking into consideration the mental state of another character. The results suggest a mixed result in that ACC activation was mainly associated to the ToM and the self-processing was associated to an additional involvement of the temporoparietal junction.

Other studies showed that the self-related brain areas are involved when processing information related to others who are perceived as similar to the self. For example, Mitchell, Banaji and Macrae (2005) and Mitchell et al. (2006) investigated brain activation with fMRI while healthy individuals mentalised about other individuals who were perceived similar or dissimilar to the self. Mitchell et al. (2006) presented their participants with a photograph and a description of an individual with a similar or different political view compared to the participant's own opinion. During scanning participants were instructed to indicate the extent to which either the self, the similar or the dissimilar other agreed on a series of statements. The results showed that activation of the DMPFC was specifically associated with mentalising about dissimilar others, while the VMPFC was associated to mentalising about others when they were perceived similar. This suggests that self-based knowledge is involved when inferring about mental states of similar others. In a different study, Jenkins, Macrae and Mitchell (2008) used a technique based on an effect known as "repetition suppression": the neural activity of a brain region sensitive to a given stimulus is reduced when the stimulus is repeated. This means that suppression of activation following two different stimuli indicates that the same population of neurons is engaged by both stimuli. This technique is therefore suitable to investigate whether self-referential processing engages the same neurons as when reflecting on similar others. During fMRI scanning, participants were required to perform self-referential introspection (e.g. "How frustrated are you in traffic?"). Immediately prior to this, participants performed one of three different types of judgement: 1) an initial self-reflection judgement; 2) a judgement about the opinion of a similar person; and 3) a judgement about the opinion of a dissimilar person. The results showed that when the self-condition was performed after a judgement regarding a dissimilar other, there was strong activation of the VMPFC. In contrast, when the self-condition followed a judgement regarding a similar other, there was reduced activation of the VMPFC. This result further supports the idea that judgements about the self and similar others may rely on a similar brain network and suggests that the involvement of the MPFC areas is modulated by the similarity perceived between the self and others.

In contrast to this view, recent evidence indicates that making self-judgements and ToM inferences rely on dissociable brain networks. In particular, D'Argembeau et al. (2005b) suggest that the DMPFC (8,9) is specifically involved in mentalising, whereas the VMPFC (10,32) is specifically involved in processing the self. In their fMRI investigation, D'Argembeau et al. (2005b) asked participants to reflect on the self, another person and social issues. The results showed that self-reflection was specifically associated with the VMPFC area (BA 10, 32), whereas mentalising relied on DMPFC activity. The researchers concluded that the VMPFC is specific for representing stable self knowledge, such as the representation of self related traits and attitudes (Klein et al., 2002) as well as mentalising about similar others (Mitchell et al., 2005), while the DMPFC is for mentalising about dissimilar others (Happé et al., 1996; Fletcher et al., 1995; Gallagher et al., 2000; Mitchell et al., 2005) as well as for mentalising on current self-emotional states (Gusnard, Akbudak, Shulman & Raichle, 2001).

In terms of ageing, contradictory results emerged. Happé, Winner and Brownell (1998) found that older adults performed even better than younger adults on the ToM stories, while no difference emerged in the control stories. The results were explained in terms of increasing in social sensitivity in older adults. Further studies report no age differences in performance on the ToM stories (Saltzman, Strauss, Hunter & Archibald, 2000; Wang & Su, 2006; Slessor et al., 2007). And still other studies have reported poorer ToM performance in older adults compared to younger adults (Maylor, Moulson, Muncer & Taylor, 2002; Sullivan & Ruffman, 2004; Keightley, Winocur, Burianova, Hongwanishkul & Grady, 2006; German & Hehman, 2006; Castelli, Baglio, Blasi, Alberoni, Falini, Liverta-Sempio et al., 2010). It has been suggested that the poorer performance in the older population may relate to the memory demands of the task. Maylor et al. (2002) investigated ToM story performance in young (age range: 16-29 years), young-old (age: 60-74 years) and old-old (age range: 75-89 years) healthy adults. Participants performed the task under two conditions: a memory load condition, where they were instructed to read the story and then the story was removed and a question presented; and a non-memory load condition, where the story and the question were presented together and participants were instructed that they could refer back to the story when answering the question. The results showed that in the memory-load condition younger adults performed significantly better than both the two older groups; in contrast, only the old-old group performed more poorly when the memory demands were reduced, while the younger and young-older participants performed similarly. In line with this result, other studies have shown that older adults performed well when they were allowed to keep the story in front them to answer the question (Saltzman et al., 2000; Slessor et al., 2007). The unimpaired and even superior performance that emerged in the Happé et al. (1998) study may be due to high general intelligence of the specific group of older adults that took part in the study (Slessor et al., 2007). In line with this claim, in a slightly different paradigm to the one used by Happé et al. (1998), Slessor et al. (2007) presented their participants with stories that were followed by a forced-choice response in a reduced memory-load paradigm and found no age difference on task performance. In addition, older participants obtained higher vocabulary scores compared to the younger participants. Once vocabulary was controlled for, however, Slessor et al. (2007) found an age difference in the two group's performance, with better ToM performance of younger participants. Therefore, the authors suggest that older adults' intact performance may relate to their high cognitive function level. In line with this, the studies that reported age effects on the ToM stories also showed that their younger and older participants performed similarly on vocabulary measures (Maylor et al., 2002;

Sullivan et al., 2004; German et al., 2006). In a more recent study, McKinnon and Moscovitch (2007) presented their participants with first (e.g. which requires to infer the mental state of another person) and second order (e.g. which requires to infer what another person believes about what another person thinks) ToM stories. The stories were presented with no memory-load and the results showed that older adults were impaired on the second order stories, while they performed as well as younger adults on the first order stories; these results suggest that their impaired performance may be due to a general impairment in processing more complex ToM information rather than an impairment in the ability to infer other people's mental states. Overall, the ageing studies suggest that older adults may perform poorly on some ToM stories due to general intellectual functions, memory and general attention demands.

The aim of the following experiment is to determine whether age differentially affects the ability make mental state inferences in relation to the self and others. As previously discussed, making ToM inferences involves activation of the temporal areas typically associated with memory retrieval, which provides individuals with a frame to understand the character's mental state (Frith et al., 2003). However, older adults typically retrieve more semantic than episodic information compared to younger adults (Levine et al., 2002; Piolino et al., 2002). As retrieval of semantic self-related information appears to be sufficient to make accurate self judgements (Rathbone et al., 2009) and since processing the self involves activity of VMPFC which is relatively spared in the older population (Phillips et al., 2002), it can be expected that older participants will perform similarly to younger adults when making inferences about the self. Furthermore, on the basis of previous studies which have shown an advantage for processing self-related information compared to non-self related material in both younger and older adults (e.g. in terms of accessibility- faster RTs- and memory retrieval; Symons & Johnson, 1997; Kelley et al., 2002; Gutchess et al., 2007a; Glisky et al., 2009), an advantage in making self compared to others ToM inferences can be expected. A similar performance between the self and ToM stories would give support for there being processes which are both common to mentalising about the self and others.

4.2. Pilot study

4.2.1. Methods

4.2.1.1. Participants

To select the stories to be used as stimuli in the experiment task, a sample of 32 stories was administered to ten undergraduate students. Participants obtained course credit for their participation in the study. The sample consisted of three male and seven female students (age range: 18-32 years; mean = 20.2; SD = 4.3); none of these participants had taken part in any other study.

4.2.1.2. Materials

The materials consisted of four different types of stories; each story type included 8 passages (8 x 4 = 32 stories). The stories were printed on A4 paper in Times New Roman font size 12. The ToM and the physical stories were originally developed by Happé (1994) and Fletcher et al. (1995). The ToM stories described a mistake(Table 4.1). Each story was followed by a question that required participants to infer a character in the story's mental state (thoughts, feelings). The physical stories required participants to understand the physical causation of an event (Table 4.1). The other two types of stories were developed by Vogeley et al. (2001), (Table 4.1). In the self-stories, the involvement of the participant as one of the characters in the passage was obtained by the use of the pronoun "you". Each self-story was followed by a question that required participants to attribute a mental state to the self. Similarly, in the ToM + self-stories, the participant was one of the characters in the story and the questions required participants to attribute a mental state to both the self and another character in the story.

4.2.1.3. Procedure

Participants performed the same task twice, so to select the stories that were given the same answers to. In the first week, each participant was provided with all 32 stories. Each story was followed by a question, which was printed, on the same sheet of paper. They were instructed to read each story silently to themselves, at their own pace, and to provide a written answer to each question. All participants returned after a week and performed the same task with the same 32 stories.

4.2.2. Results

4.2.2.1. Story selection

To select a sample of the stories to be used in the main experiment, the responses provided for each story during the first session were compared to the responses provided for the same stories during the second session. The stories that obtain a consistent response in both sessions were selected. Sixteen passages were obtained, 4 for each type of story (4 x 4 = 16 stories).

4.3. Experiment 2: Self and ToM

4.3.1. Methods

4.3.1.1. Participants

The same thirty younger and thirty older adults who took part in the behavioural and personality task (Chapter 3) took part in this study. The order of the tasks was counterbalanced across participants.

4.3.1.2. Materials

The materials consisted of 16 short passages selected on the basis of the pilot study. The stories were printed on laminated A4 paper in Cambria font size 12. Four types of stories were used: self stories, ToM stories, self + ToM stories and physical stories. Each story was followed by an open-ended question that required the participants to take their own or another person's perspective or to understand the physical causation of an event (Table 4.1). The self-condition included four stories that described a possible situation related to the participant (e.g. the story used the pronouns you and yours: "you are playing" or "your store has been robbed"). The questions asked participants to indicate how they would behave in the described situations. The correct attribution of a mental state to the self was monitored by the use of the personal pronoun (Vogeley et al., 2001). The ToM condition included four stories describing a mistake or a false belief (e.g. a thief drops his glove, a policeman calls him and the thief gives himself up because he thinks he has been caught). In order to correctly answer the questions, participants were required to attribute a mental state (thoughts or judgements) to one or more characters in the story. The self + ToM condition included four stories that described possible ambiguous social situations (e.g. you have gone for dinner with your boss, following a clumsy movement on the part of your boss, a soup bowl falls on your clothes. At this point your boss offers to pay for the cleaning). The questions asked participants to indicate how they would behave in the presented plot. In order to correctly answer the questions, participants had to refer to both the self and a character in the story. Correct assignment to the self was monitored by the use of the personal pronoun while the correct assignment of a character in the story was monitored by the use of mental state terms (e.g. thinks, believe) in reference to the character. The physical condition included four stories describing a situation that required understanding of a physical causation rather than mental state attribution to answer the question (e.g. an old woman is described as very frail. One day she falls on the doorstep. The doctor asked her to go to the hospital where an X-ray is performed. Participants are asked to indicate why the X-ray is performed). See Table 4.1 for examples of each story type.

4.3.1.3. Procedure

The stories were printed on laminated A4 paper in Cambria font size 12. The stories were presented one a time with the question regarding the story presented below the story. The type of stories was presented in a random order. Participants were instructed to read the story silently to themselves, and when ready, answer the question verbally. The experimenter recorded on a separate paper the response provided. Participants were asked to respond as accurately as possible at their own pace. Each story and the question remained in front of the participants until they had answered and then the story was removed and another story handed to the participants.

4.3.1.4. Scoring

The answers were scored on the basis of the same methods used in Fletcher et al. (1995), Happe' et al. (1996) and Vogeley et al. (2001): responses were rated 0 for a wrong or a "don't know" answer, 1 for an implicitly and partially correct answer and 2 for an elaborate and explicitly correct answer (see Table 4.1 for examples). The maximum scores ranged from 0 to 8 for each story type.

Table 4.1: Examples of stories and scored answers.

<u>Example of self stories:</u>

You and your fellow players are sitting together playing poker. You have a very good hand, which, according to the law of probability, one would only obtain about once a year if one played at least 4 hours a day. Your chances of winning are thus very high. However, one of your opponents is very self confident and has already invested enormous amounts, which are already corresponding to half a monthly salary. He thus also appears to have a good hand, or else he is simply bluffing. In order to still manage to win you would need to invest more.

Question: How do you behave?

Example of responses:

2: I would invest more because I have a good chance to win.
1: You may want to invest more because the other player does not know you have a good hand.
0: I am playing poker.

<u>Example of ToM responses:</u>

A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar, he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, "Hey, you! Stop!", the burglar turns round, see the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Question: Why did the burglar do this?

Example of responses:

2: Because he thought the policeman knew he had robbed the shop.
1: Because he thought he was caught.
0: Because he thinks the policeman wants to give him back his glove.

<u>Example of self + ToM stories</u>

A thief who has just robbed a store is fleeing. He has robbed your store but you are unable to stop him. He is running away. A policeman who is watching the thief thinks that he is running so fast in order to catch the already oncoming bus at the next bus stop. He doesn't know that the man is a thief, who has just robbed your store. You are just in time to speak to the policeman before the thief can get onto the bus.

Question:

What do you say to the policeman?

Example of responses:

2: I would tell him to stop that man because he's robbed my store.
1: You need to tell him that.
0: "Why did you let him go?"

<u>Example of physical story:</u>

A burglar is about to break into a jewellers' shop. He skillfully picks the lock on the shop door. Carefully he crawls under the electronic detector beam. If he breaks this beam it will set off the alarm. Quietly he opens the door of the store-room and sees the gems glittering. As he reaches out, however, he steps on something soft. He hears a screech and something small and furry runs out past him, towards the shop door. Immediately the alarm sounds.

Question: Why did the alarm go off?

Example of responses:

2: Because the burglar disturbed a cat, which ran through the detector beam.
1: Because something broke the beam.
0: Because he is a thief.

4.3.1.5. Analysis

The data were analysed using the non-parametric Mann-Whitney U-Test to compare the performance of the two age groups, as the scores were not normally distributed. In order to determine whether participants performed some stories better than others, the data for each group were further analysed separately using the Wilcoxon signed-rank test.

4.3.2. Results

The means and standard deviations for the two groups as function of the four story types are reported in Table 4.1. Since multiple comparisons were conducted, the results were Bonferroni corrected ($p < .01$). The results showed that younger and older adults performed similarly on the self-related stories (self: U = 444.0, z = -.112, p = .91, r = .01; self + ToM: U = 435.0, z = -.229, p = .81, r = 02) as well as the physical stories (U = 361.0, z = -1.3, p = .17, r = .16). However, older participants obtained significantly higher scores on the ToM stories compared to younger adults [U = 246.0, z = - 3.11, p = .002, r = .40].

The Wilcoxon signed-rank test results were also Bonferroni corrected for multiple comparisons ($p < .008$). The results showed that both the younger and older groups performed the self-stories better than the ToM stories [Z = - 3.59, p = .000, r = .65; Z = -3.09, p = .002, r = .56, respectively] and the self + ToM stories [Z = -2.84, p = .004, r = .51; Z = - 3.57, p = .000, r = .65, respectively]. No significant difference emerged between the self and the physical stories in younger adults [Z = -1.55, *p* = .11, *r* = .28] while the older participants showed a further advantage for the self compared to the physical stories [Z = -2.75, *p* = .006, *r* = .50]. No other comparison was significant in the older group [ToM vs. self + ToM: Z = -.108, *p* = .91*, r* = .01; ToM vs. physical stories: Z = -.229, *p* = .81*, r* = .04]. In contrast, younger participants performed the ToM stories poorer than the self + ToM [Z = - 2.89, *p* = .004, *r* = .52] and the physical stories [Z = -3.56, *p* = .000, *r* = .65].

Table 4.1. Means and standard deviations (SD) for each story type (maximum = 8) performed by the younger and older groups.

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
Self	7.26 (1.4)	7.33 (1.1)
ToM	5.30 (1.3)	6.40 (1.0)
Self + ToM	6.56 (1.3)	6.33 (1.6)
Physical	6.80 (1.2)	6.46 (1.1)

4.3.2.1. Additional analysis

In order to determine whether the level of IQ affected the performance on the stories, an ANCOVA with IQ as covariate was conducted. Since the data were not normally distributed, a bootstrapping procedure was also performed on the data. The results showed that older adults obtained higher scores on the ToM stories only compared to younger participants, after controlling for the level of the IQ [F (1,57) = 12.2, p = .001, η_p^2 = .17]. No other analysis was significant [self: F (1,57) = .430, p = .51, η_p^2 = .007; self+ToM: F (1,57) = .006, p = .93, η_p^2 = .001; physical: F (1,57) = 1.18, p = .28, η_p^2 = .02].

The bootstrap results with 1,000 bootstrap resamples and 95% confidence interval (CI) confirmed the above findings with a significant age group effect only for the ToM stories (coefficient = - 1.12, CI = -1.74 to -.515, p = .001). The same results emerged when the performance on the Verbal Fluency (VF) was controlled for, with older performing better than younger participants only on the ToM stories [F (1,51) = 18.72, p < .000, η_p^2 = .21]. No other analysis was significant [self: F (1,51) = .068, p = .79, η_p^2 = .001; self+ToM: F (1,51) = .42, p = 51, η_p^2 = .008; physical: F (1,51) = .67, p = .41, η_p^2 = .01]. The bootstrap results confirmed an age group effect for the ToM stories (coefficient = - 1.21, CI = -1.87 to -.590, p = .001). These results indicate that after controlling for the general intellectual functions, the younger and older groups still differed on the ToM stories only, suggesting that the IQ did not affect the performance.

4.4. Discussion

Younger and older adults were assessed on their ability to make ToM inferences regarding the self and others. The results showed that the performance of the two groups did not significantly differ on stories that involved the self (self and self + ToM) and both groups obtained higher scores on the self-related stories than other stories. The two groups also obtained similar scores on the physical stories. These results indicate that the ability to reflect on the self is not affected by healthy adult ageing and is performed better than the ToM stories in both age groups.

The findings also suggest that reasoning about the self and other people may rely on partially independent cognitive processes in that in both younger and older participants the performance on the self-stories was significantly different from the performance on the ToM stories. It has been shown that the VMPFC is specifically involved in processing self-related material (Kelley et al., 2002) in both younger and older adults (Ruby et al., 2009; Feyers et al., 2010), although younger adults recruit the DMPFC to a greater extent than older individuals (Ruby et al., 2009). Both the DMPFC as well as the VMPFC have been activated in relation to the ability to mentalise about others in the ToM stories (Fletcher et al., 1995; Happé et al., 1996; Gallagher et al., 2000; Gobbini et al., 2007; Hynes et al., 2006). However, in an fMRI study, Vogeley et al. (2001) showed that ToM and self-processing rely on both common brain areas, such as the anterior cingulate cortex (ACC) as well as different brain regions. The neuroimaging results showed that the temporal areas were associated with performance on the ToM stories and the temporoparietal junction was associated with self-processing. A further fMRI study (D'Argembeau et al., 2005b) showed that the DMPFC is specifically involved in mentalising and the VMPFC is specifically related to self-processing.

In the present study, older participants performed well on the ToM stories, in line with other ageing investigations that have reported intact (Saltzman et al., 2000; Wang et al., 2006; Slessor et al., 2007) or improved (Happé et al., 1998) ToM abilities in the older population. However, other results in the literature have shown that older adults perform more poorly than younger adults when the task places strong demands on memory functions (Sullivan et al., 2004; Keightley et al., 2006; German et al., 2006; Castelli et al., 2010). In line with this view, some studies have shown that the performance of older participants did not differ from that of younger adults when they were allowed to refer back to the story while providing their answer (Malloy et al., 2002; Saltzman et al., 2000; Slessor et al., 2007). Furthermore, Slessor et al. (2007) pointed out that the lack of age effects might depend on the high general intelligence of the specific group of older adults assessed, as measured by vocabulary tasks, and once vocabulary is controlled for, older participants showed reduced performance compared to younger adults on the ToM stories. In the present study, the stories were left in front of the participants while they were answering in order to reduce memory demands. In addition, although statistically not significant, older participants showed higher intellectual functions as they obtained higher IQ scores compared to the younger participants and produced more words on the verbal fluency task, suggesting that intellectual and frontal executive functions were intact. Therefore, the older adults' superior performance on the ToM stories compared to younger adults might be attributed to their higher social sensitivity but also intact intellectual functions and reduced memory demands. However, further analysis showed that once controlled for the level of IQ older participants still performed better than younger adults on the ToM stories only. The same results emerged when the performance on the VF was controlled for, only suggesting that their performance may not depend on the higher general intellectual functions.

Studies have shown that in younger adults reasoning about other people perceived as similar to the self involves activation of the VMPFC (Mitchell et al., 2005; 2006) and the VMPFC has also been related to self processing (Kelley et al., 2002). Therefore, individuals may provide their responses on the basis of how individuals, including themselves, generally behave in social situations, leading them to reflect on the similarity between their own and others' behaviours. In the current study, the younger and older adults obtained higher scores on the self stories compared to the stories that required reasoning about the mental state of another person, suggesting that the processes related to processing of the self and ToM are independent (Happé et al., 1998).

4.5. Conclusion

In conclusion, the present study showed that the accuracy in making inferences on the self as a measure does not decrease with age in the same sample of older participants that performed similarly to younger on self-related judgements (experiment 1a and 1b). The results also suggest that making inferences on the self and on another person might rely on different brain network in that both groups obtained higher scores on the self compared to the ToM stories. These results would suggest that the two tasks rely on activity of common brain areas. Finally, older participants performed better then younger adults on the ToM stories, in line with previous ageing investigation (Happé et al., 1998).

Chapter 5. Theory of Mind and Ageing

5.1. General Introduction

In the previous chapters 3 and 4, no age difference emerged on the processing of self-related knowledge as investigated using paradigms that differ in the extent to which they require memory retrieval and inferential reasoning (behaviour prediction, personality judgements and ToM inferences). The results have been explained in terms of the involvement of VMPFC brain areas, which are relatively spared in the older population compared to other brain areas (e.g. DLPFC; Phillips et al., 2002). As was discussed in Chapter 4, the ability to understand other people's affective states (e.g. affective ToM) and to process self-related information relies on the activation of common brain areas, which include the VMPFC (Kelley et al., 2002; Hynes et al., 2006). However, some TOM tasks are known to rely on DLPFC (e.g. cognitive ToM; Shamay-Tsoory et al., 2005a;b; 2007a;b). In the current chapter, the same participants that took part in the previous self-studies will perform a series of ToM tasks that differ in the extent to which they involve the VMPFC and DLPFC. On the basis of the evidence that functions tapping the VMPFC are less affected by ageing than tasks tapping DLPFC functions (MacPherson et al., 2002), the performance of older adults is expected to differ compared to that of younger participants on the cognitive (which tap the DLPFC) but not affective (which tap the VMPFC) ToM tasks.

Theory of Mind (ToM) is the ability to understand other people's mental states (e.g. their feelings, intentions and thoughts; Premack & Woodruff, 1978). Both verbal (short stories) and visual materials (cartoon, photographs) have been employed to investigate the ability to understand other people's mental states. Despite using different methodologies, several studies have reached the consensus that ToM depends on a brain network system which includes the medial frontal lobes, the superior temporal sulcus (STS), the temporal pole (TP) and the temporo-parietal junctions (TPJ), (Frith & Frith, 2003; 2006; Gallagher & Frith, 2003).

5.1.1. Neuroimaging and lesion studies

Neuroimaging studies provide support for a strong association between the ToM stories task and brain activation in the MPFC, including BA 8, 9, 8/9, 10, and the anterior cingulate cortex (ACC; Happé et al., 1996; Fletcher et al., 1995; Gallagher et al., 2000; Vogeley et al., 2001). Other studies employing ToM cartoon stories have also found activation in the MPFC (BA 8), similar to the activations reported for ToM stories (Gallagher et al., 2000; Brunet, Sarfati, Hardy-Baylé and Decety, 2000). For example, in a PET study examining the attribution of intentions to others' actions, Castelli, Happé, Frith & Frith (2000) presented their participants with simple geometric shapes that moved on a computer screen. The movements were either goal directed (e.g. triangles imitated each other actions or chased the other triangle) random (e.g. triangles randomly bouncing) or evoked mental state attribution (e.g. persuading, surprising). Participants were instructed to indicate what they thought the triangles were doing. Attribution of a mental state to the movements activated the MPFC as well as the temporal areas previously implicated in ToM. Similar involvement of the MPFC, accompanied by activation of the amygdala and the anterior cingulate cortex (ACC), emerged in a further paradigm used to investigate the ability to judge other people's mental states from the eye region of the face (Baron-Cohen et al., 1999).

Further support for the involvement of the MPFC in making both verbal and visuals ToM inferences comes from lesion studies. For example, impaired ToM as assessed with short stories has been reported in patients with damage of the VMPFC (Stone et al., 1998) and in patients with frontal variant frontotemporal dementia (fvFTD) with frontal atrophy predominantly involving the VMPFC (Lough et al., 2001; Lough & Hodges, 2002; Gregory et al., 2002). Impaired performance of fvFTD patients with atrophy involving mainly the VMPFC has also been reported on visual ToM tasks. Gregory et al. (2002) found that fvFTD patients were impaired on the Reading Mind in the Eye task (Baron-Cohen et al., 1999), a task that presents participants with photos of the eye region of the face and instructs them to indicate what the person in the photo was thinking or feeling. However, Lough et al. (2001) described the case of a patient with fvFTD with atrophy involving mainly the OFC that performed well on the same task, suggesting that the VMPFC may not be necessary to perform the task. In a further investigation Shaw, Bramham, Morris, Baron-Cohen and David (2005) investigated the performance of healthy participants compared to VMPFC- and DLPFC- damaged patients and found that the poor performance was mainly associated with damage of the DLPFC, again indicating that the VMPFC may not be the frontal area primarily involved in ToM. A different ToM task involving the judgement of another's preference (Baron-Cohen et al., 1995; Snowden et al., 2003) required participants to attribute mental state on the basis of the eye gaze direction. Snowden et al. (2003) showed that FTD patients were impaired on such a task compared to healthy controls. Although the patient studies showed that damage of the VMPFC affected the performance on ToM tasks, the VMPFC may not be necessary to perform ToM task based on different paradigms in that some patients have been reported to perform poor on verbal ToM (e.g. the faux pas, Lough et al., 2001) and to perform well on visual ToM task (e.g. Reading the Mind in the Eye, Lough et al., 2001). Furthermore, other brain areas, such as the DLPFC are involved in the performance of ToM task, such as the Reading Mind in the Eye (Shaw et al., 2005).

5.1.2. Ageing studies

In terms of healthy adult ageing and ToM, studies have investigated the effect of age on ToM stories (Happé et al., 1998) and the faux pas task performance, but they have reported contradictory results. Some studies showed similar or superior performance of older adults on the ToM stories compared to younger adults (Happé et al., 1998; Wang et al., 2006; Slessor et al., 2007), while others reported impaired ToM abilities (Maylor et al., 2002; Sullivan et al., 2004; Keightley et al., 2006; Castelli et al., 2010). Contradictory results have also emerged for the faux pas stories, with some studies reporting no effect of age on performance (MacPherson et al., 2002) and others reporting poorer performance of older adults on the faux pas compared to younger adults (Wang et al., 2006).

The inconsistent results from the ageing literature may exist because different tests measured different components of ToM. The ToM consists of two main functions, the affective and the cognitive aspects of ToM. Several neuroimaging and lesion studies support this view (Bird & Cipolotti, 2000; Bird et al., 2004; Hynes et al. 2006; Vollm, Taylor, Richardson, Corcoran, Stirling, McKie et al., 2006; Kalbe et al., 2007; Shamay-Tsoory et al., 2005a;b; 2007a;b). For example, Hynes et al. (2006) investigated brain activation for affective and cognitive ToM. For the cognitive perspective taking they used the stories from Happé et al. (1996) and Fletcher et al. (1995) to use with fMRI. The cognitive stories require participants to understand a character's mental state, usually in relation to another character's mental state. They also developed 14 affective stories. In the affective stories they need to understand someone feeling. In line with previous neuroimaging results, both types of stories activated the medial BA 9/10 and 10. The affective stories showed greater activation of the medial orbital frontal areas (BA 11, 25 and orbital 47), whereas the cognitive activated the more lateral and anterior portion of the ventral PFC (BA 10 and 47/10). In a different study, Blair and Cipolotti (2000) described the case of patient JS with VMPFC damage. He showed severe impairments on emotion recognition from facial expressions and on a series of short stories where he was instructed to indicate the feelings of a character. The patient was also impaired on a series of tasks aimed to measure understanding of social norm transgressions. Despite these results, he was unimpaired in his ability to attribute non-emotional mental states as measured with the ToM stories. These results led authors to suggest that patient JS showed a dissociation between the hot (affective) ToM (which refers to the ability to understand others' emotions) and the cold (cognitive) ToM (which refers to the ability to attribute cognitive mental states such as beliefs). Altogether these results indicate that the different components of the ToM involve distinct regions of the prefrontal cortex.

In addition to the affective/cognitive dissociation, ToM can be further described in terms of cue detection (i.e. emotional expressions, actions and eye gaze direction) and ToM reasoning (i.e. reasoning about others' mental states; Sabbagh, 2004). These two components of the ToM have been shown to rely on dissociable brain networks. For example, in an event-related potential (ERP) study, Sabbagh and Taylor (2000) investigated the neural activity associated with reasoning about a mental state with a paradigm in which participants were presented with a series of short narratives, half describing a character's false belief regarding the location of two objects and half describing a character taking a photo of the objects. The participants were asked to indicate the location of the object according to the character in the story or according to the photograph taken. In this task an object is moved unbeknown to a character. Therefore individuals need to consider the mental state of the character in relation to the false belief they hold. Although no specific brain localization was possible, the results showed more positive ERPs for the false belief compared to the photograph condition in the left frontal brain areas. In a further study, Sabbagh, Moulson and Harkness (2004) investigated the ability to detect mental states from observable cues (i.e. images of the eye region of the face). In contrast to the ToM reasoning assessed in the previous study, in this study emotional judgements could be made solely on the basis of the physical cues (e.g. eye region of the face). The participants were first shown an emotional word (e.g. embarrassed) or a gender (male or female) word. Then they were presented with an image of the eye region of the face. In a yes/no decision making task, they indicated whether the picture corresponded to the word previously shown. The results showed that correct emotion recognition was associated to activity in the right orbital frontal and middle temporal areas. The findings of these ERPs studies suggest that ToM reasoning relies on left frontal area activity (Sabbagh et al., 2000), while the detection of states from observable stimuli relies on right frontal and temporal brain regions (Sabbagh et al., 2004). In line with this view, Shamay-Tsoory et al. (2005b) showed that the ability to understand others' emotional states, as measured using the FP stories, did not correlate with the ability to recognise emotional and vocal expression of emotions. In another study, Njomboro, Deb and Humphreys (2008) showed that patients with temporo-parietal junction damage (TPJ), a brain area often associated with ToM processing (Goel, Grafman, Sadato & Hallen 1995; Gallagher et al., 2000; Frith et al., 2003; Saxe & Kanwisher, 2003), were unimpaired in their ability to recognise emotions from facial expressions, although they performed poorly on a false belief task, again suggesting that these abilities can be dissociated.

The above studies, however, have investigated off-line ToM abilities in that their participants were not directly involved in the social interaction (Frith & Singer, 2008). Individuals spontaneously mentalise when they interact with other people. In an fMRI investigation, Spiers and Maguire (2006) used a virtual reality based game to investigate spontaneous mentalising. During the scan, participants played a game where they were instructed to drive through London as taxi drivers. As they did this, the other vehicles and individuals in the game reacted to the participant's movements (e.g. giving way at a junction) and participants heard customers making requests to be taken to particular places. After scanning, participants were presented with a video that replayed their performance and they were asked to remember their thoughts while driving. The thoughts reported were then classified as referring to a visible agent (e.g. police) or to the customers. All participants reported having thought of other people's thoughts and intentions during the game. The verbal reports were matched with their performance in the scanner and demonstrated that the task activated brain areas previously reported in during ToM tasks (i.e. the MPFC, the STS and the temporal pole; Frith et al., 2003; 2006; Gallagher et al., 2003); but the MPFC showed greater activation during mentalising of a visible agent than the invisible customer. This result has been attributed to the need to interpret and predict agents' actions (Spiers et al., 2006). In line with this view, a handful of studies have demonstrated that people spontaneously mentalise when they try to guess the moves of their partner. In a PET study, Gallagher et al. (2002) instructed their participants to play a computerised version of the game "stone, paper, scissors" against either a human partner or a computer. Participants' reports collected after the game showed that they considered the human opponent to be an intentional agent and so the participants tried to identify a pattern of behaviours in the opponent's moves. This suggests that individuals spontaneously mentalise when interacting with another person. Moreover, the PET results showed activation of the MPFC and the ACC as reported in previous ToM studies (Goel et al., 1995; Fletcher et al., 1995; Gallagher et al., 2000). In contrast to the competitive game employed by Gallagher et al. (2002), McCabe et al. (2001) conducted an fMRI investigation during performance of a cooperative game. In this game, the players would win a certain amount of money based on their decision to cooperate or to compete with another player. Again they were led to believe that they were playing against another person or a computer. The results showed greater MPFC involvement including the middle frontal gyrus and the frontal pole when they cooperated with a human compared to a computer. In summary, the studies indicate that individuals spontaneously mentalise when they interact with other people (e.g. when they play a game).

An example of games where participants interact with others is represented by economic games. Evidence suggesting that ToM is important when playing economic games involving social interaction comes from the investigation of autistic children (Sally & Hill, 2006). Autistic children typically have impaired ToM abilities (Baron-Cohen et al., 1994; 1995) and fail ToM tasks (e.g. second order false belief), which are normally performed well by children between the ages of 6 and 7 years. Sally et al. (2006) asked younger and older children and children with autistic spectrum disorder (ASD) to perform the Ultimatum Game (UG; Guth, Schmittberger & Schwarze, 1982). In the classic task, participants act either as a proposer or as a responder: as a proposer participants are instructed to split a given amount of money in any way between themselves and the responder; responders decide whether to accept or reject the offer. If they accept the offer, the money is split as proposed, if instead they reject the offer, neither players receive anything. In their study, Sally et al. (2006) used stickers instead of money. The results showed that children whom have developed ToM skills, as shown by their performance on a second order false belief task, offered more compared to both normal participants and ASD who did not pass the ToM task. In addition, ASD children were more likely to accept unfair offers than children without ASD.

In the UG task, typically, the proposer offers the responder a relatively high proportion of money (e.g. between 40 and 50% of the amount to be split; Guth et al., 1982; Bolton & Zwich, 1995), because the respondent may consider a low offer unfair and therefore reject it (Frith et al., 2008). Indeed, responders show higher rejection rates for low offers (Guth et al., 1982; Nowak, Page & Sigmund, 2000), because they need to maintain a reputation that accepting too little may lead to proposers offering only a little money (Nowak et al., 2000). The need to maintain a good reputation in the game may be particularly important during iterated versions of the game, when participants play against the same partner in successive trials (Frith et al., 2008). In the UG the player's ability to mentalise and her/his emotional responses to unfair offers interact during the game. The ability to mentalise allows participants to predict the opponent's behaviour and help maintain a good reputation. Emotions play a role in determining a sense of fairness. Rejection of an offer is due to negative feelings associated offers perceived to be unfair. Pillutla and Murnighan (1996) asked their participants to report their feelings for each offer made: negative emotion elicited by the unfair offers was predictive of the likelihood of rejection. Others showed that unfair offers are less likely to be rejected when participants play against a computer partner (Rilling, Sanfey, Aronson, Nystrom & Cohen, 2004). More recent neuroimaging studies investigating brain activation during performance of the UG in healthy adults (Goel et al., 1995; Fletcher et al., 1995; Gallagher et al., 2000; Nowak et al., 2000; McCabe et al., 2001) found greater MPFC activation when playing with humans than against a computer and performance was characterised by higher rejection of offers as they became less fair (Rilling et al., 2004). These studies show that individuals spontaneously mentalise when playing an interactive game in that the emotional reactions elicited by unfair offers are specific to offers made by humans and affect the final decision to either accept or reject an offer.

The studies reviewed support the idea that ToM consists of different components that rely on distinct brain areas (affective and cognitive ToM, cue detection, ToM reasoning and spontaneous mentalising during interactive situations). For example, the affective ToM appears to involve activity of medial sector of the PFC, whereas the cognitive ToM recruits more lateral PFC brain areas (Stone et al., 1998; Blair & Cipolotti, 2000; Hynes et al., 2006; Vollm et al., 2006). The ability to accurately detect facial emotion expressions and intentions on the basis of the eye gaze direction has been shown to rely on medial areas of the PFC and to decrease following damage mainly involving the OFC and the VMPFC areas (Hornak et al., 1996; Snowden et al., 2003; Shamay-Tsoory et al., 2007a). Finally, the MPFC has also been associated with the ToM process during interactive games where individuals play a game against a human partner rather than against a computer (McCabe et al., 2001; Gallagher et al., 2002).

In the following study, younger and older participants will perform a series of ToM tasks thought to measure distinct components of the ToM: cue detection, reasoning, affective and cognitive ToM. In Chapters 3 and 4, older participants performed as accurately as younger adults on a series of self-related tasks. The ToM tasks employed are associated with different brain areas. As the medial regions of the PFC are thought to be less affected by ageing than the lateral PFC areas, no age differences are expected to emerge on ToM tasks thought to rely on VMPFC activity (e.g. affective ToM). In contrast, age differences might emerge on tasks known to involve the lateral PFC brain areas (e.g. cognitive ToM).

5.2. Experiment 3: Emotion Detection

5.2.1. Introduction

5.2.1.1. Neuroimaging and lesion studies

The ability to correctly recognise human emotions is crucial in building and maintaining social interaction. The basic emotions (happiness, surprise, sadness, anger, fear and disgust) are universally recognised (Ekman, 1994). Neuroimaging studies support the central role played by the VMPFC in emotion identification in others (Lange, Williams, Young, Bullmore, Brammer, Williams et al., 1993; Blair, Morris, Frith, Perrett & Dolan, 1999; Gorno-Tempini, Pradelli, Serafini, Pagnoni, Baraldi Porro et al., 2001). In an fMRI investigation, Lange et al. (1993) scanned nine participants who performed three different tasks with photographs depicting happiness (considered neutral) and fear (Ekman & Friesen, 1976): passive view, gender decision and emotion judgement. Participants were asked to decide whether the emotion depicted was more or less emotional than the previous expression. Results revealed that emotion decision specifically activated the VMPFC.

The role played by the VMPFC in emotion recognition is further supported by lesion studies. Blair et al. (2000) described a patient with bilateral OFC damage and found that he was impaired in recognising happiness, anger, disgust and sadness, but not surprise and fear, suggesting that different emotions are processed by different brain networks. Hornak et al. (1996) investigated performance of VMPFC damaged patients on tasks assessing facial and vocal emotion recognition and found that this group of patients was impaired on both tasks compared to a group of patients with brain damaged that spared the VMPFC. More recently, Heberlein, Padon, Gillihan, Farah and Fellows (2008) presented VM and DL damaged patients with morphs of a single individual's basic emotional faces taken from Ekman and Friesen (1976). Their task was to rate the intensity of each emotion on a 10-point Likert scale (e.g. a happy face was rated for the intensity of the each happiness, fear, anger, surprise, disgust and sadness). Results showed that overall VM patients were impaired in their judgements of all emotions (e.g. they provided lower difference scores across the emotions), while the DLPFC damaged did not differ form healthy controls.

Although the results of these studies indicate that the VMPFC is important for recognising facial expression of emotions, some neuroimaging and lesion evidence shows that brain activation is emotion specific. In terms of neuroimaging, in a PET investigation, Blair et al., (1999) scanned healthy adults performing a task which required gender discrimination of faces depicting various degree of sadness and anger and found that the VMPFC responded to expressions of anger but not of sadness. Other studies highlight the role played by different brain areas, such as the DLPFC and the temporal regions. In an fMRI study, Phillips, Young, Senior, Brammer, Andrews, Calder et al. (1997) investigated brain activation during the presentation of faces depicting fear and disgust. They found that disgust activated the DLPFC (BA 46) as well as the insula and the putamen. Sprengelmeyer, Rausch, Eyseland Przuntek (1998) assessed facial emotion recognition in healthy individuals during a gender discrimination task involving faces portraying disgust, fear, anger and neutral expressions. Although all emotions activated the VMPFC, the fMRI results also showed specific emotion-related brain activity: fear was associated with activation of the DLPFC, whereas disgust and anger showed additional activation of the insula and the temporal lobe respectively. Together, these results suggest that different emotions are processed by different neural substrates. In particular, negative emotions, such as disgust and fear, may involve activation of the DLPFC as well as the amygdala, the insula and the putamen (Phillips et al., 1997; Sprengelmeyer et al., 1998).

Further support for the idea that the VMPFC is not preferentially involved in recognising all emotions comes from lesion studies. For example, Shamay-Tsoory et al. (2003) investigated facial and vocal emotion recognition in PFC damaged patients (further split into VMPFC, DLPFC and Mixed lesion), posterior damage patients (PC) and healthy controls. The results showed that both the PFC and the PC groups were impaired on the facial emotion recognition. In addition the VMPFC and DLPFC groups did not differ. In a different study, Beer, Heerey, Keltner, Scabini and Knight (2003) investigated self and non-self conscious emotions. Self-conscious emotions (e.g. embarrassment, shame) are related to a complex appraisal of how one's behaviour is evaluated by self and others and are believed to help regulate behaviours that promote social interaction (Leary, 2007). Beer et al. (2003) compared performance of healthy individuals with that of patients with OFC damage and found that the patient group was impaired in the ability to correctly recognise self-conscious emotion; they performed normally, however, when asked to recognise non-self conscious emotions (such as anger, disgust, happiness, fear, sadness, contempt surprise and amusement). These studies therefore support the idea that facial emotion recognition involves activity of different brain areas (e.g. VMPFC, DLPFC, temporal areas) and may be modulated by the context in which emotions are expressed (e.g. social context).

5.2.1.2. Ageing studies

Although the VMPFC plays a central role in emotion identification, the ability to recognise others' negative emotions has been reported to decrease in older population (Calder, Keane, Manly, Sprengelmeyer, Scott, Nimmo-Smith et al., 2003; Mill, Allik, Realo & Valk, 2009). According to the socioemotional selectivity theory (Carstensen et al., 1999), thus, performance decrement in older age has been related to the tendency of older individuals that approach the end of their life to place more emphasis on positive affects. However, it has also been proposed that the poorer recognition of negative emotions may be due to a reduced ability to process negative information because of structural changes that occur to the brain areas associated to the processing of negative emotion. The reduced recognition of older adults of negative emotion such as anger (Malatesta, Izard, Culver & Nicolich, 1987; Phillips, MacLean & Allen, 2002b; Calder et al., 2003; Wong, Cronin-Golomb & Neargarder, 2005), fear (Calder et al., 2003; Wong et al., 2005; Keightley et al., 2006) and sadness (McPherson et al., 2002; Phillips et al., 2002b; Wong et al., 2005) and the relatively spared or increased performance on disgust (Calder et al., 2003; Wong et al., 2005), has been related to the involvement of different brain areas, again suggesting that the processing of emotions does not rely on a single neural circuit. Neuroimaging studies of older individuals showed that their impaired performance is accompanied by reduced activation of the amygdala (Gunning-Dixon, Gur, Perkins, Schroeder, Turner, Turetsky, et al., 2003) and increased activation of the VMPFC (Fischer, Sandblom, Gavazzeni, Fransson, Wright & Backman, 2005). In an fMRI investigation Fischer et al. (2005) presented their participants with angry and neutral faces and found that younger adults showed greater activation for angry faces in the amygdala compared to older participants who, in contrast, showed greater activation in the VMPFC (BA 47/13). Similarly, Gunning Dixon (2003) conducted an fMRI investigation of emotion recognition and showed that younger participants activated the amygdala and the limbic system during emotion recognition. In contrast, older adults failed to activate the same areas and instead showed greater prefrontal activity. A recent review claimed that the differential activation might reflect the reduction in the number of neurons and the neuronal atrophy in the amygdala regions in older populations

(Ruffman Henry, Livingstone & Phillips, 2008). In contrast, the greater frontal activation may reflect a compensatory recruitment for reduced efficiency of the amygdala and the limbic areas. The intact recognition of disgust in older adults (Calder et al., 2003; Wong et al., 2005) has been associated to activity of the basal ganglia (Sprengelmeyer et al., 1998), a brain region that may be less affected by ageing (Ruffman et al., 2008).

The poorer performance of older adults may also be due to reduced ability to judge the intensity of the emotion expressed. Phillips and Allen (2004) investigated the perception of the intensity of happiness fear, anger and sadness. For each emotion participants were instructed to indicate how strongly it depicted each of the 4 emotions on a 9-point Likert scale. The results showed that older adults reported lower level of perceived intensity for sadness and fear compared to younger participants.

A different series of investigations found that older individuals show differential eye movements and fixations when presented with photographs of faces depicting different emotions. In support to this claim, Wong et al. (2005) investigated the duration and the number of fixations to different portions of the face during an emotion recognition task. The results showed that older individuals were impaired on recognition of anger, fear and sadness, while they were more accurate in recognising disgust. Investigation of the eye movements showed that older made more fixations to the lower part of the face compared to younger participants. This tendency negatively affected the ability recognise certain emotions, specifically those that have been showed to rely on fixation of the upper area of the face (anger, sadness and fear). Indeed the poorer performance of older adults on these three emotions correlated with the fewer number of fixations of the top half of the face compared to younger group.

The impaired emotion recognition performance of older adults has also been related to level of education. Keightley et al. (2006) showed that older adults were impaired on recognition of sadness and fear, but that higher level of education predicted their ability to correctly recognise negative emotions. However, the effect of education could not entirely explain the worse performance of older adults, as the age effect was still significant after controlling for education level (younger had higher mean education than older group). Thus, the authors concluded that further investigation should consider which factors may affect the emotion recognition.

In the following experiment, the ability to accurately detect observable ToM cues (e.g. emotional facial expressions) will be investigated in the same younger and older participants who performed the self-related tasks described in Chapters 3 and 4. It is assumed that the finding of intact self-processing is related to the lack of an age effect on the VMPFC. As recognition of negative emotions has been associated with DLPFC activation (e.g. fear; Sprengelmeyer et al., 1998), it might be expected that the older participants in this study will show impaired recognition of negative emotions.

5.2.2. Experiment 3: Emotion Detection

5.2.2.1. Methods

5.2.2.1.1. Participants

The same thirty younger and thirty older adults who participated in the experiment 1 and 2, took part in this experiment. The order of task was counterbalanced across participants.

5.2.2.1.2. Materials

The ability to recognise emotions from facial expressions was assessed using the Ekman 60 subset from the Facial Expression of Emotion: Stimuli and Test (FEEST; Young et al., 2002). The stimuli were derived from the Ekman and Friesen (1976) series of emotional facial expressions. Ekman and Friesen (1976) developed a system to measure facial expression, the Facial Action Coding System (FACS), which allows categorisation of the physical expression of emotions. The Ekman 60 test includes black and white photographs of faces depicting the six basic emotions (happiness, anger, disgust, fear, surprise and sadness), with 10 examples for each emotion. Under each photograph, the six basic emotional labels were presented. Figure 5.1 shows an example of the test stimuli.

HAPPINESS SURPRISE FEAR SADNESS DISGUST ANGER

Figure 5.1. Example of face stimulus taken from the FEEST

5.2.2.1.3. Procedure

The test was preceded by 6 practice trials that consisted of the presentation of an example of each emotion portrayed by an 11th model. The photographs were presented one at a time on a computer screen and each one was presented with the same six emotional labels below. Participants were asked to choose the word that best describes the emotion depicted by the photograph. Although there was no time limit and participants could take as long as they needed to respond, each photograph appeared on the screen only for a maximum of 5 seconds. If the response was provided within the 5 seconds, the next photograph was presented. If no response was provided within the time limit, the photograph was replaced by a blank screen. The next trial did not appear until participants provided their response.

5.2.2.1.4. Scoring

Each correct response was awarded one point with a maximum score of 10 for each emotion (10 exemplars of each emotion) and an overall score of 60.

5.2.2.1.5. Analysis

The data were analysed using a 2 (age group: young vs. old) x 6 (emotion type) mixed-model ANOVA with repeated measures on the second factor.

5.2.2.2. Results

The means and standard deviations for accurate recognition of each emotion in the younger and the older groups are reported in Table 5.1.

Table 5.1. Means and standard deviations for recognition of each emotion in the younger and the older group.

	Younger Mean *(SD)*	Older Mean *(SD)*
Anger	8.5 (1.2)	7.8 (1.9)
Disgust	8.3 (1.3)	8.6 (1.4)
Fear	7.1 (1.8)	6.8 (2.0)
Happiness	9.9 (.30)	9.8 (.53)
Sadness	8.4 (1.1)	8.0 (1.9)
Surprise	8.8 (1.1)	8.8 (1.1)

Maximum score = 10

The results showed only a significant main effect of emotion type [F (5,290) = 29.87, p = .000, η_p^2 = .34]. Post hoc paired sample t-tests showed that happiness was the most accurately recognised emotion, while fear was the least accurately recognised emotion. Happiness was recognised significantly better than anger [t (59) = -7.40, p = .000, d = 1.13], disgust [t (59) = -7.21, p = .000, d = 1.16], fear [t (59) = -10.90, p = .000, d = 1.61], sadness [t (59) = 7.50, p = .000, d = 1.13] and surprise [t (59) = 6.56, p = .000, d = 1.03]. Fear was recognised significantly less accurately than anger [*t* (59) = 4.99, p = .000, d = .63], disgust [*t* (59) = 5.24, p = .000, d = .84], sadness [*t* (59) = -4.76, p = .000, d = .68] and surprise [*t* (59) = -6.03, p = .000, d = 1.08]. Surprise was recognised significantly more accurately than anger [*t* (59) = 2.69, p = .009, d = .46], and sadness [*t* (59) = -2.81, p = .007, d = 42]. No other comparison was significant [anger vs. disgusts: *t* (59) = -1.23, p = .22, d = .20; anger vs. sadness: *t* (59) = -.355, p = .72, d = .04; disgust vs. sadness: *t* (59) = .926, p = .35, d = .15; disgust vs. surprise: *t* (59) = -1.49, p = .13, d = .29]. The main effect of age group and the age group x emotion type interaction were not significant [*F* (1,58) = .966, p = .33, η_p^2 = .016; *F* (5, 290) = 1.00, p = .41, η_p^2 = .017, respectively].

5.2.3. Discussion

It has been proposed that the ability to make ToM inferences relies on the ability to identify the stimuli that will be used to understand another person's mental state such as eye gaze and emotion expression (Baron-Cohen, 1995; Sabbagh et al., 2000; 2004). In the current study, younger and older participants were assessed in their ability to recognise facial expressions of emotions. The results showed that older participants were not impaired in their ability to recognise any of the six basic emotions (i.e. happiness, sadness, fear, disgust, anger or surprise). This suggests that the ability to identify the stimuli important for making ToM attributions does not decrease with age. As neuroimaging and lesion studies have shown that emotion recognition relies on the involvement of the VMPFC (Lange et al., 1993; Hornak et al., 1996; Gorno-Tempini et al., 2001), the lack of age effects on the FEEST supports the notion that the VMPFC deteriorates with age much later and less rapidly than other frontal regions (Phillips et al., 2002). However, neuroimaging evidence also exists that suggests there is DLPFC involvement during the recognition of negative emotions, such as fear and disgust (Phillips et al., 1997; Sprengelmeyer et al., 1998). Moreover, the lack of age effects in terms of emotion recognition in our older sample contrasts with the studies in the literature that reported age effects in the recognition of negative emotions (e.g. anger, fear, sadness; Malatesta et al., 1987; Phillips et al., 2002b; MacPherson et al., 2002; Calder et al., 2003; Wong et al., 2005). Keightley et al. (2006) in a first task instructed younger and older participants to indicate the valence of positive and negative facial expression and found that older individuals were as accurate as younger participants. In a second task participants were presented with images of faces depicting basic emotions and were instructed to choose from a word list the term that best described the emotion depicted in the photograph. The results showed that older individuals performed poorer than younger participants in recognising fearful and sad facial expression. A further regression analysis showed that higher levels of education predicted the ability to correctly recognise negative emotions in older adults. In line with this view, the older group in the present study showed a high level of education with a mean of 14.37 years and intellectual general function with a mean of 118.43 as measured using the WASI (Wechsler, 1999). Therefore, if individuals with fewer years of education had been recruited for the study, age effects in emotion recognition may have been found.

Emotion recognition in older adults has been suggested to relate to psychological factors: the socioemotional selectivity theory (Carstensen et al., 1999) claims that older individuals who are closer to the end of their life place more emphasis on positive rather then negative emotions. This positive bias manifests as reduced attention and memory for negative stimuli (Mather & Carstensen, 2003). In their study, Mather et al. (2003) presented younger and older participants with a pair of faces, one neutral and one depicting a positive or negative emotion (happiness, anger, sadness). In each trial the two faces were presented for 1000 ms and then disappeared. A dot then appeared in the location of one face previously presented. Participants were instructed to indicate as fast as possible to the location where the dot appeared. The result showed that older individuals were faster when the dot appeared in the location of a happy face and slower when it appeared in the location of a negative face compared to the neutral faces. In contrast younger adults responded similarly to emotional and neutral faces. In a further recognition task, participants were presented with emotional and neutral faces seen during the dot task and new faces and were instructed to indicate for each face whether they had seen it before. The result showed higher accuracy in older participants for faces previously seen with positive than negative expressions. In contrast, the effect of valence of the faces presented during the dot task was not significant in younger participants. These results indicate that individuals preferentially process positive emotions as they become older.

Yet, in contrast to these findings, the results of the present investigation indicate that the ability to recognise both positive and negative emotions did not reduce in older individuals with higher levels of education. Future research might investigate whether intact emotion recognition in older adults would be accompanied by similar level of memory performance for both negative and positive emotions and whether performance might be affected by the frequency of negative emotions experienced in the daily life of older adults.

5.2.4. Conclusion

In conclusion, the current experiment shows that a group of high functioning older adults was not impaired in accurately detect the six basic emotions compared to younger participants. However, it must be also taken into consideration that our older participants were mainly recruited through the panel of volunteers at the Department of Psychology, University of Edinburgh. Therefore, many older individuals may have also taken part in other studies in the department involving emotion recognition which required them to perform the FEEST. This may have resulted in practice effects. Future studies of age effects on emotion identification should ensure that volunteers are recruited who are not familiar with the FEEST stimuli.

5.3. Experiment 4: Judgement of Preference

5.3.1. Introduction

The ability to detect eye gaze direction allows individuals to share the focus of attention, which is referred to as joint attention, and to draw inferences about another person's mental state (Baron-Cohen, 1995). One such task that investigates eye gaze direction is the judgement of preference task. The task was originally developed by Baron-Cohen et al. (1995) and modified by Snowden et al. (2003) to investigate the attribution of mental states on the basis of the eye gaze direction by autistic children and by patients with frontotemporal dementia (FTD). More recently Shamay-Tsoory et al., (2007a; b) devised a new version of the task to investigate affective and cognitive components of the ToM.

The ability to detect and follow eye gaze is considered an automatic process, as indicated by response time studies. For example, individuals typically are presented with a central cue (the eye gaze), which provides information about the occurrence of an event in the peripheral field (Friesen & Kingstone, 1998; Driver, Davis, Ricciardelli, Kidd, Maxwell and Baron-Cohen, 1999). For example, Friesen et al. (1998) presented their participants with an outline of a face with the eyes looking left or right. They were instructed that a target letter would appear on either side of the central cue and that eye gaze did not predict the location of where the target would appear. The participant's task was to indicate by a button press where the target had appeared. The results showed that participants were faster at responding when the letter appeared in the location cued by the eye direction than when it appeared in the opposite location. Driver et al. (1999) employed the same paradigm, however, the eye gaze was counterpredictive, with the target appearing most of the time in the location opposite to the one cued by the eyes. Again, the results showed that participants were faster responding to a target that appeared in the cued location. These studies indicated that information provided by the eye gaze could not be ignored even when participants were told that the eyes are not informative or are even counterinformative of the target appearance.

5.3.1.1. Neuroimaging and lesion studies

The detection of visual information (e.g. eye gaze) involves a brain network that includes the frontal and the temporal areas (Sabbagh et al., 2000; 2004). Neuroimaging evidence shows that eye gaze detection strongly activates the superior temporal sulcus (STS; Puce, Allison, Bentin, Gore & McCarthy, 1998; Hoffman & Haxby, 2000; Hooker, Paller, Gitelman, Parrish, Mesulam & Reber, 2003). In an fMRI investigation, Puce et al. (1998) found that watching movements of the eye and the mouth region (separately investigated) specifically activated the STS compared to watching the movement of an abstract pattern. In a different fMRI study, Hoffman et al. (2000) found greater involvement of the temporal and parietal areas for averted compared to straight eye gaze. More recent studies have also found involvement of the MPFC during eye gaze detection (Calder, Lawrence, Keane, Scott, Owen, Christoffels et al., 2002; Hooker et al., 2003). In an fMRI study, Hooker et al. (2003) instructed participants to indicate where a target appeared following the presentation of a central cue (eyes or an arrow) and found that eye gaze providing directional information activated the MPFC to a greater extent compared to the arrow and to non-informative eye movements. In a PET investigation, Calder et al. (2002) presented their participants with images of faces whose eyes looked straight ahead, away, down or were closed; participants were asked to indicate whether the eyebrows were thick or thin. The results showed greater MPFC (BA 8/9, 10) in the eye gaze conditions (straight and away) compared to the eyes down/closed conditions. However, the MPFC was activated to a greater extent for the averted than the straight eye gaze condition, a result that has been explained as being due the greater difficulty in making inferences about the mental state of someone who is looking away than straight ahead towards the observer (Calder et al., 2002).

The MPFC has been shown to be involved during tasks that elicit joint attention where the focus of attention is shared with another person. In an fMRI investigation, Williams, Waiter, Perra, Perrett & Whiten's (2005) participants watched a video of a person moving his eyes to follow a ball movement that appeared on the bottom of the screen and they were instructed to follow the movement of the same ball. Joint attention involved activation of the MPFC (BA 9, 10), as well as the temporal and parietal areas. Temporal involvement emerged also when individuals had to attribute intentions to visually perceived movement (Castelli et al., 2000) indicating that visual stimuli may convey social information about the intentions of an agent. In a series of studies, Pelphrey, Singerman, Allison & McCarthy (2003), Phelphrey, Morris and McCarthy, (2004; 2005) found activation of frontal, temporal and parietal areas during tasks aimed at investigating the processing of visual stimuli that convey information about intentions. Participants were shown an animated character on a screen and a stimulus appeared on the right or left of the character. In the congruent condition, the character shifted the eyes (Pelphrey et al., 2003) or moved their hand towards the object (Phelphrey et al., 2004). In the incongruent condition, the eyes/hand movement was directed toward an empty location. The STS showed greater activation for movement towards an empty location than to the object. The authors suggested that the STS activity depends on perceived intentionality and appropriateness of the movements. Individuals consider the character a rational agent and expect movement toward the objects. When this expectancy is violated (movement to an empty location) individuals would need to reformulate their expectancies in relation to the character's goals, leading to greater involvement of the STS. These results indicate that the VMPFC plays a role in processing information conveyed by eye gaze.

Further support for the involvement of the VMPFC in processing eye-gaze information comes from investigations of patients with focal frontal damage. For example, Vecera and Rizzo (2004) presented a VMPFC damaged patient and healthy controls with a task where the occurrence of a target stimulus was predicted by a central cue (e.g. eye gaze) or by a peripheral cue (e.g. box) and found that the patient did not show any eye gaze effect (faster responses) for the cued location compared to location predicted by a peripheral cue.

Deficits in the ability to use eye gaze direction to infer mental states have also been reported in autistic, schizophrenic, FTD, focal frontal and temporal damaged patients (Baron-Cohen et al., 1995; Snowden et al., 2003; Akiyama, Kato, Muramatsu, Saito, Nakachi & Kashima, 2006; Shamay-Tsoory et al., 2007a;b). Baron-Cohen et al. (1995) devised a task consisting of a central face looking at one of four possible images of sweets. Participants were asked to indicate what sweet the character was going to take. Although autistic children were as good as healthy controls at detecting eye gaze direction, they did not use this information to infer the mental state of the cartoon character; instead they indicated their own favourite sweet. Schizophrenic patients have also been shown to perform poorly on tests that measure the perception of eye gaze (Zhu, Lee, Li, Jing, Wang & Wang, 2007) as well as on ToM tests (Frith & Corcoran, 1996). Shamay-Tsoory et al. (2007b) suggested that the impairment in schizophrenic patients resembles the deficits shown by patients with damage to the ventral region of the prefrontal cortex, as they are specifically impaired on affective ToM processing while performing normally on tasks that measure cognitive ToM (Stone et al., 1998). Shamay-Tsoory et al. (2007b) devised a task based on the judgement of preference task developed by Baron-Cohen et al. (1995). In the affective condition, participants were asked to indicate which object the face loved and in the cognitive condition, participants were asked to indicate which object the face was looking at. The results showed that both schizophrenic patients and patients with VMPFC were impaired on the affective ToM condition but no difference emerged in the cognitive ToM compared to non-frontals and healthy controls.

Deficit in performing the judgements of preference task emerged also in patients with FTD with frontal damage primarily involving the OFC (Snowden et al., 2003), although some patients had more widespread frontal lobe change that included the DLPFC. In this study participants were presented with a central face and four semantically related objects in each corner of the computer screen. They were asked to indicate which object the central face liked best or which object it was looking at. A matching condition was also developed in which an arrow pointed at one of the objects not looked by the central face and participants were also asked to indicate their favourite object. The results showed that FTD patients performed poorly on the task, compared to both patients with Huntington's Disease (HD) and healthy controls, as the former group selected their favourite objects more often than the object the face "liked best". No deficits emerged in their ability to simply detect the eye gaze direction as measured by the "look at" condition, indicating that the FTD patients' impaired performance was due to difficultly using eye gaze information to infer the mental state of another person. More recently, Shamay-Tsoory et al. (2007a) investigated performance on the affective/cognitive versions of the judgement of preference task in VMPFC, DLPFC, mixed lesion (VMPFC and DLPFC), non-frontal patients and healthy controls. The results showed that patients with VMPFC lesion were the most impaired on the affective ToM measure, whereas the mixed damage group obtained the lowest scores on the cognitive ToM. This suggests that the cognitive ToM component may be affected by extensive frontal damage whereas the VMPFC is specifically associated with processing of affective information.

Further support for the dissociation between affective and cognitive ToM comes from a study that investigated the effect of temporarily disrupting the DLPFC during the performance of affective and cognitive ToM (Kalbe, Schlegel, Sack, Nowak, Dafotakis, Bangard et al., 2010). Participants were first applied repetitive transcranial magnetic stimulation (rTMS) on the DLPFC; after stimulation they performed the judgement of preference task developed by Shamay-Tsoory et al. (2007a). The results showed that the temporary disruption of the DLPFC lead to faster RTs during performance of the cognitive but not the affective ToM. The researchers reasoned that disruption of the DLPFC might have facilitated the functions of other brain areas, which may have elicited an emotional reaction to cognitive stimuli. The authors claim that the DLPFC may modulate the activity of the VMPFC, which is known to be involved in processing social and emotional stimuli. Therefore, DLPFC inhibition may lead to more emotion-based responses and, thus, faster RTs during the cognitive condition.

5.3.1.2. Ageing studies

At present, only one study exists that has investigated age effects on the judgement of preference task (Castelli et al., 2010). Participants were presented with the same task employed by Snowden et al. (2003) and the results showed no difference between the age groups in either condition. However, there is some indication of poorer performance in an older population in another study that investigated the ability to follow eye gaze direction in younger and older adults (Slessor, Phillips & Bull, 2008). Slessor et al. (2008) presented younger and older adults with a central cue (e.g. eye gaze), which was either congruent or incongruent to the location where a target stimulus would appear and were instructed to indicate where the target appeared. There was also a control condition that used an arrow instead of the face. Overall, they found that older participants were slower in both eye cueing and arrow cueing task compared to younger adults. In addition, the effect of gaze-target congruency was smaller in the older than the younger group, suggesting that the former do follow the eye gaze, though to a lesser extent than younger participants.

In summary, lesion and neuroimaging studies indicate that both dorsal and ventral frontal areas (BA 8, 9, 46, 10, 11) and the temporal regions are involved in eye gaze detection (Calder et al., 2002; Hooker et al., 2003) and in the detection of eye movement conveying information about intentions (Pelphrey et al., 2003; 2004). Evidence also suggests that there is greater DLPFC (BA 8, 9) activation during performance of the cognitive ToM (Fletcher et al. 1995; Happé et al., 1996; Gallagher et al., 2000), whereas the ability to process affective ToM is specifically associated with VMPFC functioning (Stone et al., 1998; Blair & Cipolotti, 2000; Shamay-Tsoory et al., 2007a). Due to changes in the DLPFC and the temporal cortex with age (West, 1996), older adults may perform more poorly on the cognitive ToM compared to younger adults, whereas affective processing would not be affected by age.

5.3.2. Experiment 4: Judgements of Preference

5.3.2.1. Methods

5.3.2.1.1. Participants

The same thirty younger and thirty older adults that performed the previously described experiments 1,2, and 3 were also assessed on the judgement of preference task, with the task order being counterbalanced across participants.

5.3.2.1.2. Materials

The task was based on a test developed by Baron-Cohen et al. (1995), Snowden et al. (2003) and Shamay-Tsoory et al. (2007a). The task requires understanding of first and second order mental states and allows assessment of the affective and the cognitive aspects of Theory of Mind (ToM). The judgement of preference task consists of 80 trials, 40 in the first order condition and 40 in the second order condition. Each trial shows a cartoon face, named Yoni, in the middle of a computer screen and four coloured pictures of objects belonging to a single category (fruits, vegetables, animal, furniture, transports, cartoon characters) or four faces positioned in the four corners of the screen. The participant's task is to indicate which object Yoni is referring to on the basis of a statement at the top of the screen and available cues (e.g. eye gaze direction).

Both the first and second order tasks consist of four conditions: affective, cognitive, look at and physical. In the affective condition, the facial expression and the mental state verbs used provided affective information (e.g. Yoni loves…). In the cognitive condition, both the face and the mental state verbs used were emotionally neutral (e.g. Yoni is thinking of…), (Figure 5.2).

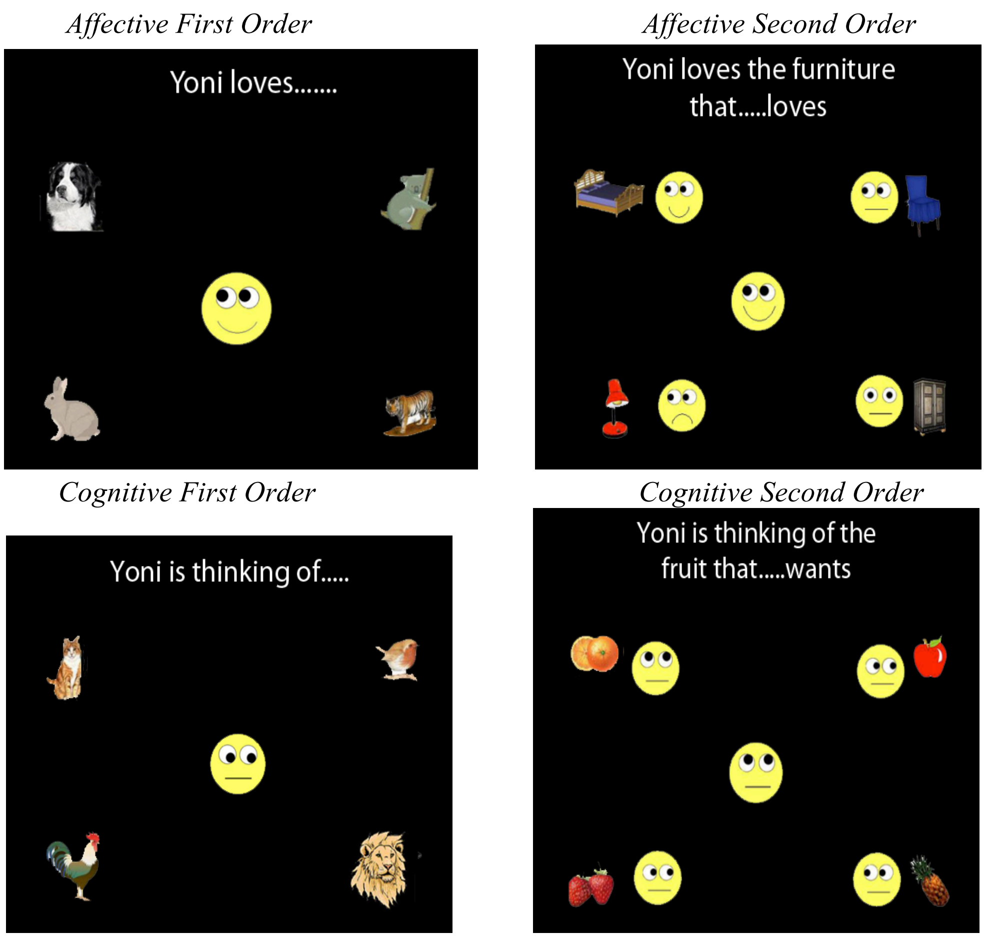

Figure 5.2. Example of affective and cognitive trials

Two control conditions were also included (Figure 5.3). The look at condition was added to determine whether participants can attend to the stimuli, based on previous evidence that frontal damage patients may fail to follow eye gaze direction and instead choose their favourite stimulus (Snowden et al., 2003). This task is also structurally similar to the affective and cognitive condition but it does not require any mental state inference. The same physical condition used in a previous study (Shamay-Tsoory et al., 2007a) was included to determine whether participants understood the task and did not simply follow the eye gaze direction. In the physical condition, no mental state attribution is required and a correct response depends on the physical features of the cartoons. In contrast to the previous conditions, participants need to ignore the eye gaze direction to answer correctly.

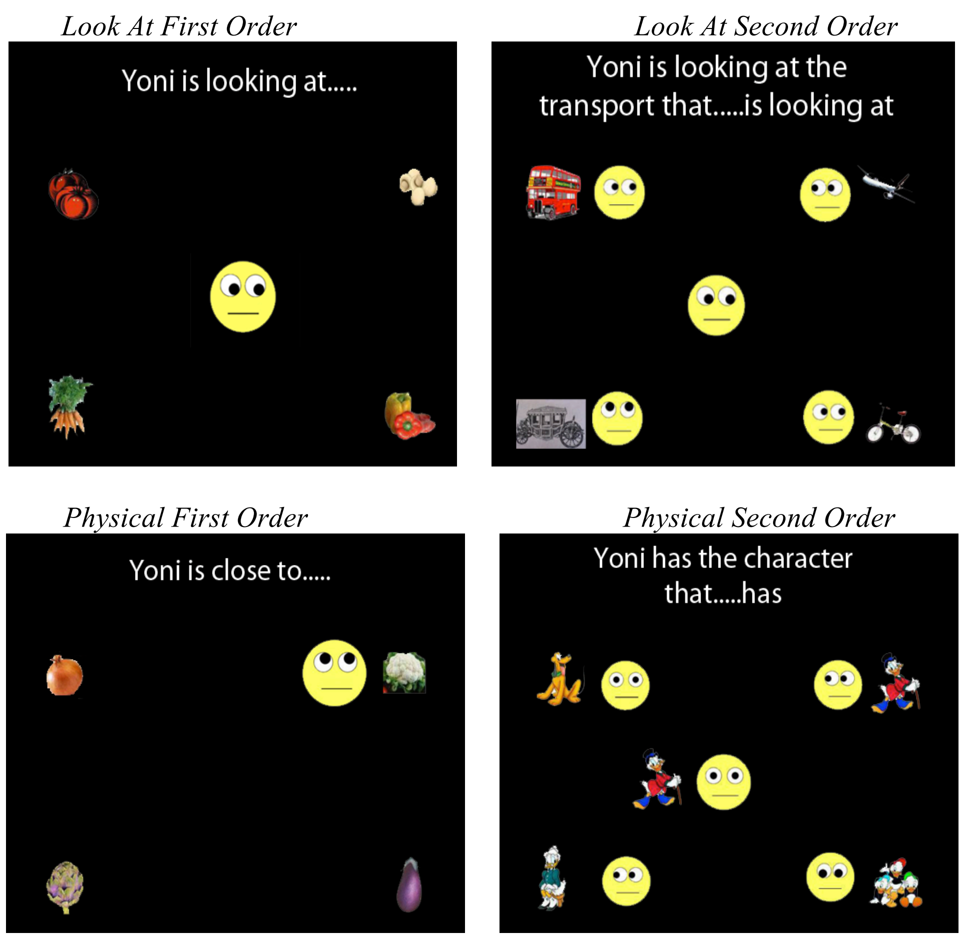

Figure 5.3. Example of look at and physical trials

In the first order affective condition (aff1), participants were presented with 12 slides and instructed to indicate which object Yoni loves. Participants were told to press one of the four buttons on the keyboard that corresponded to their response. In the first order cognitive condition (cog1), participants were presented with 12 slides and instructed to indicate which item the central face was thinking of. In the first order "look at" condition, participants were presented with 8 slides (as indicated in Shamay-Tsoory et al., 2007a) and instructed to indicate which object Yoni was looking at. In the first order physical condition (ph1), participants were presented with 8 slides and instructed to indicate which object Yoni was close to.

The second order task consisted of presentation of a central face surrounded by four items and four cartoon faces, one in each corner of the screen. In order to provide the correct response, participants had to understand the interaction between the mental state of Yoni and that of another cartoon character. In the second order affective condition (aff2), participants were presented with 12 slides and instructed to indicate which item both Yoni and another cartoon face loved. Similarly in the second order cognitive (cog2) condition, participants were presented with 12 slides and instructed to indicate which item both Yoni and another cartoon face were thinking of. In the second order look at condition (Look at 2), participants were presented with 8 slides and instructed to indicate which item both Yoni and another cartoon face were looking at. In the second order physical condition (ph2), participants were presented with 8 slides and instructed to indicate which item both Yoni and another cartoon face possessed.

A further control condition was added which consisted of the presentation of the same first and second order affective, cognitive and look at conditions, but in which a distracting arrow also appeared, pointing to an item that differed from the one that the central face was referring to. This further condition was added to determine whether participants referred to the eye gaze direction when making a judgement of preference or whether their decisions were based on other features. The whole Judgement of Preference task consisted of 64 trials, 32 in the first order condition and 32 in the second order condition.

5.3.2.1.3. Procedure

Participants were first asked to perform a "favourite" condition. This preliminary task was added to make participants familiar with the response keys and to determine which object they liked best. They were presented with 12 slides each showing four different objects, one in each corner of the screen, belonging to the same categories used in the judgement of preference task. Participants were instructed to indicate their favourite item by pressing one of the four buttons on the keyboard that corresponded to the position of the item on the screen. Once this first condition was completed, participants performed the judgement of preference task. The order of the condition was randomised across participants. For each condition, participants read the instructions on the computer screen and were instructed to respond as quickly and as accurately as possible. Then a fixation cross was presented in the middle of the screen and a statement was shown at the top of the screen. The statement remained visible throughout the trials for a given condition. The cross was then replaced by Yoni and participants indicated the item on the screen that Yoni was referring to by pressing the corresponding button on the keyboard.

5.3.2.1.4. Scoring

Accuracy was calculated by the number of correct responses in each condition (affective, cognitive, look at and physical, first and second order). Each correct response was scored as 1 giving a maximum of 12 points in the affective and cognitive conditions and a maximum score of 8 in the two look at and physical control conditions. The same scoring procedure was applied for the affective, cognitive and look at condition with arrow. Errors in the conditions with the arrow were classified as "favourite errors" (based on the responses provided on the preliminary task), "arrow errors" (when they indicated the item pointed at by the arrow) or "unclassified errors" (if the errors did not fit any of the previous classifications). Errors made in the conditions with no arrow were classified as "favourite errors" (based on the responses provided on the preliminary task) or "unclassified errors" (any other response).

5.3.2.1.5. Analysis

The affective and cognitive conditions and the two control conditions consisted of a different number of trials; therefore the proportion of correct responses was computed for each condition. As the data were not normally distributed, the two age groups were compared using the non-parametric Mann-Whitney U-Test. In order to determine whether participants performed some conditions better than others, the data for each group were further analysed separately using the Wilcoxon signed-rank test. The type of errors made on the affective and cognitive conditions was analysed using the Mann-Whitney U-Test. A separate Mann-Whitney U-Test was conducted for the errors committed in the look at and physical condition in that they consisted of a different number of trials. Since multiple comparisons were conducted, the results of both the Mann-Whitney and the Wilcoxon signed-rank test were Bonferroni corrected ($p < .008$ and $p < .01$ for the cognitive/affective condition and the control conditions respectively).

5.3.2.2. Results

5.3.2.2.1. Accuracy in the conditions with no arrow

5.3.2.2.1.1. First Order Judgement

The proportion of correct responses (means and standard deviations) of the younger and older groups in the first order conditions is reported in Table 5.2.

Table 5.2. Means and standard deviations (SD) of proportion of correct responses in the first order conditions with no arrow performed by the younger and older groups.

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
Affective	.95 (.18)	.86 (.26)
Cognitive	.95 (.18)	.95 (.15)
Look at	.97 (.04)	.99 (.03)
Physical	.97 (.04)	.99 (.03)

The analyses showed no significant differences between the younger and the older groups. [affective: U = 380.5, z = -1.38, p = .16, r = -.17; cognitive: U = 422.5, z = -.688, p = .49, r = -.08; look at: U = 405.0, z = -1.19, p = .23, r = -.15; physical: U = 405.0, z = -1.19, p = .23, r = -.15]. Similarly, no significant differences emerged in the Wilcoxon signed-rank test analyses in both younger and older adults [affective vs. cognitive: Z = -.378, p = .70, r = -.06 and Z = -2.14, p = .03, r = .39, respectively; look at: Z = -.423, p = .67, r = .07 and Z = -2.54, p = .01, r = -.46, respectively; affective vs. physical: Z = -.540, p = .58, r = -.09 and Z = -2.50, p = .01, r = .45, respectively; cognitive vs. look at: Z = -.170, p = .86, r = .03 and Z = -.535, p = .59, r = .09 respectively; cognitive vs. physical: Z = -.287. p = .77, r = 05 and Z = -1.19, p = .23, r = .02, respectively].

5.3.2.2.1.2. Second Order Judgement

The means and standard deviations of correct responses for the younger and older groups in the second order conditions are reported in Table 5.3.

Table 5.3. Means and standard deviations (SD) of proportion of correct responses in the second order conditions with no arrow performed by the younger and older groups.

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
Affective	.92 (.10)	.85 (.21)
Cognitive	.90 (.13)	.86 (.21)
Look at	.97 (.09)	.94 (.15)
Physical	.91 (.22)	.63 (.39)

No significant differences between the younger and older groups emerged in the affective [U = 390.5, z = -.94, *p* = .34, *r* = -.12], cognitive [U = 445.5, z = -.07, *p* = .94, *r* = .009] or the look at [U = 433.5, z = -.39, *p* = .69, *r* = .05] second order conditions. However, younger adults performed significantly better than older participants on the physical second order condition [U = 267.00, z = - 3.00, *p* = .003, *r* = .38]. The Wilcoxon signed-rank test results showed that older but not younger adults performed the second order physical condition worse than the look at condition [Z = - 3.68, *p* = .000, *r* = .67; Z = -1.15, *p* = .24, *r* = .21, respectively]. No other comparison was significant in either younger or older adults [affective vs. cognitive: Z = -1.04, *p* = .29, *r* = .19 and Z = -.121, *p* = .90, *r* = .02, respectively; affective vs. look at: Z = -2.18, *p* = .02, *r* = .39 and Z = -2.20, *p* = .02, *r* = .40 respectively; affective vs. physical: Z = -.607, *p* = .54, *r* = -.1 and Z = -2-26, *p* = .02, *r* = .41 respectively; cognitive vs. look at: Z = -2.16, *p* = .03, *r* = .39 and Z = -2.10, *p* = .03, *r* = .38, respectively; cognitive vs. physical: Z = -1.28, *p* = .19, *r* = .23 and Z = -2.19, *p* = .02, *r* = .40].

5.3.2.2.2. Accuracy in the condition with arrow

5.3.2.2.2.1. First Order Judgement

The means and standard deviations of the correct responses for the younger and older groups in the four first order conditions with the distracting arrow are reported in Table 5.4.

Table 5.4. Means and standard deviations (SD) of proportion of correct responses in the first order conditions with arrow performed by the younger and older groups.

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
Affective	.85 (.24)	.62 (.45)
Cognitive	.91 (.23)	.70 (.41)
Look at	.99 (.03)	.86 (.31)

No significant differences between the younger and older groups emerged in the affective and the look at conditions with the arrow [U = 346.0, z = -1.65, *p* = .09, *r* = -.21; U = 385.0, z = -1.62, *p* = .10, *r* = -.20, respectively]. However, younger adults performed better than older participants in the first order cognitive condition with arrow [U = 300.5, z = - 2.53, *p* = .01, *r* = -.32]. The Wilcoxon signed-rank test results showed higher accuracy scores in the look at condition with the arrow compared to the affective condition in both younger [Z = -2.90, *p* = .004, *r* = .53] and older adults [Z = -2.60, *p* = .009, *r* = -.47]. Older but not younger participants performed the look at condition better than the cognitive condition with arrow [Z =- 2.63, *p* = .008, *r* = .48; Z = -1.68, *p* = .09, *r* = .30, respectively]. No significant difference emerged between the affective and the cognitive conditions in both younger and older participants [Z = -1.54, *p* = .12, *r* = .28; Z = -.983, *p* = .32, *r* = .17, respectively].

5.3.2.2.2.2. Second Order Judgement

The means and standard deviations for the correct responses provided by younger and older groups in the second order conditions are reported in Table 5.5.

Table 5.5. Means and standard deviations (SD) of proportion of correct responses in the second order conditions with the arrow performed by the younger and older groups.

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
Affective	.89 (.16)	.75 (.33)
Cognitive	.86 (.24)	.78 (.36)
Look at	.99 (.03)	.87 (.27)

No significant differences between the younger and older groups emerged in the affective and cognitive conditions with an arrow [U = 350, z = -1.59, p = .11, r = -.20; U = 421, z = -.520, p = .60, r = .06, respectively]. The older group's performance on the second order look at with arrow condition approached significance [U = 341.00, z = -2.39, p = .017, r = -.30]. The results showed that younger but not older adults performed the look at condition with an arrow better then the affective [Z = -2.84, p = .005, r = .51; Z = -1.76, p = .07, r = .32, respectively] and the cognitive conditions [Z = -2.50, p = .01, r = .45; Z = -.913, p = .36, r = -.16]. No significant differences emerged in the younger and older group between affective and cognitive condition [Z = -.537, p = .59, r = .09; Z = -.806, p = .42, r = -.14].

5.3.2.2.3. **Type of errors**

5.3.2.2.3.1. Errors in the condition with no arrow

5.3.2.2.3.1.1. First Order Judgement

The means and standard deviations for the number of errors committed by the younger and older groups in the first order conditions are reported in Table 5.6.

Table 5.6. Means and standard deviations (SD) for the proportion of errors of the younger and older groups in the first order conditions with no arrow

	Younger Mean *(SD)*		Older Mean *(SD)*	
	Favourite	Other	Favourite	Other
Affective (max =12)	.20 (.61)	.33 (1.6)	.83 (2.0)	.80 (1.7)
Cognitive (max = 12)	.10 (.40)	.43 (1.8)	.36 (1.8)	.16 (.46)
Look at (max = 8)	0	.13 (.34)	.03 (.18)	.23 (1.2)
Physical (max = 8)	0	.10 (.30)	0	.06 (.25)

The analysis showed no significant differences between the younger and older groups in the affective condition in terms of favourite [U = 397.5, z -1.15, *p* = .25, *r* = -.14] or Other errors [U = 362, z = -2.00, *p* = .04, *r* = -.25]. Similarly no difference emerged in the cognitive condition in terms of both favourite and Other errors [U = 449.5, z = -.017, *p* = .98*, r* = -.002; U = 438.00, z = -.318, *p* = .75*, r* = -.04]. No difference emerged in terms of favourite and Other errors in both look at [U = 435.0, z = -1.00, *p* = .31, *r* = -.12; U = 407.0, z = -1.32, *p* = .18, *r* = -.17, respectively] and physical condition [Other errors: U = 435.0, z = -.463, *p* = .64, *r* = -.05]

5.3.2.2.3.1.2. Second Order Judgement

The means and standard deviations for the number of errors committed by the younger and older groups in the first order conditions are reported in Table 5.7.

Table 5.7. Means and standard deviations (SD) for the number of errors of the younger and older groups in the second order conditions with no arrow.

	Younger Mean *(SD)*		Older Mean *(SD)*	
	Favourite	Other	Favourite	Other
Affective (max = 12)	.20 (.92)	.70 (.83)	.36 (.66)	1.5 (2.5)
Cognitive (max = 12)	.53 (1.2)	.65 (1.0)	.43 (.85)	1.2 (1.9)
Look at (max = 8)	.03 (.18)	.20 (.76)	.13 (.43)	.26 (.94)
Physical (max = 8)	.16 (.64)	.50 (1.1)	1.2 (2.1)	1.7 (2.3)

No significant differences emerged in the affective condition in terms of favourite [U = 362.5, z = -1.99, *p* = .04, *r* = .25] and other errors [U = 402.0, z = -.766, *p* = .44, *r* = -.09]. Similarly, no significant difference emerged in the cognitive condition in terms of favourite and Other errors [U = 441.0, z = -.185, *p* = .85, *r* = -.02; U = 409.0, z = -.446, *p* = .65*, r* = -.05, respectively]. No difference emerged in the look at condition [favourite: U = 419.5, z= - 1.04, *p* = .29*, r* = -.13; Other: U = 435.0, z = -.398, *p* = .69*, r* = -.05] However, older adults made significantly more favourite errors in the second order physical condition [U = 289, z = -3.13, *p* = .002, *r* = -.45], while no difference emerged for the Other errors [U = 334.0, z = -1.99, *p* = .04*, r* = -.25].

5.3.2.2.3.2. Errors with Arrow

5.3.2.2.3.2.1. First Order Judgement

The means and standard deviations for the number of errors committed by the younger and the older groups in the first order conditions with distractor are reported in Table 5.8.

Table 5.8. Means and standard deviations (SD) for the type of errors made by the younger and older groups in the first order conditions with arrow

	Younger Mean *(SD)*			Older Mean *(SD)*		
	Favourite	Arrow	Other	Favourite	Arrow	Other
Affective (max = 12)	.17 (.46)	1.2 (2.3)	.40 (.81)	.03 (.18)	3.7 (4.8)	.73 (1.7)
Cognitive (max = 12)	.03 (.18)	.80 (2.4)	.17 (.64)	0	2.6 (4.0)	.83 (1.2)
Look at (max = 8)	0	0	.03 (.18)	0	.87 (2.1)	.23 (.56)

Since multiple comparisons were conducted, the results were Bonferroni corrected for the affective and cognitive conditions (p < .008) and the Look At condition (p < .01). No significant difference between the younger and older groups emerged in the affective [favourite: U = 404.5, z = -1.40, p = .16, r = -.18; arrow: U = 346.5, z = -1.69, p = .09, r = -.21; Other: U: 411.0, z = -.728, p = .46, r = -.09] and the look at conditions [arrow: U = 375.0, z = -2.31, p = .02, r = -.28; Other: U = 389.0, z = -1.73, p = .08, r = -.22] with arrow. However, older adults made significantly more errors that were classified as other in the cognitive first order condition with arrow [U = 303.50, z = -2.92, p = .003, r = -.37]. No difference emerged in the cognitive first order condition with arrow in terms of both favourite and arrow errors [U = 420.5, z = -.983, p = .32, r = -.12; U = 349.0, z = -1.84, p = .06, r = -.23, respectively].

5.3.2.2.3.2.2. Second Order judgement

The means and standard deviations for the number of errors committed by the younger and the older groups in the second order conditions are reported in Table 5.9

Table 5.9. Means and standard deviations (SD) of the type of errors of the younger and older groups in the second order conditions with arrow

	Younger Mean *(SD)*			Older Mean *(SD)*		
	Favourite	Arrow	Others	Favourite	Arrow	Other
Affective (max = 12)	.30 (.75)	.33 (.75)	.60 (.96)	.20 (.55)	1.8 (3.6)	.90 (1.4)
Cognitive (max = 12)	.37 (1.0)	.90 (1.9)	.23 (.72)	.21 (.62)	1.38 (2.6)	1.0 (1.9)
Look at (max = 8)	0	0.3 (.18)	.03 (.18)	0.3 (.18)	.70 (1.3)	.43 (1.1)

Since multiple comparisons were conducted results were Bonferroni corrected for the affective and cognitive conditions ($p < .008$) and the Look At condition ($p < .01$). No significant difference between the younger and older groups emerged in the affective [favourite: U = 433.0, z = -.405, $p = .68$, $r = -.05$; arrow: U = 371.0, z = -1.50, $p = .13$, $r = -.19$; other: U: 438.0, z = -.209, $p = .83$, $r = .02$] nor in the cognitive condition [favourite: U = 432.5, z = -.064, $p = .94$, $r = .008$; arrow: U = 420.0, z = -.291, $p = .77$, $r = .03$; other: U = 340.5, z = -2.03, $p = .04$, $r = -.26$]. However, older made significantly more arrow errors than younger adults in the look at second order condition [U = 313.00, z = -3.00, $p = .003$, $r = -.38$]. No other comparison was significant in the look at condition [favourite: U = 435.0, z = -1.0, $p = .31$, $r = -.12$; other: U = 403.0, z = -1.45, $p = .14$, $r = -1.18$].

5.3.3. Discussion

The ability to detect eye gaze direction allows individuals to share their focus of attention (i.e. joint attention), and, thus, to draw inferences about another person's mental state (Baron Cohen, 1995). This ability is considered an automatic process (Friesen et al., 1998; Driver et al., 1999) and involves the frontal and the temporal areas of the brain (Williams et al., 1995; Puce et al., 1998; Hoffman et al., 2000; Calder et al., 2002; Hooker et al., 2003). At the same time, evidence exists suggesting that ToM consists of two different components: the cognitive ToM, which involves activity of the DMPFC brain areas (Fletcher et al. 1995; Happé et al., 1996; Gallagher et al., 2000), and affective ToM, which instead relates to VMPFC activity (Stone et al., 1998; Blair and Cipolotti, 2000; Shamay-Tsoory et al., 2007a). In the present study, younger and older adults were administered a task that required individuals to attribute a mental state to a cartoon character on the basis of its eye gaze detection. The affective component was assessed by instructing participants to indicate which object/character a central cartoon face would love, while cognitive ToM was investigated by asking participants to indicate which object/character the cartoon face was thinking of (Shamay-Tsoory et al., 2007a). In addition, the ability to detect the eye gaze direction without the need to draw inferences on the cartoon's mental state was assessed by asking participants to indicate what object/character the central cartoon face was looking at. The results showed that both eye gaze detection as well as the affective and cognitive mental state attribution was not impaired in older adults compared to younger adults. These result indicate that the ability to attribute mental state on the basis of the eye gaze direction does not decrease with age, providing support to a previous investigation that showed intact performance of older participants on a simpler version of the task (Castelli et al., 2010). Poor performance on the affective component of the task has been reported in patients with damage of the VMFC (Snowden et al., 2003; Shamay-Tsoory et al., 2007a), brain areas that showed slower deterioration with age compared to other frontal regions, such as the DLPFC (Phillips et al., 2002). In contrast to the affective component, the ability to attribute cognitive mental that has been suggested to rely on more dorsal frontal areas (Fletcher et al. 1995; Happé et al., 1996; Gallagher et al., 2000), appears to be intact in the present study. This result may be due to the fact that the dorsal involvement emerged with different paradigm, such as the ToM stories, that may be more demanding than a ToM task that relies on detection of physical attribute (as in this study). In line with this view, older adults have been shown to perform poorer when the task makes stronger cognitive demands, such as when participants need to infer another person's mental state on the basis of their memory for the material studied (Keightley et al., 2006). However, older participants are known to perform well when the memory demands are reduced (Maylor et al., 2002). Finally, older adults with high intellectual functions perform well on ToM tasks (Happé et al., 1998; Slessor et al., 2007). Therefore, the intact performance of older adults in the present investigation may be due to their high intellectual functions and the reduced task demands.

Yet, some deficits in older adults' performance emerged when the task demands of the task were increased. The ability to accurately detect eye gaze was not impaired in older individuals compared to younger individuals in either the first or second order conditions without a distracting arrow. However, older participants were significantly worse at detecting eye gaze than younger adults in the “look at” second order condition when a distracting arrow was also presented, often choosing the objects indicated by the arrow instead. This result suggests that the second order condition may place stronger demands on older than younger participants leading older individuals to perform worse when the task requires them to ignore a distractor. In line with this view, while no difference emerged in the first order physical condition, older participants performed more poorly on the second order physical condition where, in contrast to the first order condition, participants were instructed to refer to both the main cartoon and a secondary cartoon. In this condition participants selected their favourite objects more often than younger participants. Similarly, McKinnon et al. (2007) showed that more cognitively demanding ToM tasks are more affected by age when they demonstrated that older individuals were impaired in their understanding of second order ToM mental states compared to younger adults, while no difference emerged in the first order ones. Therefore, poorer ToM abilities reported in the older population compared to younger adults (Maylor et al., 2002; Sullivan et al., 2004; Keightley et al., 2006; Wang et al., 2006; McKinnon et al., 2007) might be due a general impairment in processing more complex ToM information rather than an impairment in the ability to infer others' mental states.

While younger and older adults performed similarly in the attribution of both the affective and the cognitive mental states in both the first and the second order conditions (without a distractor arrow), a deficit in the attribution of cognitive mental states emerged in the first order condition with a distracting arrow. Since older individuals did not show any deficit in detecting the eye gaze of the cartoon character, the results indicate that older participants experienced more difficulties than younger adults in ignoring a distracting arrow only when the task required the attribution of a cognitive mental state. This suggests that different cognitive processes might be involved in the ability to attribute the affective and the cognitive mental states on the basis of the eye gaze direction. In the second order condition with distracting arrow older participants obtained lower accuracy scores compared to younger adults, however the difference was not significant for the affective and cognitive mental state attribution. The difference between younger and older participants in detecting the eye gaze without the need to infer mental state approached significance. This result was probably due to the near ceiling performance of the younger participants in this condition. The impaired performance of older participants in the first order condition with distracting arrow may be due to the novelty of the stimuli that would not affect the performance of the second order condition, suggesting that the poorer performance of older adults related to deficits in understanding the requirements of the task. Although the response provided by the older participants often related to the item pointed at by the arrow, it was not possible to clearly differentiate between arrow and favourite errors when the objects indicated by the arrow matched he objects that participants indicated as their favourite.

5.3.4. Conclusion

In conclusion, the results of the present study showed that older participants were not impaired compared to younger in their ability to detect and attribute affective and cognitive mental states in both the first and second order conditions. However, more cognitively demanding tasks may elicit deficits in the ability to accurately detect the eye gaze direction when no mental state inference is required and to accurately attribute a cognitive mental state (e.g. the presence of a distractor, second order ToM). In contrast, affective mental state attribution was not affected by increasing the task demands. The results suggest that the performance on the affective component of the task, thought to involve VMPFC brain areas (Shamay-Tsoory et al., 2007a), does not reduce with age during both low and high cognitive demands (e.g. presence of a distracting arrow). In contrast, the performance on the cognitive mental state attribution, thought to rely on more lateral frontal (Hynes et al., 2006; Kalbe et al., 2010) and temporal (Shamay-Tsoory et al., 2007a) brain areas, was possibly impaired in older adults compared to younger participants when the task demands increased.

5.4. Experiment 5: The Faux Pas

5.4.1. Introduction

In this experiment, the performance of younger and older participants will be compared on the Faux Pas task, which is thought to measure the ability to understand another person's affective state. On the basis of previous studies, which have indicated that affective ToM relies on the VMPFC (Stone et al., 1998; Hynes et al., 2006), older adults (who performed well on self and affective ToM tasks - experiments 3 and 4 - believed to rely on functions associated to VMPFC brain areas) are expected to perform as well as younger adults on the Faux Pas.

Typically studies that have demonstrated that the MPFC (BA 8/9), the superior temporal sulcus (STS) the temporal pole and the temporo-parietal junction (Frith et al., 2003; 2006; Gallagher et al., 2003) are important for theory of mind abilities have employed tasks that measure the cognitive aspect of ToM (Fletcher et al., 1995; Goel et al., 1995; Happé et al., 1996; Gallagher et al. 2000; Brunet et al., 2000; Castelli et al., 2000). However, as has already been discussed, ToM consists of two main abilities: affective ToM, which refers to the ability to process the affective mental state of another person, and cognitive ToM, which refers to the ability to understand others' beliefs (Blair & Cipolotti, 2000). The Faux Pas task (FP; Stone et al., 1998) consists of a series of short stories in which a faux pas has been committed. The task differs from Happé's (1994; 1996; Fletcher et al., 1995) ToM stories in that the detection of a faux pas requires a participant to both infer the mental state of the person that made the faux pas (cognitive ToM) and the effect of what has been said on the person that receive the faux pas (affective ToM), (Shamay-Tsoory et al., 2005a;b). The faux pas task is thought to assess the affective ToM in that a faux pas can be detected only if individuals understand that the person that receives it might feel hurt or offended (Shamay-Tsoory et al., 2005b).

There do not appear to be any neuroimaging studies investigating the neural correlates of the faux pas task as developed by Stone et al. (1998); however, a few neuroimaging investigations that employed affective stories and lesion studies that investigated the performance on the FP suggest that the VMPFC plays a crucial role in the task performance and that the FP measures the affective component of the ToM (Hynes et al., 2006; Shamay-Tsoory et al., 2005a;b).

5.4.1.1. Neuroimaging and lesion studies

Support for the existence of separate brain networks underlying the cognitive and the affective aspects of ToM has been recently shown using fMRI. Hynes et al. (2006) used the ToM stories as the cognitive ToM task (Happé, 1994; Fletcher et al., 1995) and developed a series of affective stories that required participants to understand a character's feeling as the affective ToM task. In line with previous neuroimaging results, all stories activated the MPFC (BA 9/10 and 10) as well as temporo-parietal areas. The affective stories compared to the cognitive stories showed greater involvement of the medial orbital frontal areas, which included the orbital part of the inferior frontal cortex (BA 47) and the orbital sulcus (BA 11), whereas the cognitive stories showed greater lateral frontal activation.

Further evidence in favour of a dissociation between cognitive and affective ToM comes from lesion studies. Stone et al. (1998) compared the performance of patients with OFC lesions and patients with DLPFC damage on the FP task. The results showed that the OFC patients performed poorly, failing to understand that something socially awkward had been said. The poor performance of OFC patients was due to a difficulty integrating ToM and empathic information (Stone et al., 1998). In particular, the authors proposed that the impairment may be due to problems connecting their inference of another person's mental states with their understanding of the emotional implications. In contrast to the performance on the FP, the OFC group performed well on the tasks that did not require to process emotional information, suggesting that their cognitive ToM remained intact.

Bird et al. (2004) described the case of a patient with bilateral frontal damage involving the orbital and medial frontal areas following infarction of the anterior cerebral artery. Their patient was unimpaired on both the ToM and the faux pas stories. However, while she performed at ceiling on the ToM stories, her performance on the faux pas stories was at the lower end of the normal range, suggesting that she may have some difficulties in understanding embarrassing social situations. Shamay-Tsoory et al. (2005 a;b) compared the performance of patients with localised lesions of the PFC, posterior damage and healthy controls on a series of tasks that differed in their need to appreciate others' emotional states: the second order false belief task (which assesses the ability to understand others' beliefs without the need to process their emotional state), the irony detection task (which requires individuals to understand the intention of the speaker and the affective features associated with ironic utterances, as the literal meaning of the sentence -a positive valence comment- contrasts with the true meaning conveyed by the speaker -a negative valence meaning), and the faux pas (which requires to appreciate both the mental state of a character and the emotional state of the person receiving the faux pas). The results showed that the VMPFC patients were impaired on the irony detection and the faux pas tasks, which measured affective ToM abilities, while no significant difference between the groups emerged on the false belief task that requires individuals to understand a cognitive mental state.

Shamay-Tsoory and Aharon-Peretz (2007a) examined the effect of VMPFC, DLPFC, and mixed prefrontal lesions and posterior lesions on tests assessing the affective and cognitive components of ToM. The tasks require participants to use verbal (the affective and cognitive false belief task) and visual (the affective and cognitive judgement of preference task) cues to make judgements about mental states. Based on the results of a composite score of the two tasks, they found that VMPFC patients performed significantly worse than the other groups on the affective ToM, while cognitive ToM was impaired by extensive damage (mixed prefrontal lesions) which extended to the temporal areas. This would suggest that damage to the VMPFC brain area is associated with the affective component of ToM, while the cognitive ToM is impaired by more extensive damage in the frontal region as well as the temporal areas. The temporal areas are thought to be involved in the ability to detect the stimuli used to make mental inferences (Calder et al., 2002) and to make intention attributions based on perceived movement (e.g. eye gaze, hand movements; Pelphrey et al., 2003; 2004). More recently, Lee et al. (2010) investigated performance on the FP of patients with MPFC, lateral PFC, non-PFC and healthy controls. A first analysis was conducted on the total FP score (summing up the responses to all questions) and found that all patient groups obtained lower scores compared to the healthy controls, with the MPFC group performing significantly more poorly than the all other groups in that they were markedly impaired in understanding that the faux pas was not intentional. However, no difference was reported on the control questions, indicating that the story understanding was intact in all patients.

Although the above studies suggest that the VMPFC is involved in affective ToM, the dorsal frontal areas also seem to play a role in the FP task, as some of the patients in the previously discussed studies had lesions extending into the DLPFC. In Stone et al. (1998), one of the patients in the OFC group who was the most impaired on the faux pas task had a lesion extending into both the dorsolateral and ventrolateral areas (BA 9 and 47). Similarly, the VMPFC group in Shamay-Tsoory et al.'s studies (2003; 2005a; 2005b) included dorsomedial prefrontal damage (BA 9).

Evidence supporting DLPFC involvement in the faux pas task has been provided by Costa, Torriero, Olivieri and Caltagirone (2008). They investigated Faux Pas performance when rTMS was applied to the left or right DLPFC compared to a sham condition. The results showed that rTMS applied to the DLPFC reduced accuracy on the FP, while no difference emerged for the control stories. Furthermore, Bird et al. (2004) showed that a patient with a lesion to the orbital and medial frontal areas performed at the lower end of the normal range, suggesting that the MPFC brain areas may not be crucial for the task performance.

5.4.1.2. Ageing studies

Only a few studies have investigated the effect of healthy adult ageing on the task performance and results are contradictory. MacPherson et al. (2002) compared performance on the FP in young (age range = 20-38), middle age (age range = 40-59) and older healthy adults (age range = 61-80) and did not found any significant age difference. More recently, Wang et al. (2006) compared the performance of younger and older adults on the FP task and the ToM stories (Happé, 1994; 1998) and found that older adults were impaired on the FP task while they performed as well as younger individuals on the ToM stories, suggesting that the two tasks rely on different neural circuits. However the stories they used were different to those developed by Stone et al. (1998): Wang et al. only included three FP stories, one taken from Stone et al. and two newly developed ones. More recently, Halberstadtd, Ruffman, Murray, Taumoepeau and Ryan (2011) developed a visual version of the FP task to assess performance in 60 younger and 61 older adults. They were presented with 16 video clips featuring people at work. In half of the video clips a character committed a FP, while in the remaining stimuli, the behaviour was socially appropriate. Participants were instructed to indicate the appropriateness of the behaviour in each video clip. Younger adults rated the faux pas behaviours more inappropriate and the non-FP behaviours more appropriate than older participants, indicating that younger adults discriminated the two types of behaviours to a greater extent than older participants. In addition, the performance on the FP, but not on the control stories, was predicted by the performance on a series of tasks aimed to assess emotion recognition, a task in which older adults performed more poorly than younger adults.

The patient and neuroimaging studies discussed show that affective ToM relies on the VMPFC (Blair et al., 2000; Hynes et al., 2007; Kalbe et al., 2007; Shamay-Tsoory 2005a;b; 2007a), which is relatively spared in older populations (Phillips et al., 2002). In the following experiment, the performance on the FP task will be compared in younger and older adults. The task has been included as measure of affective ToM. Since performance on the FP has been shown to strongly rely on VMPFC (Stone et al., 1998; Shamay-Tsoory et al., 2005a;b), no age effect is expected to emerge in the current sample of older adults who have performed similarly to younger adults on self-related and affective ToM tasks.

5.4.2. Experiment 5: affective mental state understanding

5.4.2.1. Methods

5.4.2.1.1. Participants

Thirty younger and thirty older adults took part in this study. Twenty-four of the younger participants who participated in the previous experiments took part in this task. Six younger participants that took part in the experiment 3 did not complete the experimental session and were replaced. The same older sample from all previous tasks participated in the experiment. The task order was counterbalanced across participants. As in the previous tasks, the Wechsler Abbreviated Scale of Intelligence (WASI: Wechsler, 1999) was used as a measure of the level of general intelligence. Table 5.10 provides the demographic characteristics of the two groups. The two groups did not significantly differ in their IQ [t (58) = -1.38, p = .171, d = .35] or their level of education [t (58) = -.385, p = .702, d = .10].

Table 5.10. Demographic characteristics of the two groups.

	Younger *(M: 4; F: 26)* *Mean (SD)*	Older *(M: 9; F: 21)* *Mean (SD)*
Age	19.67 (1.7)	69.77 (6.6)
Years of Full-Time Education	14.17 (1.7)	14.37 (2.2)
WASI Full Scale IQ	115.80 (7.7)	118.43 (6.9)

WASI = Wechsler Abbreviated Scale of Intelligence

5.4.2.1.2. Materials

The test consisted 20 short stories: 10 Faux Pas stories and 10 control stories (Stone et al., 1998; Baron-Cohen et al., 1999). In the Faux Pas (FP) stories, participants read 10 stories in which someone said something inappropriate, such as insulting a wedding gift without remembering that it was given to them by the person they were speaking to (see Table 5.11). The control stories describe a social situation in which no faux pas has occurred (see Table 5.11). After each story, participants were asked whether someone in the story said something they should not have said. In the faux pas stories, if the faux pas was detected, participants were asked further clarifying questions to determine whether the participants understood who committed the faux pas, the mental state of the character who experienced the faux pas, the mental state of the character who delivered the faux pas, why it was inappropriate, how the character who received the faux pas may have felt and finally a control question which asked details of the story without the need to refer to the characters' mental states (e.g. what gift was given for the wedding). In order to understand that a faux pas occurred, participants needed to understand that the faux pas was not intentional. Participants also needed to understand that the person who experienced the faux pas would be hurt or offended by it. If the faux pas was not detected, the participants were only asked the control question, which did not require to infer any mental state.

Table 5.11. Example of a story used in the Faux Pas.

EXAMPLE OF FAUX PAS STORY

Helen's husband was throwing a surprise party for her birthday. He invited Sarah, a friend of Helen's, and said: "Don't tell anyone, especially Helen." The day before the party, Helen was over at Sarah's, and Sarah spilled some coffee on a new dress that was hanging over her chair. "Oh!" said Sarah, "I was going to wear this to your party!" "What party?" asked Helen. "Come on," said Sarah, "Let's go see if we can get the stain out."

EXAMPLE OF NON-FAUX PAS STORY

Jim was shopping for a shirt to match his suit. The salesman showed him several shirts. Jim looked at them and finally found one that was the right colour. But when he went to the dressing room and tried it on, it didn't fit. "I'm afraid it's too small," he said to the salesman. "Not to worry," the salesman said. "We'll get some in next week in a larger size." "Great. I'll just come back then," Jim said.

QUESTIONS:

1: Detecting faux pas: "Did someone say something he/she should not have said?"

2: Understanding the faux pas: "Who said something he/she should not have said?"

3: Understanding the mental state of the character affected by the faux pas: " Why should he/she not have said it?"

4: Understanding the mental state of the character making the faux pas: "Why did he/she say it?"

5. Empathy question: To indicate how the character in the story affected by the faux pas may feel.

6. Control question: To understand whether the participant understands the details of the stories without asking them to infer any mental state.

5.4.2.1.3. Procedure

The stories were orally presented to the participant one at a time. The experimenter read the story aloud to the participant while the participant read her/his own copy printed on an A4 sheet of paper. The story remained in front of the participant while the questions were asked, to reduce the memory demands of the task (Maylor et al., 2002; Wang et al., 2006; Slessor et al., 2007). The participant had to give his/her answers orally and the responses were written down by the experimenter. In the faux pas stories, if the faux pas was detected, the participant was asked the further clarifying questions. If the faux pas was not detected, the participant was only asked the control question. In the control stories, if the faux pas occurrence was correctly rejected, the participant was not asked further questions except the control question. If the faux pas occurrence was not correctly rejected, they were asked the further clarifying questions. The control question was always asked, even when the response provided to the first detecting question was wrong.

5.4.2.1.4. Scoring

Each correct response was awarded one point. Performance on the faux pas and the control stories was scored separately. For the faux pas stories, there was a maximum of 40 points awarded for correct answers to questions 1 to 4 and a maximum of 10 points for the control questions. The empathy questions were also scored separately awarding a maximum of 10 points (MacPherson et al., 2002). For the control stories, there was a maximum of 10 points for the correct rejection of a faux pas and 10 points for correctly answering the control questions.

5.4.2.1.5. Analysis

The performance of the two groups in terms of faux pas accuracy (maximum score = 40), control story accuracy (maximum score = 10) and the empathy questions (maximum score = 10) were converted into proportions and then entered into a MANOVA with age group as between factor. A separate MANOVA was conducted on correct responses associated with the control questions for the FP and non-FP stories.

5.4.2.2. Results

Table 5.12 shows the means and standard deviations for the performance of the younger and older groups on the faux pas and the non faux pas stories. Results showed that neither the MANOVA on the FP stories [Pillai's V = .072, F (2, 57) = 2.20, p = .12, η_p^2 = .072], nor the univariate analysis were significant [accuracy: F (1,58) = 1.37, p = .24, η_p^2 = .023; empathy: F (1,58) = .155, p = .69, η_p^2 = .003]. Similarly, no significant difference emerged in the MANOVA on the control questions for both types of stories [Pillai's V = .017, F (1,58) = 1.00, p = .32, η_p^2 = .017] or the univariate analysis [F (1, 58) = 1.0, p = .32, η_p^2 = .017].

Table 5.12. Means and standard deviations for performance on the faux pas and non-faux pas related stories in the younger and the older groups.

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
FP: Accuracy (max = 40)	33.5 (5.7)	35.0 (4.2)
FP: Control Question (max = 10)	10 (0)	10 (0)
FP: Empathy (max = 10)	8.5 (1.4)	8.3 (1.8)
Non-FP: Control Question (max = 10)	9.9 (.18)	10 (0)

FP = Faux Pas stories; Non-FP = Non-Faux Pas stories

5.4.3. Discussion

In the present study, younger and older adults were administered the Faux Pas (FP) task which requires participants to understand both the mental state of the person who deliver the faux pas as well as the affective state of the person receiving the faux pas. In line with the findings of MacPherson et al. (2002), using the same stories, the results showed that older participants did not significantly differ compared to younger adults in their ability to detect that something awkward had been said or in their empathic responses. Yet, these findings contrast with the results reported by Wang et al. (2006) who found poorer performance in older adults compared to younger adults. However, it must be noted that the FP stories employed by Wang et al. (2006) included only one story taken from the original set of faux pas stories developed by Stone et al. (1998) and two newly developed passages.

In a more recent study, older adults performed more poorly than younger individuals when they were instructed to determine the social appropriateness of visually presented behaviours (Halberstadtd et al., 2011). The authors also showed that performance on this version of the FP task correlated with performance on a series of emotion recognition tasks (facial, vocal and body posture) and that the poorer performance of older adults on the video version of the FP task was predicted by their poorer performance compared to younger individuals on the emotion recognition tasks, suggesting that the two types of task might be related. In the present study, older participants performed well on the faux pas task and were not impaired in their facial emotion recognition. Therefore, had the older participants in the current study been impaired in terms of emotion recognition compared to younger participants, this might have also affected their ability to perform well on the FP task and this might explain the conflicting findings among the different studies in the literature examining age effects on the FP task.

As previously discussed, research suggests that the VMPFC is central to FP performance (Stone et al., 1998; Shamay-Tsoory et al., 2005 a;b). Stone et al. (1998) found that patients with damage of the OFC failed to understand that a faux pas had been committed in contrast to patients with DLPFC damage who correctly identified all the faux pas. The lack of age effects on the faux pas task in the current study supports the notion of the VMPFC being relatively spared in healthy adult ageing (Phillips et al., 2002).

5.4.4. Conclusion

In conclusion, the study shows that older participants performed similarly to younger adults on a task that require the empathic understanding of another person's feelings. The result is in line with a previous aging investigation (MacPherson et al., 2002) as well as with patient studies that reported impaired performance on the FP following damage of the VMPFC (Stone et al., 1998; Shamay-Tsoory et al., 2005a; b; 2007a). The same group of older adults have been found to perform as well as younger participants on facial emotion recognition and on the affective components of a cue detection ToM task, supporting the view that the VMPFC is crucially involved in processing the affective components of ToM (Stone et al., 1998; Hynes et al., 2006; Kalbe et al., 2007; Shamay-Tsoory et al., 2005a;b; 2007a). Furthermore, the same group of older participants performed similarly to younger adults on self-related tasks, supporting the view that processing the self and making ToM inferences involves a common brain network (Frith et al., 2003; Happé, 2003).

5.5. Experiment 6: The Ultimatum Game

5.5.1. Introduction

ToM investigations typically present their participant with written stories, cartoons or photographs (Happé et al., 1994; Fletcher et al., 1995; Baron-Cohen et al., 1999; Gallagher et al., 2000). These tasks have been claimed to measure a passive ToM, however, in that participants are not involved in the situation described (Frith et al., 2008). In contras, the Ultimatum Game (UG) has been suggested to measure online ToM in that individuals actively interact with another player (Frith et al., 2008). In line with this view individuals are known to spontaneously interact when they play a game with a human partner (McCabe et al., 2001; Gallagher et al., 2002).

In the UG, participants are instructed that a proposer will split a certain amount of money with them (e.g. £10) and they can choose to either accept or reject the offer. If the respondent accepts the offer (e.g. £8: £ 2), the money will be split as proposed, however, if instead the respondent rejects the offer, both players will get nothing. Economically rational performance on the task predicts the proposer will offer the smallest amount of money and that the respondent will accept it. However, research has shown that proposers make offers to responders which are close to 40%-50% of the total amount of money to be split, that offers less than 20%-30% are often rejected and rejection rates increase as offers become more “unfair” (Guth et al., 1982; Bolton et al., 1995; Nowak, 2000).

The proposer's behaviour has been considered strategic and not guided by consideration of fairness. Kagel, Kim and Moser (1996) showed that when players are aware that different payoffs are associated to the proposer and the respondent, the proposer offered higher amounts of money compared to the condition where only the proposer was aware of the different values of the chips. These results suggest that in the classic UG, the proposer, in order to maximize their income, would offer a fair amount of money that is likely to be accepted.

In contrast, the behaviour of respondents cannot be considered strategic, as they simply decide to accept or reject the offer. The respondent's decision is guided by two different motives: a sense of fairness (which leads to the rejection of low amounts of money that are considered unfair), and a sense of self-interest (which leads to acceptance of any offer, as something little would be better than nothing; Handgraaf, van Dijk, Wilke & Vermunt, 2003). The final decision to accept or reject an offer depends on whether participants focus on the interpersonal component of the task or on the outcome. The authors claimed that since the UG instructs participants to react to an offer made by another person, individuals focus on interpersonal comparison (considering how much they themselves and the proposer would obtain), rather than self-interest. In this study, Handgraaf et al. (2003) instructed participants to play the standard UG or a choice version of the game. In the standard UG, participants were presented with an offer where the proposer obtained 70 chips and the respondent obtained 30 chips and were instructed to accept/reject the offer by choosing between the two options: ''Yes, I accept this offer'' and ''No, I refuse this offer''. In the choice game, they were presented with the same offer but the structure of the choice (accept/reject) was changed so they were instructed to choose between two possible outcomes: "I choose option 1: I receive 30 chips and Player A receives 70 chips'' and ''I choose option 2: I receive 0 chips and Player A receives 0 chips". The results showed higher acceptance rates for the unfair offers when the outcome was made more explicit than in the standard UG. The authors claimed that, although both motives (fairness and self-interest) determine the final decision, self-interest would emerge when individuals are led to focus on the outcome. Support to this claim emerged in a second experiment, where Handgraaf et al. (2003) found higher acceptance rates when participants were told that in the case of rejection both themselves and the proposer would get 15 chips (rather than nothing).

The sense of fairness has been observed in studies where there is a higher rejection of "unfair" offers when participants play against a human partner compared to a computer. For example, Blount (1995) investigated the respondent's behaviour when they played against a human opponent, when a third person makes the offer and against a computer that randomly generated the offers. The participants accepted more offers from the computer compared to the other two conditions, indicating that when they do not play against a human opponent they tend to maximise their outcome. It was also found that no difference emerged between the classic UG (where participants received offer from a human partner) and the third party's offers. The authors argued, however, that different reasons might underlie the rejections of the two conditions: in the classic UG respondents perceive the unfair offer as intentional and therefore, by rejecting it, they punish the proposer. In contrast, in the third party conditions, there is no reason to punish the other player, because the offer is made by a third party. Instead, the rejection would relate to a sense of fairness for both the self and the other player.

The rejection of unfair offers is determined, in particular, by a feeling of anger associated with low offers. For example, Pillutla et al. (1996) found that higher anger levels accompanying unfair offers led to a higher probability of rejection. More recently, Bosman, Sonnemans and Zeelenberg (2001) investigated the effect of negative emotions on the acceptance/rejection rates. Participants played the standard UG and after the game the respondent filled in a questionnaire where they were shown a list of nine emotions (fear, envy, anger, sadness, happiness, shame, irritation, contempt, and jealousy) and were asked to report the intensity of each emotion they felt. The results showed that the probability of rejection depended on the intensity of anger, irritation, contempt, sadness, and envy.

The rejection of low offers In a previous study (Pillutla et al., 1996) participants rejected more offers when there was an external option, that is a payoff that respondents would receive when reject an offer. Pillutla et al. (1996) claimed that in the case of common knowledge, the respondent would interpret a low offer as intentional and therefore would be more willing to reject it. This study highlights the effect of shared knowledge between the respondent and proposer. In a recent study, Nellisen, van Someren and Zeelenberg (2009) showed that when respondents are told that the proposer is not aware of the external option, respondents accept the offer, even when the rejection would provide them with higher earnings than the acceptance. Participants were told that a proposer would offer to split 10 Euros and they could accept it or not. In the case of rejection, they were given 7 Euros, while the proposer would get nothing. All participants were presented with only one (fair) offer (5 Euros). The results showed that respondents accepted the 5:5 offers rather than rejecting them (which would give them 7), suggesting that they were guided by a sense of fairness for both the self and the proposer. Overall, these results suggest that self-interest and a sense of fairness guide the decision, and which motive is more important may depend on the type of opponent they are playing with (human or computer). Similarly, respondents evince a strong fairness motivation when they considered the unfair offer as intentionally made. In contrast, fairness motives may be less crucial when participants are presented with explicit outcomes and when both themselves and the partner are provided with some gain in the case of rejection.

In summary, the above studies indicate that the rejection of unfair offers might be due to the negative emotions associated with offers considered unfair. As older adults are known to preferentially process positive emotions (socioemotional selectivity theory; Carstensen et al., 1999), they might process negative emotions associated with unfair offers to a lesser extent than younger individuals. Therefore, older participants might be expected to accept more unfair offers compared to younger adults. As the current sample of older adults does not show any decline in processing negative emotions (Experiment 3), their acceptance rate might be comparable to that of younger participants. However, the dorsolateral prefrontal cortex theory of ageing (MacPherson et al., 2002; Phillips et al., 2002) would predict an age effect on the acceptance rate of unfair offer in terms of the brain areas associated to unfair offers.

5.5.1.1. Neuroimaging and lesion studies

Neuroimaging studies have reported activation of both the VMPFC and the DLPFC during UG performance of participants in the role of respondents. Tabibnia, Satpute and Lieberman (2008) recorded brain activity with fMRI in healthy participants playing a "stake" version of the game, which is where the possible outcome for the participant was the same for fair and unfair offers, but the stake was varied to seem more fair (e.g. 7 out of 15 offered versus 7 out of 23 offered). The results showed greater VMPFC activity of respondents for high offers compared to low offers. Meanwhile, there was greater ventrolateral activation (VLPFC) accompanied by reduced activation of the anterior insula when accepting an unfair offer, suggesting that the VLPFC modulates the negative emotions elicited by unfair offers leading to offer acceptance. Unfair offers have also been shown to activate the DLPFC (Sanfey, Rilling, Aronson, Nystrom and Cohen, 2003; Rilling et al., 2004). In an fMRI study, Sanfey et al. (2003) found increased activation of the DLPFC and the insula for unfair compared to fair offers. Activation of the DLPFC has been associated with the maintenance of the cognitive goals of a given task, in this case accepting as much money as possible (Anderson et al., 2002). The insula showed greater activation as the offer became more unfair and when participants rejected a higher proportion of unfair offers. These results indicate that the final decision of whether to accept an offer or not depends on the relative activation of both the DLPFC and the anterior insula, with greater insula activity over DLPFC activity leading to the rejection of an unfair offer whereas greater DLPFC activity over insula activity results in the acceptance of an unfair offer. Knoch, Pascual-Leone, Meyer, Treyer and Fehr (2006) showed that following rTMS application over the right DLPFC, participants accepted a greater proportion of unfair offers. Despite these behavioural results, the temporary disruption of the DLPFC did not affect the subjective fairness ratings in that low offers were rated unfair in all conditions. Knoch et al. (2006) suggested that the DLPFC is involved in the ability to implement fair behaviour, and that after its disruption, the decision is guided by the goal of accepting as much money as possible.

The high rejection of unfair offers in healthy young adults performing the UG has been related to the negative emotional reaction to an offer perceived as unfair (Pillutla et al., 1996). To determine the role played by negative emotions during UG performance, Koenigs and Tranel (2007) assessed VMPFC damaged patients, non-VMPFC patients and healthy controls on the task. The VMPFC patients were characterised by reduced ability to modulate their emotion (e.g. exaggerated anger, irritability and outburst). The three groups showed a similar acceptance of fair offers. However, VMPFC patients accepted a smaller proportion of unfair offers compared to both control groups, which authors interpreted as due to the patients' inability to modulate their anger, which arises during the presentation of unfair offers. An alternative explanation for the higher rejection rate for unfair offers is reduced sensitivity to abstract financial outcome, in line with previous studies that indicate the role played by the VMPFC in the representation of abstract rewards (O'Doherty et al., 2001). Moretti, Dragone, di Pellegrino (2009) compared the performance of patients with VMPFC damage, patients with non-VMPFC damage and healthy controls on three versions of the UG where offers were made by a human partner (human opponent condition, HO), a computer (computer opponent condition, CO) or by a human partner that offered actual cash (human opponent with cash, HOc). The results showed that the VMPFC patients were more likely to reject an unfair offer compared to both the control groups in the HO and in the CO conditions. In contrast, no difference emerged in the acceptance rate of the VMPFC and both healthy and non-VMPFC groups in the Hoc. Moreover, the VMPFC showed a similar acceptance rate in the HO and CO conditions, while the control participants were more likely to accept an offer made in the CO than the HO. The difference in acceptance rates for offers made by a human and a computer in healthy individuals has been interpreted as a reaction to social unfairness in human partners (Blount et al., 1995; Sanfey et al., 2003; Rilling et al., 2004) which does not occur in VMPFC patients as they do not differ in their acceptance rates in the HO and CO conditions. The higher rejection rate of the VMPFC patients compared to healthy and non-VMPFC controls in the HO and the CO conditions would depend on a deficit in representing an abstract reward. In line with this view, no difference emerged between the VMPFC patients and the two control groups in the acceptance rate when real money was involved. VMPFC damage has also been related to impaired processing of social emotions, such as guilt. Krajbich, Adolphs, Tranel, Denburg and Camerer (2009) used a version of the UG task that instructed participants to play a one-shot version of the task.

They played the game twice, once as the proposer and once as the respondent. A feeling of guilt would manifest as the tendency of participants to offer more than they would be expected to be offered themselves. And, indeed, this effect was observed amongst control participants, suggesting that a reduction in the feeling of guilt in the VMPFC patients would lead them to offer no more than what they would demand.

5.5.1.2. Ageing studies

The literature on cognitive, emotional and anatomical changes with age suggests that older adults' performance may be affected on the UG due to impaired processing of negative emotions. Carstensen et al. (1999) claimed that older individuals show a tendency to place more emphasis on positive information, which is evidenced by their greater attention and memory for positive than negative stimuli (Mather et al., 2005). Older adults have also been reported to perform poorly on economic games in general, as they do not attempt to maximise their interests and may be less cautious when making economic decisions (Denburg, Tranel, Bechara & Damasio, 2001).

In terms of the neuropsychology literature, ageing studies have shown that the insula is particularly vulnerable to the effects of ageing (Good, Johnsrude, Ashburner, Henson, Friston & Frackowiak, 2001) and the insula has been shown to be related to emotional processing, especially of negative emotions such as disgust (Phillips et al., 1997). This brain area is also involved in the representation of the social value of rewards in terms of fairness. As discussed earlier, neuroimaging investigations of brain activation during UG performance have shown increased anterior insula activation as the offers became more unfair, and greater insula activation leads to greater rejection (Sanfey et al., 2003). The DLPFC also plays a role in rejecting unfair offers, as research shows that the temporary disruption of the DLPFC using TMS is associated with higher acceptance of unfair offers (Knoch et al., 2006). As both the DLPFC and insula are thought to be affected by ageing, older adults might accept more unfair offers, while no difference should emerge in the acceptance rate of fair offers.

At present, only one study has investigated the effect of healthy adult ageing on a variant of the UG, the Repeated Fixed Opponent Ultimatum Game (Beadle, 2009). This task differs from the classic UG in that the game is played with the same opponent across all trials while, in the classic UG, the opponents change from trial to trial. In that study, the alternative version of the UG was employed as a measure of empathic abilities in a task that may simulate a real life situation, where people repeatedly interact and build a relationship. In contrast to the expected higher acceptance of unfair offers in older adults, as suggested by the neuroimaging evidences previously discussed (Sanfey et al., 2003; Knoch et al., 2006), the results showed that older participants accept fewer unfair offers compared to younger adults.

Rejection in the UG has been proposed to be determined by a sense of fairness and the belief that rejecting an unfair offer would promote fairer behaviour for future interactions (Fehr & Fischbacher, 2003). Beadle (2009) suggests that older adults might be more inclined than younger participants to make it clear that they will not accept unfair treatment. In addition, a significant relationship emerged between the rejection rate and the empathy scores with higher rejections associated with reduced empathy scores. These results would suggest that, in this version of the game, the higher rejection rates of older individuals might be a consequence of reduced empathic abilities, defined as the ability to take another person's perspective when building a relationship (Beadle, 2009). The need of the individuals to consider the other's perspective and make clear that they will not accept too little offers might be less strong when participants do not interact repeatedly with the same opponents (Frith et al., 2008). Previous neuroimaging studies investigated brain activity when individuals performed the classic UG, where they interacted with different opponents.

In the following investigation, younger and older participants will perform the classic UG where offers are made by different proposers. The previous literature discussed above shows that the brain areas associated with ToM (e.g. MPFC) are activated when individuals play against a human partner, suggesting that people consider other's intentions during the game. Furthermore, it has been reported that both the VMPFC and DLPFC are involved in UG task performance. Damage to the VMPFC will determine greater rejection of unfair offers (Koenigs et al., 2007; Moretti et al., 2009). In contrast, damage to the DLPFC will lead to greater acceptance of unfair offers (Knoch et al., 2006). On the basis of these results and the view that DLPFC deteriorates more than VMPFC as people age (Phillips et al., 2002), older participants are expected to accept more unfair offers compared to younger individuals. It is also known that the rejection of unfair offers is typically accompanied by an increase in self-related negative emotions

(Pillutla et al., 1996). Since older adults are thought to place more emphasis on positive rather than negative effects (socioemotional selectivity theory; Carstensen et al., 1999), it may be that older participants will process the negative emotions elicited by unfair offers less than younger adults, leading them to accept a higher proportion of unfair offers compared to younger participants.

5.5.2. Experiment 6: Online ToM

5.5.2.1. Methods

5.5.2.1.1. Participants

Thirty younger and thirty older adults took part in this study. Twenty-seven of younger participants were the same participants who performed the self-processing, the emotion processing and the judgements of preference tasks. Three younger participants did not complete the experimental session and were replaced. The same sample of older adults from the previous experiments participated in the current experiment. The order of the tasks was randomised across participants. The Wechsler Abbreviated Scale of Intelligence (WASI: Wechsler, 1999) was used as a measure of the level of general intelligence where participants performed the vocabulary and the reasoning subscales. The two groups did not significantly differ in their IQ [t (58) = -1.10, p = .29, d = .27] or their level of education [t (58) = -.563, p = .57, d = .14]. Table 5.13 provides the demographic characteristics of the two groups.

Table 5.13. Demographic data of the younger and older groups.

	Younger *(M: 4; F: 26)*	Older *(M: 9; F: 21)*
	Mean (SD)	*Mean (SD)*
Age	19.73 (1.7)	69.77 (6.6)
Years of Full-Time Education	14.07 (1.8)	14.37 (2.2)
WASI Full Scale IQ	116.6 (6.4)	118.43 (6.9)

WASI = Wechsler Abbreviated Scale of Intelligence

5.5.2.1.2. Materials

5.5.2.1.2.1. The Ultimatum Game

In this task, participants acted as responder during a series of trials in which a fictitious player, the opponent, makes an economic offer via the computer. The identity of the opponent was represented by a photograph of their face displayed on the computer screen and by their name. The photographs of emotionally neutral faces were taken from the NimStim Face Stimulus Set (www.macbrain.org; Tottenham et al., 2009). Eight different opponents, four female and four male faces, were used. The task consisted of six types of offer each repeated 8 times, once by each female opponent and once by each male opponent. In total, 48 offers (6 x 8) were made. The offers consisted of splitting £10 between the participant and the opponent. Half of the offers were considered fair (opponent: participant - £4: £6, £5: £5, £6: £4). The remaining half of the offers were considered unfair (opponent: participant - £9: £1, £8: £2, £7: £3), (Figure 5.4).

5.5.2.1.2.1.1. Procedure

Participants were first instructed that they were about to play a game with another player who would make them an economic offer to split £10 between one another. They could either accept or reject the offer by pressing the corresponding button on the keyboard. If they accepted the offer (e.g. £6: £4), the money would be divided as stated (the opponent would get £6, the participant would get £4). If they rejected the offer, both players would receive nothing. After reading the instructions, participants were presented with two practice examples.

For each offer, participants were first given 15 seconds to prepare. The preparation time consisted of the presentation of a "waiting" slide for 7 seconds (i.e. "Please, wait…"), followed by the presentation of an "offer being made" slide for 8 seconds (i.e. "Your partner is making an offer…"; Figure 5.4).

The actual offer screen was then presented. On the left hand side of the slide, participants saw the photograph of the opponent's face. On the right hand side, they saw the name of the opponent and the offer. Under each offer, participants were present with the choice "accept or reject?" After the response was made, a final slide was presented for 3 seconds showing the outcome for that offer (e.g. "You rejected the offer. You both get nothing").

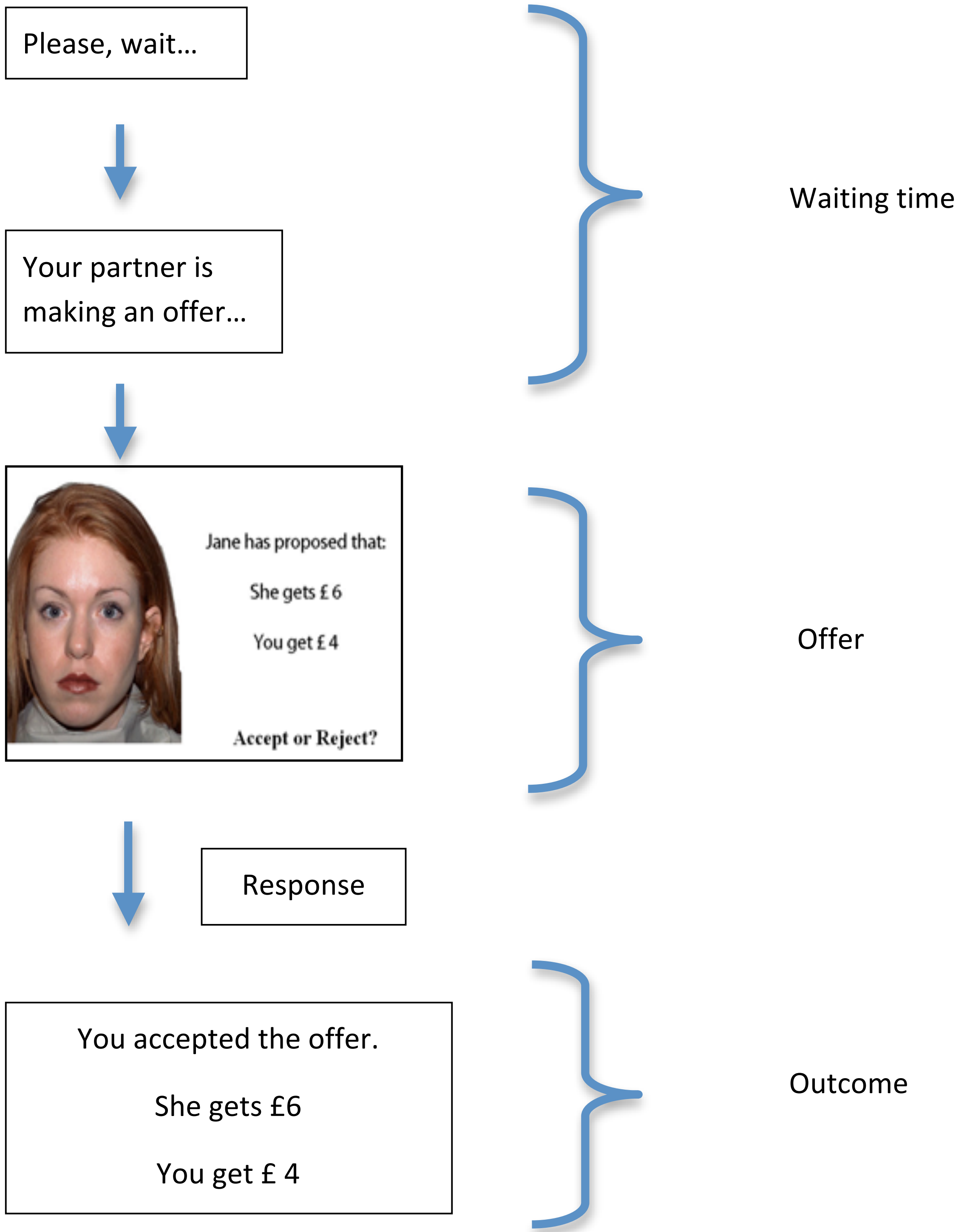

Figure 5.4. Schematic representation of trial design

5.5.2.1.2.2. Subjective ratings

Immediately after completing the Ultimatum Game, participants were presented with the six types of offer they were presented with during the game. For the fairness ratings, they were instructed to indicate the extent to which they perceived each offer as fair or unfair on a 5-point Likert scale (1: very unfair; 5: very fair). For the subjective emotional responses, they indicated on a separate 5-point Likert scale how angry they felt after each offer type (1: not angry; 5: very angry).

5.5.2.1.2.3. Skin conductance response (SCR) recording

The skin conductance (SC) level of each participant was continuously recorded while performing the Ultimatum Game using a SC5 24 bit digital skin conductance amplifier connected via a serial cable to a PSYLAB stand-alone-monitor unit (Contact Precision Instruments, London, England). A constant voltage of 0.5V was applied across a pair of electrodes (8 mm prewired silver/silver chloride electrodes), which were filled with isotonic conductant and attached to the medial phalanx surface of the middle and index finger of the non-dominant hand. Participants were instructed to keep their hand firmly in one place while performing the task. Values of SC were transformed into numeric values using PSYCHLAB 8 software for Windows (www.psychlab.com). To ensure that there was adequate time for SCR measurement, a 15 second preparation interval between trials was used. Presentation of the offers was manually marked on the recording when they occurred. SC responses occurring at the presentation of each offer were computed. The complete SCR data for 23 younger and 21 older participants was collected, as some participants' SCR data had to be excluded due to technical faults with the equipment.

5.5.2.1.2.4. Analysis

The acceptance rates of the three fair and unfair offers were added together to obtain measures of the acceptance of fair and unfair offers. The data were analysed with a Tweedie mixed model fitted with the generalised estimating equations (GEE). The GEE method is a non-parametric test of response probability and the model is "mixed" in the sense that it combines properties of continuous and discrete distributions and allows the data set to contain values greater or equal to 0. The acceptance rates were further analysed separately for each type of fair and unfair offer using a logistic regression fitted with the generalised estimating equations (GEE). This analysis is suitable for variables that involve binary responses. Subjective ratings associated with fairness and anger judgements for each type of offer were not normally distributed and were analysed using the Mann-Whitney non-parametric test. Finally, the skin conductance responses associated with fair and unfair offers were analysed with a 6 (offer type: fair vs. unfair) x 2 (group: younger vs. older) ANOVA.

5.5.2.2. Results

5.5.2.2.1. The Ultimatum Game

The mean acceptance rates and standard errors of the mean for younger and older groups for each offer are reported in Figure 5.5.

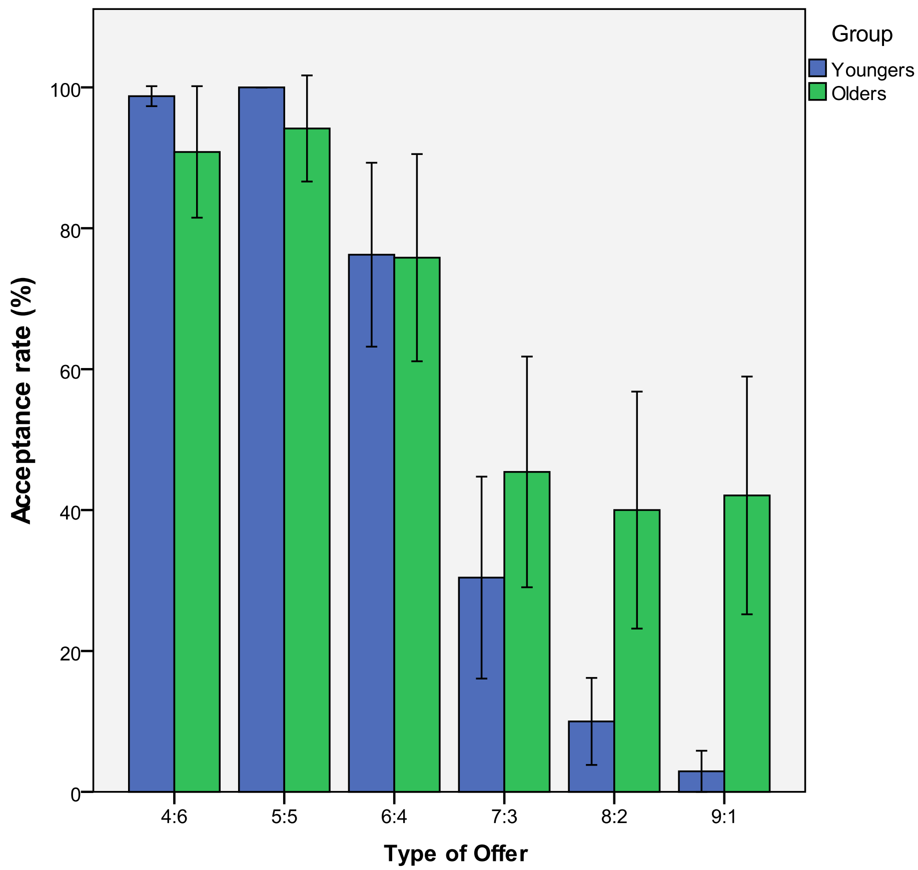

Figure 5.5: Mean acceptance rate (%) with standard error (SE) bars for each offer in the younger and older groups.

The analysis of the collapsed fair vs. unfair offers showed a significant main effect of offer type [$\chi 2$ (1) = 90.48, *p* = .000, w = 1.2], with a higher acceptance rate for fair than unfair offers. The group x offer type interaction was also significant [$\chi 2$ (1) = 15.68, p = .000, w = .51]. Pairwise comparisons showed that both groups accepted more fair then unfair offers (all p < .001). There was no difference in the acceptance rates for fair offers by younger (μ = 91.66; SD = 12.08) and older participants (μ = 86.94; SD = 19.83). In contrast, older adults (μ= 42.50, SD = 43.77) accepted significantly more unfair offers than younger participants (μ = 14.44, SD = 17.73; p < .001). The main effect of group was also significant [$\chi 2$ (1) = 10.35, p = .001, w = .41], with older adults accepting more offers on average than younger participants.

Investigation of the acceptance rate of each type of offer showed a main effect of offer type [$\chi 2$ (5) = 772.84, p = .000, w = 3.5]. Post-hoc pairwise comparisons showed that all fair offers were accepted significantly more than the unfair offers (all p values < .001). No difference emerged in the acceptance rate of two of the fair offers (£4: £6 and £5: £5), which were both accepted more than the third fair offer (£6: £4, both p values < .001). The unfair offer £7: £3 was accepted significantly more than both the remaining unfair offers (both p values < .001). No significant difference emerged in the acceptance rate of the unfair offers £8: £2 and £9: £1.

There was also a significant group effect [$\chi 2$ (1) = 86.86, p = .000, w = 1.2], with older adults accepting more offers (μ = 64.72; SD = 26.13) than younger participants (μ = 53.05; SD = 12.55). The group x type of offer interaction was also significant [$\chi 2$ (4) = 48.25 p < .000, w = .89]. Post-hoc pairwise comparisons showed that the unfair £9: £1 offer was accepted significantly more often by older participants than younger participants ($p < .01$). The unfair £8: £2 offer showed a trend towards higher acceptance in the older group compared to the younger group ($p = .058$), while the two age groups exhibited a similar acceptance rate for all fair offers and the unfair £7: £3 offer. Further post-hoc comparisons showed that younger adults accepted all three fair offers significantly more than the unfair offers (all p values < 001). No significant difference emerged in the acceptance rate of the £4: £6 and the £5: £5 offers which were both accepted more than the £6: £4 offer (both p values $< .05$). The unfair offer £7: £3 was accepted more than both the remaining unfair offers £8: £2 and £9: £1 ($p < .05$ and $p < .01$, respectively). No significant difference emerged in the acceptance of the £8: £2 and £9: £1 offers. Similarly, older participants accepted all fair offers significantly more than the unfair offers (all p values $< .001$). However, in contrast to younger adults, older adults showed reduced acceptance of the unfair offers £8: £2 and £9: £1 compared to the unfair offer £7: £3, no significant difference emerged in the acceptance of any of the three fair offers in older participants.

5.5.2.2.2. Subjective Ratings

5.5.2.2.2.1. Subjective ratings of fairness for each type of offer

The results of the fairness judgements for each type of offer were not normally distributed and, thus, they were analysed using the non-parametric Mann-Whitney U-tests (the means and standard deviations are reported in Table 5.14). The results (Bonferroni corrected for multiple comparisons $p = .008$) showed that the two age groups did not significantly differ in their subjective rating of fairness for any fair [£4:

£6: U = 399.0, z = -.789, *p* = .43*, r* = -.10; £5: £5: U = 406.0, z = -1.16, *p* = .24, *r* = -.14; £6: £4: U = 369.0, z = -1.25, *p* = .21*, r* = -.16] and unfair offers [£7: £3: U = 345.5, z = -1.73, *p* = .08*, r* = -.22; £8: £2: U = 389.5, z -.989, *p* = .32*, r* = -.12; £9: £1: U = 412.0, z = -.866, *p* = .38*, r* = -.11].

Table 5.14. Fairness judgements for each type of offer given by younger and older participants

	Younger	Older
	Mean *(SD)*	Mean *(SD)*
£4: £6	3.1 (.87)	3.3 (1.2)
£5: £5	4.8 (.50)	4.7 (.70)
£6: £4	3.0 (.94)	2.7 (1.0)
£7: £3	2.3 (.65)	2.0 (.91)
£8: £2	1.7 (.53)	1.7 (1.1)
£9: £1	1.1 (.46)	1.4 (1.0)

Higher scores indicate higher fairness reported. Maximum = 5.

5.5.2.2.2.1. Subjective ratings of anger for each type of offer

The results of the anger judgements for each type of offer were not normally distributed and, thus, they were analysed using the non-parametric Mann-Whitney U-tests (the means and standard deviations are reported in Table 5.15). The results (Bonferroni corrected for multiple comparisons) showed that groups did not significantly differ in their subjective rating of fairness for any fair [£4: £6: U = 397.0, z = -.972, *p* = .33, *r* = -.12; £5:£5: U = 390.0, z = -1.70, *p* = .08, *r* = -.21; £6:£4: U = 400.0, z = -781, *p* = .43, *r* = -.10] and unfair offers [£7:£3: U = 300.5, z = -2.29, *p* = *.02, r* = -..29; £8: £2: U = 336.0, z -1.74, *p* = .08, *r* = -.22; £9: £1: U = 307.5, z = -2.17, *p* = .03, *r* = -.28].

Table 5.15. Anger judgements for each type of offer given by the younger and older groups

	Younger Mean *(SD)*	Older Mean *(SD)*
£4: £6	1.3 (.53)	1.5 (.85)
£5: £5	1.0 (.36)	1.3 (.75)
£6: £4	2.0 (.84)	1.9 (.92)
£7: £3	3.0 (.90)	2.4 (1.0)
£8: £2	3.5 (1.1)	2.9 (1.3)
£9: £1	3.8 (1.1)	3.1 (1.4)

Higher scores indicate higher anger reported. Maximum = 5.

5.5.2.2.3. Skin conductance result

The SC results were analysed using a 2 (group: younger vs. older) x 2 (type of offer: fair vs. unfair) ANOVA. Means and standard deviations are reported in Table 5.16. The results only showed a significant age group effect, with higher SC responses for the younger than the older group [F (1,41), 8.18, p = .007, η_p^2 = .16]. The main effect of offer type and the group x offer type interaction were not significant [F (1,41) = .001, p = .97, η_p^2 = .000; F (1,41) = 1.41, p = .24, η_p^2 = .033 respectively].

Table 5.16. Skin conductance results of fair and unfair offers of younger and older groups

	Younger Mean *(SD)*	Older Mean *(SD)*
Fair	7.00 (4.09)	4.10 (2.23)
Unfair	7.06 (4.12)	4.04 (2.27)

5.5.3. Discussion

Performance on the UG was investigated in younger and older participants on a task where they were presented with fair and unfair money offers and instructed to decide whether they would accept or reject the offer. Normative performance on the task is where individuals accept any offer. However, several studies have shown that acceptance rates reduce as offers become more unfair (Guth et al., 1982; Bolton et al., 1995; Nowak, 2000; Handgraaf et al., 2003). In line with this view, in the present study both younger and older participants showed higher acceptance of fair offers and their acceptance rates reduced as offers became more unfair. The study also showed that, overall, older adults accepted more offers than younger participants, but that this was due to the older group accepting a higher proportion of unfair offers. No age difference emerged in the acceptance rate of fair offers. The results of the present investigation are in line with the dorsolateral prefrontal theory of cognitive ageing that claims that older adults would perform more poorly than younger individuals on tasks that rely on the DLPFC while performance on tasks that rely on the VMPFC would be spared (MacPherson et al., 2002; Phillips et al., 2002). Tabibnia et al. (2008) showed greater VMPFC activation in relation to high compared to low offers. In contrast, the acceptance rate of unfair offers has been shown to rely on the DLPFC (Sanfey et al., 2003; Rilling et al., 2004) and its temporary disruption leads to higher acceptance of unfair offers (Knoch et al., 2006). Indeed, in the current study, the older adults accepted a higher proportion of unfair offers compared to younger participants. Despite the difference in the acceptance rate of unfair offers, subsequent ratings of fairness and anger did not differ among younger and older participants, indicating that older adults were not more likely to accept the unfair offer because they felt less angry or perceived the offer less unfair than young adults.

The performance of our older group is similar to the performance of the middle-aged healthy adults reported in Moretti et al. (2009). In contrast, the performance of our younger participants resembles the performance of Moretti et al.'s (2009) VMPFC patient group who, similarly to the younger groups in the present study, demonstrated reduced acceptance of unfair offers. The reduced acceptance of unfair offers in younger participants may be determined only by a sense of fairness as shown in previous investigations (Blount et al, 1995). In contrast, although older participants showed similar subjective ratings of fairness compared to younger adults, their higher acceptance of unfair offers, suggests that they might be more willing to accept any money in that a little is better than nothing, which is what the economic theory would predict.

However, the results of the present investigation contrast with the reduced acceptance of unfair offer in older participants reported by Beadle (2009). It should be noted that Beadle used an iterated version of the task, in which participants repeatedly interacted with the same opponent across all trials. Beadle suggested that older individuals might be more prone to make it clear to their opponents that they would not be willing to accept offers which are too low compared to younger participants. In line with this view, a recent review indicated that UG individuals take into consideration the mental state of the other person (e.g. to build a reputation) and this process would manifest more strongly when individuals interact with the same person (Frith, 2008). The high rejection rate of unfair offers would allow individuals to promote cooperative behaviour for future interactions (Fehr et al., 2003). In contrast to Beadle, the UG used in the present investigation presented participants with offers made by different proposers, which may have reduced the need to "build a reputation".

5.5.4. Conclusion

Overall, the results showed the perception of fairness and the emotional reactions associated with fair and unfair offers is similar in younger and older individuals. Despite the similarity of the subjective ratings, older adults accepted more unfair offers than younger participants, a process thought to rely on the DLPFC (Sanfey et al., 2003; Rilling et al., 2004; Knoch et al., 2006). whereas no difference emerged in the acceptance of fair offers, thought to rely on VMPFC activity (Tabibnia et al., 2008).

5.5.5. Overall effect of age on Theory of Mind task performance

A multivariate ANOVA was conducted on the proportion of correct responses for the FEEST, FP task and Judgement of Preference task and the accepted offers for the UG. For the FEEST, the proportion of correctly recognised emotions was included in the analysis. For the FP task, the proportion of correctly detected faux pas and the subsequent clarifying questions was included. For the judgement of preference task, the proportion of correct responses was computed for both the affective and the cognitive conditions. Finally, the proportion of fair and unfair offers accepted was computed for the UG. These data were then entered into a multivariate ANOVA.

Since the data were not normally distributed, a bootstrapping procedure was also performed on the data. The bootstrap is a very general approach for calculating the standard errors of parameter estimates and is applicable to the multivariate analysis. The bootstrap technique extracts several samples from the original dataset to generate an empirical sampling distribution for a statistic. A 95% confidence interval for the mean is estimated using 1000 bootstrap samples.

5.5.5.1. Results

The means and standard deviations for the proportion of correct responses and accepted offers are reported in Table 5.17.

Table 5.17. Means and standard deviations for the proportion correct and offers accepted for each test in the younger and older groups.

	Younger	Older
	Mean (SD)	Mean (SD)
FEEST	.84 (.05)	.83 (.09)
Faux Pas	.82 (.16)	.87 (.10)
Affective judgements of preference	.93 (.10)	.85 (.19)
Cognitive judgements of preference	.92 (.11)	.90 (.12)
Fair offers accepted	.91 (.12)	.89 (.19)
Unfair offers accepted	.12 (.45)	.42 (.43)

The results showed that the multivariate analysis was significant [Wilks' Λ = .724, *F* (6, 45) = 2.85, *p* = .01, η_p^2 = .27]. Follow-up univariate ANOVAs showed that older participants accepted a higher proportion of unfair offers compared to younger adults [F (1, 50) = 9.43, p = .003, η_p^2 = .16]. No significant difference emerged in terms of emotion recognition [F (1,50) = .17, p = .68, η_p^2 = .003], faux pas understanding [F (1,50) = 2.21, p = .14, η_p^2 = .04], affective and cognitive judgements of preference [F (1,50) = 3.2, p = .07, η_p^2 = .06; F (1,50) = .170, p = .68, η_p^2 = .003 respectively] and acceptance of fair offers [F (1,50) = .742, p = .39, η_p^2 = .01].

The bootstrap results with 1,000 bootstrap resamples and 95% confidence interval (CI) confirmed the above findings with a significant effect only for the proportion of unfair offers accepted (coefficient = -.304, CI = -.465 to -.131, p < .01).

5.5.6. General conclusion of Chapter 5

Evidences exist suggesting that ToM consists of different component that rely on different neural network. The ability to understand another person's mental state involved both the cognitive and affective ToM (Blair and Cipolotti, 2000). Evidences suggest that the cognitive ToM relies on lateral frontal areas (Hynes et al., 2006) while the affective ToM involved the VMPFC (Stone et al., 1998; Shamay-Tsoory et al., 2007a;b). Furthermore, the ToM involves the ability to detect physical stimuli (e.g. facial expression of emotions, eye gaze direction) and to infer other's mental states based on knowledge of the person and social situation (Sabbagh et al., 2004), with the former relying on right frontal and temporal brain areas (Sabbagh et al., 2004) and the latter on left frontal activity (Sabbagh et al., 2000).

In the present study younger and older participants performed a series of ToM task, aimed to investigate ToM detection and reasoning as well as affective and cognitive ToM. The results showed that the ability to detect and attribute mental states on the basis of facial expression of emotion as well as the eye gaze was not affected by age. However it must be considered that the older participants were volunteers at the department of psychology and therefore they might have performed the facial emotion recognition task in the past. The ability to attribute cognitive and affective mental states on the basis of the eye gaze direction also was not impaired in older individuals. The task employed in the present investigation does not place strong cognitive demands in terms of memory, suggesting that the ability to attribute mental state on the basis of physical stimuli is not affected by ageing. In line with this view, previous studies showed intact ToM performance in older individuals when the memory demands of the task were reduced (Maylor et al., 2002; Slessor et al., 2007). Despite these results, older participants in the current study performed worse than younger adults on the cognitive condition with increasing task demands (e.g. presence of a distracting arrow). This deficit however may relate more to difficulty in understanding the task requirement, rather then to the ability to attribute mental states, in that an age effect emerged only on the first order condition, while no significant difference emerged between younger and older group's performance in the more advanced second order condition.

The ability to mentalise on the basis of social understanding, as measure with the FP task, was intact in older adults. This result is in line with a previous ageing study (MacPherson et al., 2002) while it contrasts with a more recent investigation (Wang et al., 2006). The contrasted result is probably related to the different stimuli employed. In the present investigation participants performed the FP task as originally developed by Stone et al. (1998). In contrast Wang et al. (2006) employed only one story from the original set and two newly developed stories. The results of the three experiments showed that older individuals with high intellectual functions performed well on all component of the ToM, named detection, reasoning, affective and cognitive.

A further task was included on the basis of the claim (Frith et al., 2008) that the classic ToM tasks (e.g. stories, cartoons, photographs) require a passive understanding of another person's mental state. Early ToM studies showed that individuals spontaneously mentalise when they play with a human partner in the attempt to predict and understand their partner's moves (McCabe et al., 2001; Gallagher et al., 2002). In this study participants played the UG and the results showed that older individuals accepted more unfair offers compared to younger participants, while no difference emerged in the acceptance rate of fair offers. These results are line with the dorsolateral prefrontal cortex theory of ageing (Phillips et al., 2002; MacPherson et al., 2002) which suggests that performance on tasks thought to rely on DLPFC brain areas would differ in younger and older adults.

Support for this view also comes from both neuroimaging and lesion studies that showed involvement of the DLPFC associated to unfair offers (Sanfey et al., 2003; Rilling et al., 2004). In contrast, lesion studies showed that damage of the VMPFC determine higher rejection of unfair offers compared to healthy controls (Koenigs et al., 2007; Moretti et al., 2009). The DLPFC is affected by ageing to greater extent than the VMPFC and younger and older adults differ on their performance on task thought to rely on DLPFC brain areas (MacPherson et al., 2002). In line with this view, older participants accepted a higher proportion of unfair offers, similarly to the results reported by Knoch et al. (2006) where the temporary disruption of the DLPFC determined higher acceptance of unfair offers.

The results suggest that younger and older participants performed differently only on the more ecologically valid task, the UG, where individuals are actively involved in a social situation while the performance on passive ToM tasks does not change with age. Furthermore, these findings show that the same older adults perform as well as younger participants on affective ToM tasks and on a series of self-related tasks. In contrast, older participants showed a significantly poorer performance compared to younger adults on a task thought to involve the DLPFC. The results suggest that processing the self and making affective ToM inferences rely on a common brain network that involves the VMPFC but not the DLPFC brain areas.

Chapter 6. Experiments 7 and 8: The self-referential effect

6.1. General Introduction

The ability to make self-related judgements does not decrease with age, even when the task is known to rely on episodic memory retrieval (Chapter 3) and it is known that processing information in relation to the self enhances memory performance (Rogers et al., 1977). As the negative beliefs associated with ageing negatively affect well being and cognitive functions (Levy et al., 1996; Sneed et al., 2005; Levy et al., 2000; 2002a;b; Steverink et al., 2001), by improving cognitive functioning, such as memory retrieval, the view of the self that older individuals possess might be enhanced. Therefore it appears to be important to determine what aspects of the self are less affected by ageing. As previously discussed, processing information in relation to the self enhances memory retrieval. The effect has been demonstrated for both personality traits (Kelley et al., 2002) as well as for self-executed actions (Cloutier et al., 2006) and self-possession (Cunningham et al., 2008). These latter tasks, typically, do not explicitly require individuals to process information in relation to the self. As several studies indicate that implicitly process self-related information involves the same brain areas related to explicit self-judgements (Moran, Heatherton & Kelley, 2009; Rameson, Satpute & Lieberman, 2010), older adults would be expected to perform as well as younger adults when implicitly processing information in relation to the self.

The memory advantage provided by encoding information in relation to the self is known as the Self Referential Effect (SRE; Rogers et al., 1977). Typically, participants are presented with a series of trait adjectives and required to make descriptive judgements about whether the traits are descriptive of the self, whether they are descriptive of another person or they are instruct to process the words in a shallow manner (e.g. Is the word printed in capital letters?). The encoding phase is followed by a memory task where participants are instructed to either recall as many words as possible from the previous encoding phase or are administered a recognition task. The results show better memory performance for self related items compared to those related to another person or those which have been encoded in a shallow manner (Rogers et al., 1977; Ferguson et al., 1983; Brown et al., 1986; Reeder et al., 1987; Klein et al., 1989; Conway & Dewhurts, 1995; Symons and Johnson, 1997). The SRE is a robust phenomenon and has been demonstrated in studies that have employed different paradigms. Brown et al. (1986) presented their participants with a series of concrete nouns (e.g. dog) and instructed them to form mental images of themselves or a famous journalist (i.e. Walter Cronkite) interacting with each object. The results showed that in a subsequent memory tasks, participants recalled more nouns encoded in relation to the self than a famous other person. In a different paradigm, Bellezza (1984) presented participants with trait words and instructed them to report a personal event related to each trait or to form an association between the word and a body part (e.g. fist may associate with the word hostile). In a subsequent memory test, participants in the experience conditions remembered significantly more words than those in the body part condition, suggesting that the memory advantage for the traits emerged because referring to the self provided context (in terms of personal experience) that is easily associable with the trait word. D'Argembeau et al. (2005a) employed a similar paradigm where participants were instructed to make descriptive judgements related to the self and a famous singer on a series of positive and negative traits. Participants had better memory for positive than negative words but only in relation to the self. More recent investigations employed a similar paradigm to investigate neural correlates of the SRE (Craik et al., 1999; Kelley et al., 2002; Heatherton et al., 2006; Yaoi, Osaka & Osaka, 2009) and found better memory for self related information. These studies therefore indicate that memory is enhanced by information processed in relation to the self.

Other studies show that processing information in relation to the self affects not only the amount of information retrieved, but also the quality of memory retrieved. For example, Conway et al. (1995) investigated whether memory for self-related material was characterized by recollection of a vivid memory of the item previously encountered. Participants rated a series of traits as self-descriptive, descriptive of a famous person or whether they were positive/negative. They then engaged in a recognition memory task. For each recognised word, they indicated whether they could remember details (e.g. thoughts) associated to the event (i.e. a remember response) or if they had the feeling that the item had appeared without recollecting any additional information (i.e. a know response). The correct recognition of traits previously encoded in relation to the self was accompanied by the highest number of "remember" responses and the lowest number of "know" responses for correct recognition. The famous person condition showed the opposite results, with more "know" responses and fewer "remember" responses for correct recognition. These results indicate that the recollective experience was stronger for self-related material while a sense of familiarity accompanied recognition of non-self related material.

The SRE has been explained in relation to highly elaborative and organisational properties (Klein & Loftus, 1988). Elaboration refers to the production of extra list information when encoding given materials, so that each word can be encoded in relation to additional information not presented in the list to be learned. Organisation refers to the associations among the words included in a list, so that words are organized in terms of the self and non-self related items. Klein and Kihlstrom (1986) found that self- was more likely than non-self related material to induce organisation of the word list. Furthermore, when self-encoding was compared to semantic encoding (which encouraged similar organisation), the SRE disappeared. Klein et al. (1988) claimed that when a task presents a list of highly related words, an elaborative process would facilitate recall more than an organisation process. In contrast, when the task presents material with non-specific relationships among the items, organisation would lead to higher memory performance. In their study, Klein et al (1988) presented participants with a list of 30 words either related or unrelated to each other. During encoding, participants performed one of three tasks: 1) think of a definition of each word (elaboration); 2) place each word under one of 5 corresponding categories (organisation) or; 3) indicate whether each word brought to mind a personal memory (self referential). Participants were then instructed to remember as many words as possible. The recall was higher for the related than unrelated list of words. For the unrelated list, the self-condition led to higher memory compared to the word definition task (elaboration) but not compared to the category sorting (organisation). This result highlights the organisational properties of the self in that the memory performance determined by encoding material in relation to the self did not differ from the performance determined by encoding information on the basis of organisational strategies. For the related list, the self-condition led to higher memory compared to category sorting (organisation) while it did not differ from definition encoding (elaboration) highlighting the elaboration properties of the self-concept.

6.1.1. Ageing and the self-referential effect

As discussed in Chapter 3, the ability to make self related judgements relies on semantic processes without the need to retrieve episodic past memories (Klein et al., 1989; 1992ab; 1993a;b; Schell et al., 1996) and older adults have been found to perform as well as younger adults when judging self attributes (Ruby et al., 2009). Neuroimaging investigations in younger individuals have shown that self-judgements engage the VMPFC (Kelley et al., 2002; Macrae et al., 2004; Schmitz et al., 2004; Ochsner et al., 2005; Heatherton et al., 2006; Moran et al., 2006). Some fMRI studies have shown similar VMPFC activation in younger and older adults when processing self-related information. Gutchess, Kensinger and Schacter (2007b) measured fMRI brain activity in younger and older individuals who were instructed to encode a series of words in relation to the self, another person (Albert Einstein) or to provide structural judgements (e.g. whether the word was presented in upper case letters). The results showed that both age groups similarly activated the VMPFC as well as the anterior cingulate cortex

(ACC) and the temporal areas when making self-judgements. Investigation of brain activity in relation to the valence of the words (positive/negative) showed that older adults activated the MPFC (BA 10) and DLPFC (BA 46) for the positive words to a greater extent than younger participants, suggesting they put greater effort into processing positive information. More recently, Gutchess et al. (2010) investigated brain activation using fMRI during encoding in relation to subsequent memory performance (remember versus forgotten items). Their results showed that the MPFC activation in younger participants was correlated with a subsequent forgetting effect for self-related items (i.e. it was more engaged during self encoding for items that were then forgotten). The MPFC was also more engaged for subsequent memory of trait words associated to others. The opposite pattern occurred for older adults who showed better memory performance for the self and reduced memory performance for others associated with activation of the MPFC. The differential effect of the MPFC involvement for encoding of the self and others was particularly pronounced in the older than younger group. This result has been explained in relation to different strategies employed by younger and older individuals at encoding (Gutchess et al., 2010). Older adults may have encoded words on the basis of traits that they possess and share with others, leading to better memory for the self. In contrast, younger individuals may have thought of the self in term of unique traits that they possess and, therefore, younger participants may encode the words on the basis of how they differ with others, leading to a better memory for other encoded traits. These findings support the view that younger and older participants rely on different strategies to process self-related knowledge. However, the accuracy in making self-judgements and the memory advantage for referring to the self at encoding, emerged in both age groups (Guthcess et al., 2007a; Glisky et al., 2009; Ruby et al., 2009).

As the ability to make explicit self-judgements does not seem to decrease with age (Ruby et al., 2009) and the VMPFC, which plays a role in self judgements, is thought to deteriorate more slowly with age than other frontal regions (Haug et al., 1991), it has been proposed that encoding information in relation to the self would enhance memory performance in older adults compared to semantic and shallow encoding strategies regardless of age. A series of studies indeed found that the SRE occurs in older adults (Mueller et al., 1986; Gutchess et al., 2007a; Glisky et al., 2009). Mueller et al. (1986) investigated the SRE on a free recall task and found that older adults showed enhanced memory for self-related information, although their memory was still below that of the younger participants' performance. Other studies have employed a recognition memory task, which is considered less demanding than free recall (Craik & McDowd, 1987). Gutchess et al. (2007a) instructed their participants to make descriptive judgements about a series of traits in relation to the self, another person (Albert Einstein or a friend/relative) or structural judgements (e.g. whether the word was displayed in uppercase letters or not). The encoding phase was followed by a recognition task. The results showed that, although younger adults recognised more words across all three conditions, the benefit of self-processing emerged in both groups, suggesting that encoding information in relation to the self enhances memory performance in both younger and older adults. Yet, the younger participants overall retrieved more words than older adults.

A recent study, however, claimed that, despite the reduced memory performance of older adults, the specific advantage provided by the self would not decrease with age (Glisky et al., 2009). The researcher investigated the SRE and semantic encoding in a recognition task administered to three groups of participants: younger (age range = 18-27), younger-older (age range: 66-75) and older-older (age range = 76-91) adults. Participants were presented with a series of trait adjectives and instructed to indicate whether each trait was descriptive of the self (self encoding), if the dictionary definition of the trait was positive (semantic encoding) or if it was displayed in uppercase letters (baseline structural encoding). The results of a subsequent recognition task showed that encoding the word in relation to the self led to higher recognition compared to semantic processing, which in turn led to higher memory performance compared to the structural condition in all age groups. The younger-older group did not significantly differ from the younger group in terms of memory performance and both groups recognised more words encoded in relation to the self and the semantic condition compared to the older-older group. No difference emerged across the age groups for the baseline condition. These results indicate that the benefit of self-encoding during the semantic condition is constant across age. That is, the SRE effect also exists in older individuals.

6.1.2. The implicit self referential effect

The studies described above investigated the SRE in relation to explicit encoding conditions, where participants were instructed to encode a series of traits in relation to the self or another person. However, the explicit judgements may relate to the social desirability of the traits, so that people may assume they possess a trait because is desirable. In line with this view, it has been shown that no difference emerges in terms of the SRE for self-irrelevant desirable and self-related traits (Ferguson et al. 1983; Symons & Johnson, 1997). Investigation of the implicit SRE relies on the assumptions that self-related information is automatically processed without requiring conscious awareness, reducing the occurrence of desirability-based judgements. Investigations of the implicit processing of self-concept typically present participants with self-related information irrelevant to the task performance. For example, Geller and Shaver (1976) used a version of the Stroop task where participants were presented with evaluative self-relevant (e.g. proud) and irrelevant (e.g. survey) stimuli and instructed to name the colour of ink used to write the word. The participants took longer to name the colour when they were shown self-related words indicating that greater effort was required in order to ignore the word and attend to the task relevant stimulus (the colour). In a different study, Bargh (1982) showed that self-related information is automatically processed and hard to ignore. Authors selected participants on the basis of their self-view in relation to the dependence/independence personality construct. In the task, a different word was delivered to each ear simultaneously (one noun and one adjective) and participants were instructed to attend to only one of the stimuli presented to one ear (either the noun or adjective) and ignore the other one presented to the other ear. Half of the adjectives presented were related to the concept of independence. The participants' task was to repeat out loud the word they had to attend to. The results showed that when participants attended to the adjectives, individuals with an independent self-view were faster in responding to descriptive adjectives than dependent participants. However, when they were instructed to ignore the adjective and attend to the nouns, the independent participants took longer to respond, suggesting that the self-relevant information is more difficult to ignore. Implicit processing of self-related information has also been reported for visual material. For example, Bredart, Delchambre and Laureys (2006) found that one's own face is more difficult to ignore than the face of a friend. Participants were instructed to find a proper name (their own or their classmates) between two letter strings, accompanied by the photograph of a face (self or friend). The results showed that presentation of a participant's own face during a search for a classmate's name produced more interference and longer RTs than the presentation of another's face during a search for one's own name, suggesting that self-related information is difficult to ignore.

Support for the claim that information about the self is automatically processed comes from ERP and neuroimaging studies. For example, Gray, Ambady, Lowenthal and Deldin (2004) presented participants with a series of words printed in black or red ink and instructed them to only pay attention to the red words. The task was to report whether any stimuli appeared in red. Participants were first shown a noun indicating a category (e.g. hometown) followed by the presentation of six different names of different locations (Grand Rapids, Long Beach…). The stimuli lists consisted of a target word (red ink), non-relevant words (black ink) and a non-relevant self-related word (the participant's hometown name). The results showed that the ERP amplitude elicited by self-relevant information was much larger than that elicited by a control task and did not differ from those elicited by the task-relevant information (words presented in red ink), suggesting that the self receives special access to attention even when irrelevant.

Neuroimaging investigations have shown that the beneficial effect of implicitly encoding information in relation to the self might emerge because the explicit and implicit processing of the self relies on common brain areas. Two recent fMRI studies (Moran, et al., 2009; Rameson et al., 2010) investigated brain activation in relation to the implicit SRE and found activation of the same brain areas previously reported when making explicit self-related judgements (Kelley et al., 2002). Moran et al. (2009) employed a task similar to the one used in the previous ERP study of Gray et al. (2004) and found greater MPFC activation in relation to the self related words compared to the neutral and the oddball conditions, suggesting that the MPFC orients attention to personally important information even when it is task irrelevant. More recently, Rameson et al., (2010) recruited participants that that possess a schematic self-view related to either athletics or science. In the implicit task, participants were presented with images related to athletics and science and instructed to indicate whether or not there was a person in the image. They compared brain activation during the implicit task with activation during an explicit task where participants were presented with a series of words related to athletics and science and were instructed to indicate whether each word was descriptive of the self. The results showed that both tasks activated a similar brain network, which included the VMPFC (BA 10, 11), the amygdala, the ventral striatum and the ACC in response to self-relevant information. These results suggest that the VMPFC might be modulated by the self-relevance of the material employed during the performance of both implicit and explicit tasks.

Only a small number of studies have investigated the effect of implicit encoding on a subsequent memory test and showed that the SRE emerged even when participants were not explicitly instructed to encode the information in relation to the self or another person (Cloutier et al., 2008; Cunningham et al., 2008; Turk, Cunningham & Macrae, 2008; Van den Bos, Cunningham, Conway & Turk, 2010). Turk et al. (2008) investigated whether implicit self-encoding of one's own face or name would yield better memory than another person's face/name processing. In their task, participants were presented with a photo or their own proper name or that of a famous person and a trait adjective either above or below the name/photo. Participants were presented with their own photo or proper name or that of a famous person. A trait adjective was then presented above or below the name/photo. Participants were tested under the explicit condition where they were required to judge whether word described the person it was presented with, and the incidental condition where they had to indicate whether the word appeared above/below the name/photo. The results of a subsequent recognition task showed that, although the magnitude of the effect was larger in the explicit rather than implicit task, both conditions produced enhanced memory for items paired with the self rather than the other person, indicating that the SRE exists even when individuals are not engaged in an explicit self-evaluative task.

The studies discussed show that the SRE is a robust phenomenon that emerges during both explicit and implicit encoding conditions. Furthermore, both conditions involve activation of the VMPFC brain areas. However, it remains unclear whether the SRE exists in healthy older adults when implicit encoding is involved. The aim of the following experiments is to investigate the performance of younger and older participants on tasks that require the implicit processing of self-related information. The memory advantage provided by referring to the self appears not to decrease with age when performing tasks that require participants to explicitly relate information to the self (Gutchess et al., 2007a; Glisky et al., 2009). Furthermore, activation of the VMPFC was found when making both explicit and implicit judgements (Moran et al., 2009; Rameson et al., 2010). On the basis of these results, older adults are expected to show an advantage for self-related information similar to the advantage reported in younger participants when performing two tasks that require a less explicit reference to the self at encoding.

6.2. Personality, memory and the self.

6.2.1. Introduction.

Some research suggests that actions are used to distinguish between the self and others (Hornstein & Mulligan, 2001; Knoblich et al., 2001; Ruby & Decety, 2001; Cloutier et al., 2008; Manzi & Nigro, 2008). In line with this view, it has been shown that self-generated actions are better recognised than other peoples' actions. For example, Knoblich and Prinz (2001) instructed their participants to draw a series of characters. In a subsequent recognition task, they were shown the movements of a dot on a monitor that reproduced their own or another person's movements while drawing the characters. Participants were instructed to indicate whether the movement was originally performed by themselves or by another person. The results showed that participants recognised their own hand movements compared to the other person's movements significantly above chance.

Performed actions have been found to be better recognised than studied actions (Knopf & Neidhart, 1989), imagined actions (McDaniel Lyle, Butler & Dornburg, 2008) and observed actions (Hornstein et al., 2001; Manzi et al., 2008). For example, Knopf et al. (1989) instructed their participants to perform a series of actions or provided them with a description of the action. The results of a subsequent recall task showed higher memory for the performed action than the verbal learning of the same action. Self-performed actions are also better remembered than actions performed by other individuals (Hornstein et al., 2001; Manzi et al., 2008). Manzi et al. (2008) presented to pairs of participants sentences describing actions. The experimenter placed an object in the centre of a table and participants performed the described action. The subsequent recognition test presented the same sentences and new sentences and participants were instructed to indicate whether they encountered each sentence in the previous session or if it was new. The results showed that the self performed actions were better recognised than actions performed by the others.

Cloutier et al. (2008) investigated whether self-generated actions may determine higher memory for the outcome of the action performed. Two participants performed a task in pairs (i.e. self and other). Participants were instructed to alternatively choose a slip of paper with a number on it and to pass it to the experimenter. The experimenter then read aloud a word (a trait adjective) associated with the number printed on the paper. In one condition, participants actively chose the slip of paper from a bowl placed between the participants. In another condition, the slips were pre-assigned and placed in front of each participant meaning that participants did not choose the slips, but rather simply passed them to the experimenter. After the initial phase, participants performed either a free recall task (where they tried to remember as many words as possible presented during the encoding phase) or a recognition task (where they were presented with old or new words not presented during the previous phase and had to indicate whether each word was old or new). The results showed the classic SRE only when they actively chose the slip of paper. The authors claimed that the involvement of the self, expressed by the volitional choice of the slips, would determine a strong relationship between the action and the outcome leading to higher memory performance for self-related material. In a second experiment (Cloutier et al., 2008), participants were again instructed to choose a slip of paper from a bowl and the word was spoken aloud by the experimenter. This time for the recognition task, the words were presented on a screen with traits previously chosen by the self, traits chosen by the other person and also new traits. Participants were instructed to indicate whether the trait presented was favourable or unfavourable. The results showed that participants were faster in making evaluative judgements about the self-chosen traits suggesting enhanced accessibility to information related to the self.

Neuroimaging evidence indicates that performing an action relies on activation of the MPFC, which does not emerge when watching an action being performed by another person. In a fMRI investigation, David, Bevernick, Cohen, Newen, Lux, Fink et al. (2006) manipulated both the perspective (1st vs. 3rd person) and the agency (performing vs. watching an action) and showed that taking a first person perspective activates the MPFC, cingulate cortex and temporal areas to a greater extent than taking a third person perspective. In their task, participant played a computerised ball-tossing game with two virtual characters. In the active condition, they were asked to throw a ball to one of the characters by a button press. In the passive condition, they observed one of the characters throwing the ball to the other character. The fMRI results showed that being the agent of the action was associated to MPFC activity, which has frequently been reported to be involved in processing self-related information (Kelley et al., 2002; Macrae et al., 2004; Schmitz et al., 2004; Heatherton et al., 2006). Watching other's actions instead related to activation of the temporal, parietal and occipital areas. The inferior parietal area is thought to be crucial in distinguishing between self and others' actions (Jeannerod, 2004), especially when taking a third perspective (Ruby et al., 2001; Vogeley, May, Ritzl, Falkai, Zilles & Fink, 2004).

As activation of the MPFC emerged when participants are instructed to make self-descriptive judgements (Chapter 2), the discussed studies suggest that a common network may underlie the processing of any type of self-related information. In order to investigate this possibility in an fMRI study, Powell, Macrae, Cloutier, Metcalfe and Mitchell (2009) investigated whether different aspects of the self (conceptual self and action self representations) rely on different neural networks. In their study, participants were instructed to perform a conceptual and an agentic task. The conceptual task required participants to make trait judgements in relation to the self and the president (George Bush). The agentic task was based on the choice-task devised by Cloutier et al. (2008). Participants were presented with a series of cards on a computer screen. At the beginning of each trial they were presented with a prompt and were instructed to select a card on the screen ("you" prompt) or to passively watch the computer selecting a card ("computer prompt). After each card selection, a word (trait/noun) appeared on the screen. Participants were then administered a recognition memory test. Both the conceptual and the agentic task led to higher memory for self related items compared to other related items. The fMRI results showed that the conceptual tasks activated the VMPFC to a greater extent for the self than others. In contrast, in the agentic task, the inferior parietal sulcus (IPS) distinguished between the self and others, suggesting that the conceptual and the agentic self rely on a different brain networks. However, the task employed in this paradigm did not include a condition where another person would perform the action and it has been shown that individuals interact differently with computers and humans and that the MPFC is specifically involved when participants interact with a human partner (McCabe, Houser, Ryan, Smith & Trouard, 2001; Gallagher, Jack, Roepstorff & Frith, 2002), suggesting that the structure of the task employed by Powell et al. (2009) relies on a reduced MPFC involvement.

Ageing studies have shown that older adults are impaired on tests assessing memory for actions compared to younger individuals. Kersten, Earles, Curtayne and Lane (2008) presented their participants with a series of video clips reproducing simple actions (e.g. peeling a banana) performed by different actors and found that older participants performed more poorly than younger adults on a subsequent recognition task. Some evidence indicates that older participants are impaired in remembering the source of action. For example, McDaniel et al. (2008) instructed participants to perform a series of actions (perform only), to imagine different actions (imagine only) or to both imagine and perform the action. The recognition task required participants to indicate whether the action was performed, imagined or both. Younger and older participants did not show any difference in recognising performed actions. However, older adults were more likely than younger participants to misattribute an action as both performed and imagined than imagined only. The authors claimed that the greater confusion between imagined and imagined + performed actions may be that in older adults the sensory details associated with performing an action would be similar to those associated with imagining the action, while in younger adults sensory details would more reliably distinguish between performed and imagined actions. Similarly, Hashtroudi et al. (1990) found that memory reports of older adults are characterised by recalling thoughts and feeling while younger individuals rely more on perceptual details (e.g. visual details), suggesting that older adults may rely more on retrieval of general thoughts and feelings than on details associated to an event. More recently, Rosa and Gutchess (2011) investigated the source memory for actions in younger and older adults in a more naturalistic setting where participants worked together in groups of three. Within each group, two participants knew each other (close friend/relative) and one was unknown to both the other two. Each participant completed 16 actions and observed 16 actions performed by the other two participants. The actions belonged to two different scenarios, packing a picnic basket and a suitcase. Participants worked together and in turns placed different objects in the basket/suitcases. During the subsequent memory test, they were instructed to indicate who placed each item in the basket/suitcase or if the item was new. The results showed that younger adults recognised more actions than older participants. However, both groups recognised more self-performed actions than other-performed actions. The authors interpreted the results in relation to the greater availability of sensorimotor information for the self-performed than observed actions and participants may have encoded the actions as self and not-self performed.

The above studies indicate that, although older individuals show intact memory for actions performed by the self (McDaniel et al., 2008; Rosa et al., 2011), they showed memory impairments for actions performed by others (Kersten et al., 2008), for sensory details (Hashtroudi et al, 1990) and use sensory motor information less efficiently than younger adults to determinate the source of an action (McDaniel et al., 2008). Furthermore, the parietal areas, known to deteriorate with age (Resnick et al., 2003) are involved in tasks based on self-generated actions (i.e. make a choice; Powell et al., 2009) and discriminate between self and others' perspective (Ruby et al., 2001; Jeannerod, 2004). It has also been claimed that older adults engage a self-referential strategy in a less flexible manner than younger individuals when the task does not require them to make explicit self-referential judgements. For example, earlier investigation showed that making desirability judgements enhanced memory performance of young participants as much as self related judgements in that making desirability judgements relies on the ability to spontaneously refer to self (e.g. Do I think "rude" is a desirable trait? Would I like to display such a trait?; Ferguson et al., 1983; Gutchess et al., 2007a). In contrast to these results, Gucthess et al. (2007a) showed that younger adults benefited more than older participants in making self and desirable judgements relative to case judgements. Authors concluded that younger adults adopted a self-referencing strategy when making non-self judgements more than older participants, suggesting that older participants might use a self-based strategy less flexibly than younger adults. Specifically, Gutchess et al. (2007a) claimed that older participants did not spontaneously refer to the self when processing traits on the basis of their desirability. However, participants were instructed to make desirability judgements on the basis of their personal experience, therefore it is not clear whether the SRE would emerge in older participants for implicitly presented stimuli.

All this evidence would suggest that during an implicit task based on self-generated action, older participants may not benefit as much as younger adults of self-related material as they are not explicitly asked to relate information to the self which may reduced the use of a self-referencing strategy (Gutchess et al., 2007a, experiment 3) and because of reduced processing of sensory details. Yet, a recent ageing investigation employed an action-based paradigm where participants were instructed to prepare a picnic basket or a suitcase. The task did not require participants to make any explicit judgements. However, in contrast to the task employed by Powell et al. (2009), participants interacted with two human partners. The results showed that older adults recognised more self-performed action than actions performed by other human partner (Rosa et al., 2011). It may be that including a human partner would involve the MPFC to a greater extent than when participants interact with a computer leading individuals to encode information as me/not me and determining higher memory for the self related information. However, none of the previous studies have investigated the implicit encoding of trait adjectives on the basis of self-generated action in older individuals.

In the following task, younger and older adults will be assessed on a task involving action-based encoding of the self and other related traits, which are based on the task developed by Cloutier (2008). The structure of the task does not require explicit self-judgement, which is similar to the previous studies (Cloutier, 2008; Rosa et al., 2011). Also, similarly to previous ageing SRE studies and in contrast to the task employed by Powell et al. (2009), another person will be included in the task (Gutchess et al., 2007a; Glisky et al., 2009; Rosa et al., 2011). Older participants are expected to show higher memory for self encoded traits as the inclusion of another person in the task may facilitate the spontaneous processing of the items as self related which processing is known to rely on the VMPFC function (Kelley et al. 2002).

6.2.2. Experiment 7: Personality, memory and the self

6.2.2.1. Methods

6.2.2.1.1. Participants

A different group of thirty younger and thirty older adults took part in this study. The Wechsler Abbreviated Scale of Intelligence (WASI: Wechsler, 1999) was used as a measure of the level of general intelligence. Signed consent forms were obtained from all participants. The study was approved by the Philosophy, Psychology and Language Sciences Research Ethics Committee at the University of Edinburgh. Participants performed the vocabulary and the reasoning subscales and the IQ score was obtained by the sum of the scores of the two subscales. The two groups did not significantly differ in their IQ [t (58) = -1.19, p = .23, d = .30] or their level of education [t (58) = 1.54, p = .12, d = .39]. Table 6.1 provides the demographic characteristics and performance on the background measures of the two groups. Other neuropsychological background measures included the phonemic verbal fluency task (Spreen & Strauss, 1998) and the Digit Symbol subtest of the Wechsler Adult Intelligence Scale-III (WAIS-III, Wechsler, 1997). In the verbal fluency task, participants were asked to generate as many words as possible beginning with a specific letter (F, A and S). One minute was allowed for each letter. The results showed that the older group produced significantly more words than the younger group [t (58) = - 2. 01, p = .04, d = .51]. The two groups were also asked to perform the Digit Symbol (DS) subscale of the Wechsler Adult Intelligence Scale- III (WAIS-III, Wechsler, 1997). The test consisted of four conditions: a coding phase as a measure of processing speed, an incidental learning phase (with two tasks: pairing and free recall) as measures of the ability to learn under conditions where participants were not explicitly asked to study the provided information, and a copy phase as a measure of motor abilities. During the coding condition, participants were presented with a record form. At the top of the page, two lines of nine squares each were printed. The bottom line contained symbols and the upper line contained numbers so that each number was matched with a specific symbol. Under the coding pattern, there were 133 squares each with a number printed in the upper section while the bottom section was left blank. The participant's task was to fill in as many boxes as possible in 2 minutes with the matching symbol printed at the top of the page. Each correctly drawn symbol within the 2 minutes was given 1 point (maximum score = 133). The task instructions require 4 rows to be completed in order to administer the learning subtask. Therefore, if participants had not filled in at least 4 rows within the time limit, they were allowed to continue until they completed 4 rows. The number of correct items was still given by the correct symbols copied within the 2 minutes. Immediately following the coding task, participants were administered the incidental learning tasks. The pairing task consisted of two rows of numbers without the symbols. Participants were instructed to remember as many symbols as possible and to fill in the empty section with the matching numbers. Each correct match was scored one point (maximum score = 18). After the pairing subtask, participants performed a free recall task where they were instructed to remember as many symbols as possible in any order and draw them on a blank sheet. Each correct symbol was scored 1 point (maximum score = 9). Finally they were administered the copy condition that consisted of a record sheet similar to the one presented during the coding phase. However, this time each box in the upper section contained the same symbols that were previously coded while the bottom section was blank. Participants were instructed to copy as many symbols as possible in 90 seconds. Each correct symbol was scored 1 point (maximum score = 133). The results showed that the two groups significantly differed in both the coding [t (58) = 6.35, p = .000, d = 1.64] and the copying conditions [t (57) = 5.23, p = .000, d = 1.35], with younger adults coding and copying more items than older adults. Analysis of the two memory measures showed that younger adults also performed significantly better than older adults on the paired memory measure [t (58) = 2.19, p = .03, d = .57] but no difference emerged on the free recall measure [t (58) = .396, p = .69, d = .10].

Table 6.1. Demographic data and background neuropsychological performance of the younger and older groups.

	Younger *(M: 8; F: 22)* *Mean (SD)*	Older *(M: 9; F: 21)* *Mean (SD)*
Age	20.43 (2.1)	69.73 (6.3)
Years of Full-Time Education	14.93 (1.7)	14.10 (2.3)
WASI Full Scale IQ	114.7 (4.3)	116.2 (5.5)
VF (F, A, S)	42.83 (10.9)	48.70 (11.6)
DS coding (maximum score = 133)	90.23 (14.1)	67.80 (13.1)
DS copying (maximum score = 133)	126.73(11.2)	107.10 (16.9)
DS paired memory (maximum score = 18	15.17 (3.1)	13.30 (3.4)
DS free recall (maximum score = 9)	7.90 (.88)	7.80 (1.0)

WASI = Wechsler Abbreviated Scale of Intelligence; VF = Verbal Fluency; DS = Digit Symbol

6.2.2.1.2. Materials

The task material consisted of 120 trait adjectives taken from a pool of personality trait adjectives (Anderson, 1968). Half of the words were positive and half negative. The words were divided into 3 lists of 40 traits each. Each list was randomly assigned across participants to one of the following conditions: self, other and foils. The self and other lists were used during the learning task, while the foil list was used during the memory test. Three counterbalanced orders allowed the adjectives to be assigned to each condition across participants.

6.2.2.1.3. Procedure

The experiment consisted of two parts: a learning phase followed by a recognition memory test. During the learning phase, participants were told that they were about to perform the task with another person (i.e. the experimenter). Participants were randomly assigned to the role of player 1 or player 2. The cover story was the same one used by Cloutier et al. (2008): participants were told that the study investigated the duration of a procedure to be used in the future with children. The two players sat side by side. There was no verbal interaction between the two players during the game. Participants were presented with 8 red cards on a computer. After 1000 ms, a sentence appeared at the top of the screen indicating which player had to make a choice (player 1 or player 2). The card choice was made by pressing the corresponding button on the keyboard, where 8 red labels had been previously placed so that they matched the position of the cards on the screen (Figure 6.1). After a card was selected, a word appeared on the screen for three seconds then the 8 red cards were presented again with a sentence indicating which player had to make the next choice. The card selection did not influence the valence of the subsequent word. At the end of the learning phase, participants performed one of the background measures (verbal fluency or digit symbol coding). After 5 minutes, they were given a surprise recognition task where they were presented with 120 trait words: 80 words previously used during the learning phase and 40 new trait words. Words were presented one at a time in the middle of a computer screen. For each word they were asked to indicate whether the word was old (i.e. they had seen it before), or new (i.e. they had not seen it in the previous card game).

Participants responded by pressing the corresponding button on the keyboard; the trait remained on the screen until participants responded. If they responded that they had seen the word in the previous session, they were also asked to indicate how confident they felt about their decision on a 5 point Likert scale that ranged from 0 (not at all confident) to 4 (extremely confident). The response times (RTs) and the response provided were recorded.

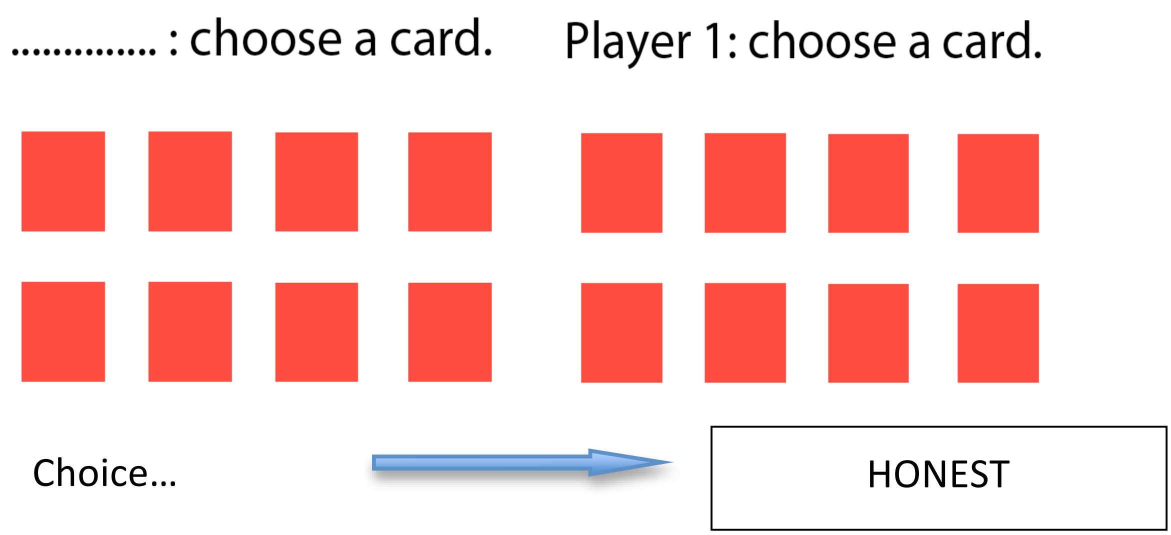

Figure 6.1: Schematic representation of the task.

6.2.2.1.4. Scoring

The proportion of correct responses (hits) was calculated for both words previously associated with the self or other (Gutchess et al., 2007b; Glisky et al., 2009). The proportion of false alarms (FA) was also calculated. Two corrected memory measures, one for the self and one for the other, were computed by subtracting the proportion of FA from the proportion of hits.

6.2.2.1.5. Analysis

Since previous studies have found that the results may be affected by the combination of hits and false alarms (FA), ANOVAs were conducted on the proportion of positive and negative hits and FA (Gutchess et al., 2007b; Glisky et al., 2009). Recognition accuracy was further investigated using the corrected memory scores (hits – FA) for traits with a 2 age groups (as between factors) x 2 conditions (self vs. others, as within factors) x 2 emotional valence (as within factors) mixed model ANOVA. A separate analysis investigated the confidence ratings for hits with a 2 age group (younger vs. older) x 2 condition (self vs. other) x 2 emotional valence (positive vs. negative) mixed model ANOVA. A separate 2 age group x 2 emotional valence mixed model ANOVA was conducted on the FA.

6.2.2.2. Results

6.2.2.2.1. Response Time

A 2 age group (as between factor) x 3 condition (self vs. other vs. new, as within factor) mixed-model ANOVA was conducted on the RTs at recognition. Faster RTs are typically considered a measure of accessibility. Means and standard deviations are shown in Table 6.2. The results showed a significant main effect of group, with younger adults responding faster than older participants [F (1, 58) = 5.93, p = .01, η_p^2 = .093]. The main effect of condition approached significance [F (2, 116) = 2.95, p = .056, η_p^2 = .049], with faster RTs for self-related traits compared to new traits. The group x condition interaction was also significant [*F* (2, 116) = 4.77, *p* = .01, η_p^2 = .076]. A post hoc paired t test showed that younger participants recognised self-related traits faster than new trait [*t* (29) = -3.27, *p* = .003, *d* = .34], while this comparison did not approach significance in older adults [*t* (29) = .298, *p* = .76*, d* = .02]. No difference emerged between recognition of self and other related traits in both younger and older participants [*t* (29) = -1.93, *p* = .06*, d* = .23; *t* (29) = 1.38, *p* = .17*, d* = 05, respectively]. Similarly, no difference emerged between recognition of other related traits and new words in both younger and older group [*t* (29) = -1.37, *p* = .18*, d* = 10; *t* (29) = -.654, *p* = .51*, d* = .04 respectively].

Table 6.2. RTs at recognition for self, other and new words in younger and older group.

	Young	Old
	Mean (RT)	*Mean (RT)*
Self	1607.73 (461.62)	2097.35 (712.92)
Other	1730.31 (568.52)	2056.32 (664.70)
Foil	1787.17 (554.10)	2082.41 (659.81)

6.2.2.2.2. Accuracy

A 2 age group (young vs. old, as between factor) x 2 encoding condition (self vs. other, as within factor) x 2 valence (positive vs. negative, as within factor) mixed-model ANOVA was conducted on the proportion of hits. Means and standard deviations are shown in Table 6.3.

Table 6.3. Means and standard deviations for the proportion of positive and negative hits and FA for the younger and older groups.

	Younger		Older	
	Positive	Negative	Positive	Negative
Self (Hits)	.78 (.13)	.76 (.14)	.71 (.12)	.60 (.16)
Other (Hits)	.69 (.13)	.66 (.14)	.61 (.18)	.55 (.17)
FA	.44 (.15)	.30 (.12)	.45 (.18)	.26 (.15)
Hits-FA (self)	.33 (.15)	.46 (.18)	.25 (.16)	.34 (.17)
Hits -FA (other)	.25 (.15)	.36 (.20)	.15 (.21)	.28 (.18)

The results demonstrated a main effect of encoding condition [F (1,58) = 52.63, p = .000, η_p^2 = .47], with higher hits for the self than other encoded traits. There was also a main effect of valence [F (1, 58) = 14.30, p = .000, η_p^2 = 1.98], with the positive words better recognised than the negative traits. Finally, the main effect of group was significant, with the younger group recognising more previously presented words than older adults [F (1, 58) = 10.43, p = .002, η_p^2 = .152]. The group x valence interaction (Figure 6.1) approached significance [F (1,58) = 3.96, p = .051, η_p^2 = .064]. Post hoc paired samples t-tests showed that younger adults did not significantly differ in the number of positive and negative words correctly recognised [t (29) = 1.26, p = .21, d = .02], while older participants recognised significantly more positive than negative words [t (29) = 4.08, p = .000, d = .56]. No other interaction was significant [condition x group:

F (1,58) = .362, p = .55, η_p^2 = .006; condition x valence: F (1,58) = .414, p = .52, η_p^2 = .007; condition x valence x group: F (1,58) = 2.17, p = .14, η_p^2 = .036].

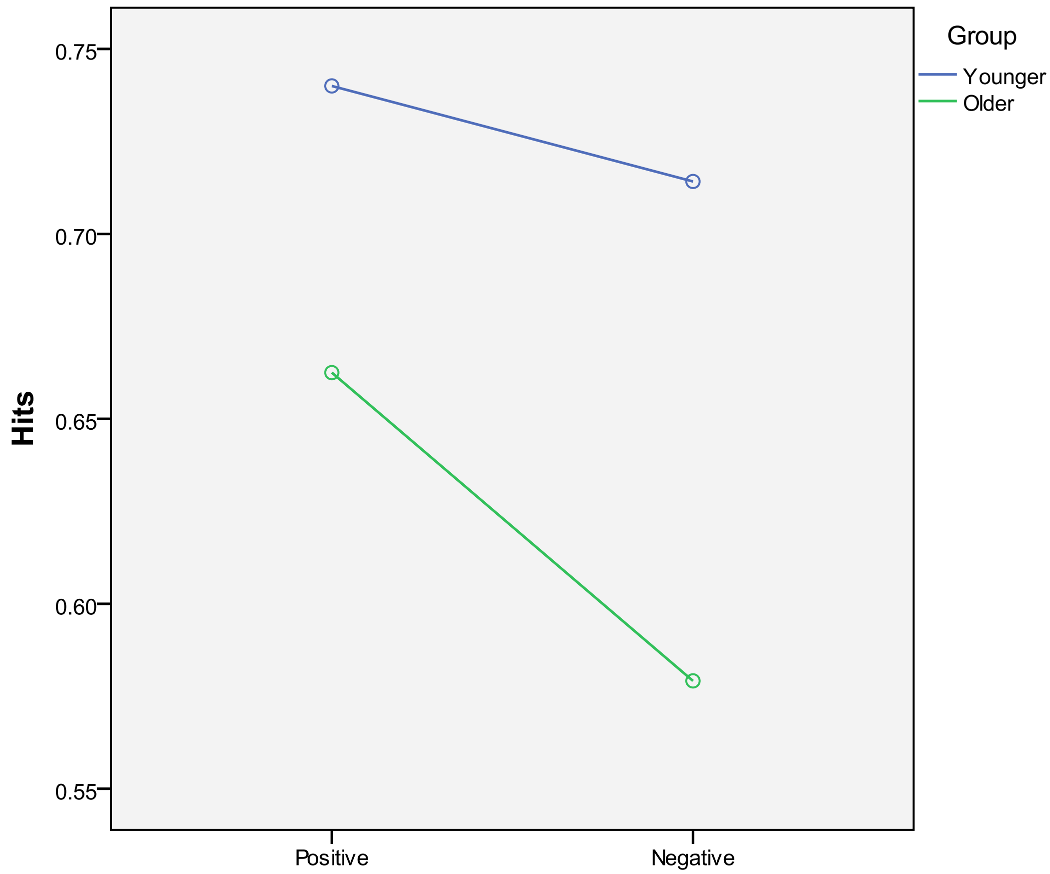

Figure 6.1. Means for the correct recognition of positive and negative traits of the younger and older groups.

Separate analysis was also conducted on the proportion of FA for positive and negative traits. A 2 age group (young vs. old as between factor) x 2 valence (positive vs. negative, as within factor) mixed ANOVA was conducted on the proportions of FA committed. The results showed a significant main effect of valence [F (1,58) = 61.44, p

= .000, η_p^2 = .51], with a higher number of FA committed for positive than negative traits. The main effect of group and the group x valence interaction were not significant [*F* (1,58) = .165, *p* = .68, η_p^2 = .003; *F* (1,58) = 1.30, *p* = .25, η_p^2 = .02]. Then a 2 group (young vs. old) x 2 encoding condition (self vs. other) x 2 valence (positive vs. negative) ANOVA was conducted on the corrected scores (hits – FA). The results showed a significant main effect of encoding condition [*F* (1,58) = 52.63, *p* = .000, η_p^2 = .47] with traits encoded in relation to the self being better recognised than those encoded in relation to the other person. A significant main effect of valence was also found [*F* (1,58) = 22.70, *p* = .000, η_p^2 = .281] with higher recognition of negative than positive traits. The main effect of age group was also significant with younger participants recognising more traits than older adults [*F* (1, 58 = 6.04, *p* = .01, η_p^2 = .09]. None of the interactions were significant [age group x condition: *F* (1,58) = .362, *p* = .55, η_p^2 = .006; valence x group: *F* (1,58) = .039, *p* = .84, η_p^2 = .001; valence x condition: *F* (1,58) = .414, *p* = .52, η_p^2 = .007; age group x valence x condition: *F* (1,58) = 2.17, *p* = .14, η_p^2 = .036].

6.2.2.2.3. Additional analysis

A previous study by Glisky et al. (2009) compared the performance of younger adults with a group of young-old (age range = 66-75 years) and a group of old-old participants (age range = 76-91 years) and found that only the oldest group performed worse compared to the younger participants, whereas no difference emerged between the young and the young-old group. Therefore, an additional analysis was conducted where the older adults were subdivided into a young-old group (*N* = 21, age range = 60 – 74 years) and an old-old group (*N* = 9, age range = 75- 81 years). The three groups did not significantly differ in terms of education [F (2,57) = 2,12, p = .12, f = .25] or IQ [F (2,57) = 1.76, p = .18, f = .22] (means and standard deviations are provided in Table 6.4).

Table 6.4. Demographic data and background neuropsychological performance of the young, young-old and old-old groups.

	Young *(M: 8; F: 22)* *Mean (SD)*	Young -Old *(M: 7; F: 14)* *Mean (SD)*	Old-Old *(M: 2; F: 7)* *Mean (SD)*
Age	20.43 (2.1)	66.62 (4.7)	77 (2.1)
Years of Full-Time Education	14.93 (1.7)	13.76 (2.5)	14.89 (1.9)
WASI Full Scale IQ	114.7 (4.3)	115.38 (5.6)	118.22 (5.0)

A 3 age group (young, young-old and old-old, as between factor) x 2 encoding condition (self vs. other, as within factor) x 2 valence (positive vs. negative, as within factor) mixed-model ANOVA was conducted on the corrected memory scores (hits-FA). The means and standard deviations are reported in Table 6.5. The results showed again a significant main effect of condition [F (1, 57) = 43.29, p = .000, η_p^2 = .432] with more self traits recognised than the other traits. The main effect of valence was also significant [F (1,57) = 14.97, p < .000, η_p^2 = .208] with positive traits better recognised than negative traits. There was also a main effect of group [F (2,57) = 4.44, p = .01, η_p^2 = .135]. Post hoc pairwise comparisons showed that the performance of the young-old group did not differ significantly from the younger or the old-old group. However the old-old group performed significantly more poorly than the younger participants (p < .05). None of the interactions were significant [condition x group : F (2,57) = .642, p = .53, η_p^2 = .02; valence x group: F (2,57) = .289, p = .75, η_p^2 = 010; condition x valence: F (1,57) = 1.63, p = .20, η_p^2 = .028; condition x valence x group: F (2,57) = 1.37, p = .26, η_p^2 = .046].

Table 6.5. Means and standard deviations for the proportion of the positive and negative hits and FA for performance of the three age groups.

	Young-Old		Old-Old	
	Positive	Negative	Positive	Negative
Self (Hits)	.72 (.13)	.63 (.16)	.68 (.10)	.53 (.20)
Other (Hits)	.64 (.29)	.58 (.16)	.53 (.20)	.47 (.17)
FA	.45 (.18)	.25 (.17)	.45 (.21)	.27 (.08)

6.2.2.2.4. Confidence ratings

A 2 age group (young vs. old, as between factor) x 2 encoding condition (self vs. other, as within) x 2 valence (positive vs. negative, as within factor) mixed-model ANOVA was performed on the mean confidence ratings for words correctly recognised as old. The results showed a significant main effect of encoding condition [F (1, 58) = 16.03, p = .000, η_p^2 = .21], with higher confidence ratings for the self than the other hits

(p < .001). A main effect of valence was also found [F (1, 58) = 4.30, p = .04, η_p^2 = .069], with higher confidence ratings for negative than positive traits (p < .05). Finally, the main effect of group was significant [F (1,58) = 9.60, p = .003, η_p^2 = .14] with younger participants reporting higher confidence ratings than older adults. None of the interactions were significant [condition x group: F (1,58) = .547, p = .46, η_p^2 = .009; valence x group: F (1, 58) = .705, p = .40, η_p^2 = .012; condition x valence: F (1,58) = .002, p = .96, η_p^2 = .001; condition x valence x group: F (1,58) = .179, p = .67, η_p^2 = .003]. A separate 2 group (young vs. old) x 2 valence (positive vs. negative) ANOVA was conducted on the confidence ratings for the false alarms committed. The results showed that none of the comparisons were significant [condition: F (1,58) = .057, p = .812, η_p^2 = .001; group: F (1,58) = 1.1, p = .299, η_p^2 = .019; condition x group: F (1,58) = .203, p = .654, η_p^2 = .003]. Table 6.6 showed the means and standard deviations for the confidence ratings.

Table 6.6. Means and standard deviations of the confidence ratings of the positive and negative hits and FA for younger and the older groups.

	Younger		Older	
	Positive	Negative	Positive	Negative
Self (Hits)	3.1 (.41)	3.2 (.47)	2.6 (.75)	2.7 (.83)
Other (Hits)	2.9 (.48)	3.0 (.50)	2.5 (.73)	2.5 (.88)
FA	2.5 (.58)	2.5 (.58)	2.3 (.93)	2.3 (.84)

6.2.3. Discussion

The self-representation that individuals possess may implicitly (without individual's awareness) affect physiological reactions and cognitive performance (Levy et al., 1996; 2000). In the current experiment, memory for implicit self-related information has been investigated in younger and older adults where participants were instructed to choose cards associated with traits adjectives. In contrast to the previous studies, participants were not instructed to make explicit evaluative judgements of the trait. The results showed no significant RT differences in responding to self and other related information in either group. However, younger participants were faster in responding to self compared to new words. These findings suggest that implicitly encoding information does not facilitate access to self-related information in both younger and older participants.

The results of the memory performance are in line with previous ageing studies on the evaluative SRE, which have shown enhanced memory in both younger and older participants for self related information compared to information encoded in relation to another person (Gutchess et al., 2007a; Glisky et al., 2009). Investigation of the corrected memory scores (hits-FA) showed higher recognition for self-items in both groups, although younger individuals showed an overall higher level of recognition than older adults. This result was not qualified by a significant interaction. Thus, the results support an advantage for self-information in both younger and older adults on a task that does not require participants to make explicit evaluative judgements on the trait presented. Moreover, both groups showed higher confidence for self than other related items. In the present study higher levels of confidence are associated with retrieval of more specific memories in relation to the self in contrast to memory related to another person. In line with this view an earlier study (Conway et al., 1995) asked their participants to indicate for each recognised item, whether they remembered having encountered the information before and any contextual details (remember response) or if they simply experienced a sense of familiarity indicating that they knew they had encountered the information before but could not remember any detail related to the encoding phase of the item (know response). Authors found that recognition of self related items was accompanied by the highest number of remember responses and therefore more detailed memories. In contrast, items encoded in relation to another person were accompanied by the highest number of the know response compared to the other two encoding conditions.

A further result showed a main effect of valence, with negative items better recognised than positive traits by both younger and older participants. This effect was accompanied by higher confidence for negative than positive items. This result is in line with Gutchess et al. (2007a) who found a main effect of valence with negative items better recognised than positive items. However, in the Gutchess et al.'s study the main effect of valence was qualified by a significant interaction of valence x condition with better recognition for negative items related to a non-close other person and a case condition and better memory for positive items for self related information. In contrast to Gutchess et al. (2007a) no significant interaction emerged in the present study, suggesting that a positive bias for the self may be reduced when information pertaining to self and others is implicitly encoded. The higher recognition of negative items in the present study was driven by the higher number of FAs committed by both groups for positive than negative words. Glisky et al. (2009) suggested that higher FA for positive information indicated that the positive items were more difficult to discriminate at recognition than negative words, leading participants to commit more FAs for positive items. In their investigation, this effect was stronger in older than younger participants, in that the FAs committed for positive items increased with older age that authors interpreted as older participants attend positive information to a greater extent than younger adults in line with the socioemotional selectivity theory (Carstensen et al., 1999). In contrast, the low number of FAs committed for negative information would indicate that negative items are more discriminable than positive items at recognition. The results led the authors to suggest that positive information was encoded in the form of gist and individuals would recognise the positive valence of an item rather than the specific item itself. In contrast, negative items, for which fewer FAs were committed, would determine a more detailed encoding of the information. In contrast to Glisky et al. (2009), the present study showed that in the case of implicit encoding, younger and older adults did not differ in the number of FAs committed and both showed higher positive FAs, suggesting that younger adults are not better than older adults in discriminating positive hits from positive distracters and both showed a similar level of gist memory for positive items. The higher memory for negative than positive words as emerged in the results of hits-FA would suggest that in both the younger and older groups, negative information is encoded in a more detailed manner than positive items. Glisky et al.

(2009) also showed higher positive hits across all age groups and that the positive bias disappeared when considering the hits-FA results. Authors claimed that the higher hits for positive items was driven by higher attention for positive than negative information which however would not render new and old positive items more discriminable at recognition in the positive bias disappeared when considering the results of hits-FA. In the present study only older adults showed higher hits for positive than negative information while younger participants did not show any difference for positive and negative items, suggesting that older participants attended more positive than negative information compared to younger adults. Similarly to the results of Gutchess et al., (2009) the positive bias disappeared once the results of hits-FA have been considered.

The concept of the self has been thought to represent a form of semantic knowledge, in that it is independent from temporal and contextual information (Conway et al., 1999; Klein et al., 2002). In the present study, further investigation compared the memory performance of younger, younger-older and older-older participants and showed that only the oldest participants performed significantly more poorly on recognition compared to younger participants, whereas no difference emerged between younger and younger-older adults on their memory performance. In line with this finding, Glisky et al. (2009) showed that semantic memory deficits emerged in older adults after the age of 75 years as the memory advantage for self related material reduced in older individuals (age range: 76 – 91 years) while there was no significant difference between younger and older adults.

6.2.4. Conclusion

In conclusion, the results indicate a memory advantage for information encoded in relation to self than another person in a task based on self performed action rather than evaluative judgements. Recognition memory performance was also only impaired in a subgroup of older-older individuals who have been previously reported to show a deficit in semantic memory (Glisky et al., 2009). An intact SRE may have emerged because of involvement of VMPFC areas. Both younger and older adults have been reported to recruit VMPFC when processing self-related information and the VMPFC has been showed to be more resistant to deterioration with age compared to other brain areas such as the DLPFC (Phillips et al., 2002). In contrast, the ability to retrieve detailed information has been shown to be poorer in the older population (Levine et al., 2002; Piolino et al., 2002) and is thought to involve the DLPFC (Gilboa, 2004). It has also been suggested that better memory for self performed actions than others may emerge because of sensorimotor information which is available more for the self than watching another person perform the action (Rosa et al., 2011). The parietal areas have been found to be recruited during action-based tasks that involve the self and others. Powell et al. (2009) showed that in the agentic task the parietal areas rather than the VMPFC were differentially activated for self and others, suggesting that the VMPFC moderates performance on conceptual tasks (e.g. required judgements on trait descriptiveness), while the parietal lobes are involved to a greater extent than MPFC in tasks based on the self and others' actions. In contrast to Powell et al. (2009) participants in the present study interacted with a human partner rather than a computer. Previous studies showed that the MPFC is specifically involved when individuals interact with humans (McCabe et al., 2001; Gallagher et al., 2002), suggesting that the present paradigm might rely on MPFC activity to a greater extent than the paradigm employed by Powell et al. (2009). It must be considered that the nature of the task might also have elicited explicit self and other related judgements (e.g. "I am certainly clever" and "The other person seems kind"). Further investigation may investigate whether the SRE emerge in older adults for both human and computer partners.

6.3. The ownership effect

6.3.1. Introduction

The self-concept can extend to also include one's own possessions, a phenomenon known as self-ownership (Belk, 1988). The notion that possessions can be included in the construction of the self concept is not new and was first introduced by William James (1890, pp.291-292, cited in Belk, 1988):

"A man's Self is the sum total of all that he can call his, not only his body, but his clothes, house, wife and children, his reputation at work, his bank account…".

An early extensive review of the relation between perception and the use/understanding of language (Miller and Johnson-Laird, 1976) suggested that the self can extend to include other objects. The inclusion process depends on the extent to which individuals can exercise some form of control over them that can be expressed as his or her right to use an object, to let others use the object and to transfer the possession of the object to another person (Miller et al., 1976).

The concept of possession has also been shown to help individuals organise studied information that is to be recognised in a subsequent memory test. Radvansky et al. (1997) investigated response latencies for recognition of studied sentences that refer to the action of buying an object. The logic underlying the experiment is that individuals may organise the information on the basis of their physical features (i.e. temporal or spatial). Investigation of the response latencies during a recognition task can help determine how information is organised. When a series of facts share a common concept that belongs to a different situation, a different representation is built for each situation (e.g. the potted palm is in the hotel; the potted palm is in the public library; the potted palm is in the city hall). When the concept (e.g. potted palm) is presented at recognition, all the representations will be activated and, thus, individuals will take longer to recognise the correct model. In contrast, when different facts refer to the same situation (e.g. same location), they will be represented all in one model and retrieval will be easier in that only one model is activated (e.g. the pay phone is in the airport; the wastebasket is in the airport; the ceiling fan is in the airport). Radvansky et al. (1997) showed that information may be organised around the person or buyer. Participants were presented with sentences describing a single person buying multiple objects from the same location (e.g. a pharmacy) and with sentences describing multiple people buying the same object. The results showed faster responses at recognition for single person/multiple objects and the response latencies did not increase as the number of objects increased. In contrast, recognition was slower for multiple people/single objects and increased as the number of people increased, suggesting that the information was organised around a single concept, the buyer.

Self-possession is affected by the same mechanism that affects the self. In line with the tendency to maintain a positive view of the self, people also rate their possessions more positively than non-possessed objects. Beggan (1992) investigated the ownership effect by asking participants to make evaluative judgements about a series of objects. Participants were assigned to one of three possible conditions: (1) in the ownership condition they were given the target object as a gift for taking part in the study and the label for the object was also presented in a subsequent test list; (2) in the control condition, they were not given any gift; and (3) in the mood-control condition they were given an object as a gift, the label for which was not part of the subsequent list. This condition was included to determine whether the subjective rating of the objects might be affected by an enhanced mood following receiving a gift. In all conditions, participants were instructed to rate the attractiveness, value and quality of a series of neutral objects (chocolate, peanut brittle, soap, a key ring, a mini-stapler, plastic combs, an address book, and playing cards). The object they were gifted in the gift condition was also included in the list. Participants in the ownership condition rated the target object as being more attractive than those in the other conditions, whereas no difference emerged between the mood and the control conditions, indicating that simply receiving a gift (as in the mood condition) did not increase an object's ratings. The three groups did not differ in their mood ratings, suggesting that the higher judgement for the target object reported in the ownership condition was not associated with their enhanced mood as a consequence of receiving a gift. Owned objects are also considered more valuable than non-owned objects. Kahneman, Knetsch and Thaler (1991) reviewed a series of market studies where people were given an object and instructed to indicate how much they were willing to accept to give up the object; other individuals were asked to indicate how much they would offer to buy the object. Typically, the object was worth more by those who owned it than those who would buy it, that is, people demanded much more to sell an object they owned compared to how much they would be willing to pay for the same object. This is known as the endowment effect.

The high evaluative judgments for owned objects are due to the fact that people consider their possessions an extension of the self: enhancing the evaluation of their possessions help people to enhance their self-view. For example, Began (1982) reasoned that the need to enhance the self-view would increase after receiving negative information in relation to the self and, as a result, self-enhancement would emerge in a subsequent ownership task. To test this proposition, participants were instructed to perform a perceptual task where they were presented with pairs of items that varied on different dimensions, such as letter (A or T), colour (red or black), letter size (upper or lower case), the frame around the letter (square or triangle) and the underline (dotted or solid). They were instructed to indicate which rule determines what object in the pair was the correct one based on the feedback provided (right or wrong). In fact, there was not actually a correct response and the feedback was predetermined. In the success condition, participants were told that they made mostly correct judgements; in the failure condition they were told that they indicated the wrong item most of time. After the perceptual task, participants performed the ownership task where they were gifted with a target object, a non-target object or were not gifted with any object. Participants were then instructed to rate a series of objects. The results showed that participants who had received negative feedback compared to those that received a positive feedback on the perceptual task, rated the target object as more favourable when owned than when not owned. These results indicate that the enhancement of owned objects helps to maintain a self-positive view after failure.

Investigation of the SRE for owned objects differs from the classic SRE studies on personality traits in that participants are not asked to express explicit judgements in relation to the self or another person. Cunningham et al. (2008) employed a shopping paradigm task in which each participant was provided with a shopping basket (blue or red). The shopping items were presented on a series of cards and each card had a coloured sticker that matched the colour of one of the two baskets. Participants were instructed to sort the items into the corresponding basket according to the colour of the sticker (red or blue). A subsequent recognition memory test showed that self-owned objects were more accurately and faster recognised than other-owned items regardless of who performed the action, indicating that the self-ownership effect also emerges for assigned and not chosen items. The authors suggested that the lack of an action effect depended on the structure of the task in that participants did not perform a self-generated action to make a choice. The result of this study also indicate that the ownership effect emerges not only for objects that are actually gifted (Beggan, 1992) but also when participants know that possession is just temporary and that they will not be given the items placed in their basket. Cunningham et al. (2008) state that the brain areas involved in reward processing may also be involved in the SRE for owned objects. Indeed, studies exist that indicate that reward processing relies on a brain network that includes the VMPFC (O'Doherty, Kringelbach, Rolls, Hornak & Andrews, 2001; Elliot, Newman, Longe & Deakin, 2003). Moreover, neuroimaging investigations indicate that the VMPFC is also involved in processing self-related information (Kelley et al., 2002; Schmitz et al., 2004; Heatherton et al., 2006). Recently, Van den Bos et al. (2010) instructed their participants to perform a computerised version of the shopping task (Cunningham et al., 2008). At recognition, participants were presented with a series of objects that included objects seen during the previous shopping task as well as foils. Participants were instructed to indicate whether they had seen the object before or if it was new. If they responded that the object appeared in the previous game, they were instructed to indicate whether they remembered having seen the objects (remember responses) and could retrieve information related to that particular event (e.g. what they were thinking at that time) or whether they just felt that the object had been presented during the shopping game but could not retrieve any other details (know responses). The results indicated higher memory for objects that belong to the self than objects that belong to another person. Investigation of the awareness associated with correct recognition showed that the correctly recognised self owned objects were given more remember responses than objects owned by others. In contrast, more know responses were given for objects owned by the other person than by the self. These results are in line with previous investigations on trait judgements (Conway et al., 1995) where encoding information in relation to the self determined detailed memory recollection of the event compared to information, which is not self, related.

Studies that investigated memory for self-encoded information in younger and older participants typically showed that the SRE emerged in both age groups, although older participants overall performed more poorly than younger adults (Mueller et al., 1986; Gucthess et al., 2007a; Glisky et al., 2009). In contrast to these studies that have employed verbal materials, the shopping game requires participants to encode visual information in relation to the self and another person. The use of visual material might increase the overall memory performance of older participants. In support of this idea, early investigations showed that the memory performance of visual stimuli is not always impaired in older adults compared to younger participants (Park, Puglisi & Smith, 1986; Royal, Dudley & Morrel, 1988). For example, Chalfonte and Johnson (1996) showed that older participants' performance when using images of objects was intact compared to that of younger adults. These results suggest that memory performance might be enhanced in older participants when visual material is employed.

In the following experiment, younger and older participants will be asked to perform the shopping game in relation to the self and a close other. Previous research has suggested that individuals tend to include close others in their concept of the self (Aron et al., 1991). Early investigations reported that the memory advantage provided by referring to the self reduces when participants are instructed refer to a close other person (Symons and Johnson, 1997). It has been claimed that the concept of self may expand to include representation of a close other (Aron et al., 1991). In their task Aron et al. (1991) instructed their participants to make traits judgement in relation to self, their partner and a TV character. Participants were then presented with the same trait adjectives and instructed for each trait to make a series of like me/not like me choices. The results showed that participants took longer to decide whether a trait was self-descriptive or not and were slower for traits that were different between self and the partner (true/false for partner, false/true for self). Mashek et al. (2003) had participants that first rated a series of trait as descriptive of self, their partner and two strangers. Then they were presented with the same traits and instructed to indicate for each word which person (self, partner, strangers) they had previously rated it for. Individuals made more source memory confusions between self and the partner compared to the two strangers. The inclusion of a close other into the self-representation may affect the task performance of the present investigation, in that participants may not show a memory advantage for objects associated to the self compared to objects encoded in relation to a well known other person. In this situation, the SRE is not expected to emerge.

6.3.2. Experiment 8: the ownership effect

6.3.2.1. Methods

6.3.2.1.1. Participants

The same thirty younger and thirty older participants who performed the personality and memory task completed the shopping game task.

6.3.2.1.2. Materials

The task materials consisted of 150 coloured pictures of objects that can be found in the supermarket. The pictures were taken from supermarkets' website and belonged to 5 different categories (food, clothing, bathroom items, kitchen items and electrical items). The items were divided into 3 lists of 50 pictures, each list matched for 5 item types (e.g. fruit, vegetables). Each list was randomly assigned across participants to one of the following conditions: self, other and distracters. The self and other lists were used during the learning task, while the distracter list was used during the memory test.

6.3.2.1.3. Procedure

The experiment consisted of two parts: a learning phase and a recognition memory test. During the learning phase, participants were told that they were about to perform a shopping task. Participants were instructed to imagine that both themselves and a member of their family had won a basket of shopping items. The shopping baskets were blue or red and the colour of the self-owned basket was counterbalanced across participants. The instructions stated that participants had to imagine that all items in their basket belonged to them and that the items in their relative's basket belonged to their relative. They were presented with one shopping item at a time in the centre of a computer screen. The blue and red shopping baskets were presented at the bottom of the screen with one bottom right and one bottom left. The location of the shopping basket was counterbalanced between participants. Each item was first presented inside a black frame for 1000 ms after which the frame turned either blue or red for 2000ms, indicating the ownership of the item. The participant's task was to move the item into the corresponding basket (blue or red) as fast as possible by pressing the corresponding button on the keyboard. The target remained on the screen for 2000 seconds (Figure 6.3). The response times (RTs) were recorded.

After 5 minutes, participants were given a surprise recognition task: they were presented with 150 pictures: 100 of which were previously used during the learning phase of the task and 50 of which were new pictures. The items were presented one at a time in the middle of the computer screen. For each item, participants were asked to indicate whether it was old (i.e. they had seen it before), or new (i.e. they had never seen it in the shopping task). Participants responded by pressing the corresponding button on the keyboard. The item remained on the screen until they responded. If they responded that they had seen it during the previous session, they were also asked to indicate how confident they felt on a 5 point Likert scale that ranged from 0 = not at all confident to 4 = extremely confident. The (RTs) and the responses provided were recorded.

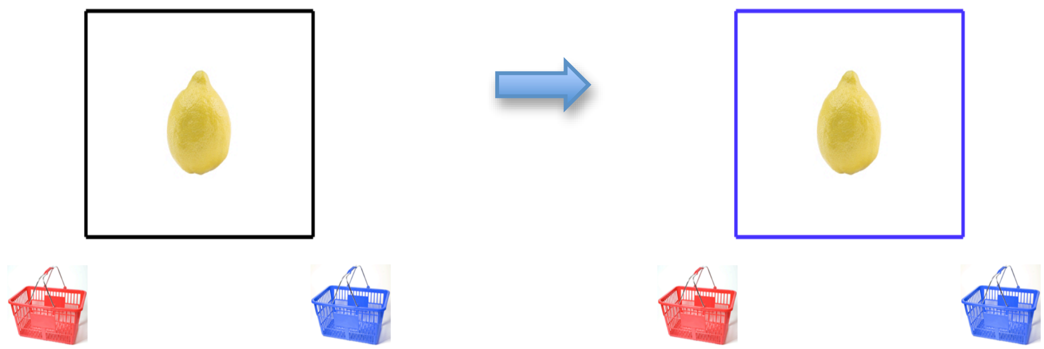

Figure 6.2. Examples of stimuli used in the Shopping Game.

6.3.2.1.4. Scoring

The proportion of correct responses (hits) for objects was calculated for both items previously associated to the self and the other. The proportion of FA was also calculated. Two corrected memory measures, one for the self and one for others, were computed by subtracting the proportion of FA from the proportion of hits.

6.3.2.1.5. Analysis

Recognition accuracy was assessed with a 2 age group (younger vs. older) x 2 encoding condition (self vs. other) mixed-model ANOVA on the corrected memory scores (hits – FA) for self and others. A separate analysis investigated the confidence ratings for positive and negative hits and FA.

6.3.2.2. Results

6.3.2.2.1. Response Times

6.3.2.2.1.1. Encoding

A 2 age group (as between factor) x 2 encoding condition (self vs. other, as within factor) mixed ANOVA was conducted on the RTs to determine whether participants were faster at encoding self-related information. Means and standard deviation are shown in Table. 6.7. The results showed a significant main effect of group, with younger adults responding faster than older participants [F (1,58) = 11.61, p = .001, η_p^2 = .167]. The main effect of condition [F (1,58) = .729, p = .39, η_p^2 = .012] and group x condition interaction [F (1,58) = .006, p = *.92*, η_p^2 = .000] were not significant.

Table 6.7. RTs at encoding for self and other words in younger and older group.

	Younger		Older	
	Mean	*SD*	*Mean*	*SD*
Self	625.6	186.3	835.7	293.9
Other	617.9	174.5	829.2	285.8

6.3.2.2.1.2. Recognition

A 2 age group (as between factor) x 3 condition (self vs. other vs. new, as within factor) mixed ANOVA was conducted on the RTs at recognition. Means and standard deviations are shown in Table 6.8. The results showed a significant main effect of group with younger adults responding faster than older participants [F (1, 58) = 27.36, p = .000, η_p^2 = .32]. The main effect of condition [F (1.47, 85.60) = .027, p = .94, η_p^2 = 001] and group x condition interaction [F (1.47, 85.60) = 2.73, p = .07, η_p^2 = .04] were not significant.

Table 6.8. RTs at recognition for self, other and new words in younger and older group.

	Young	Old
	Mean (RT)	*Mean (RT)*
Self	1189.40 (279.37)	1746.35 (468.63)
Other	1204.85 (266.02)	1715.96 (449.44)
New	1260.39 (294.36)	1668.51 (464.62)

6.3.2.2.2. Accuracy

A 2 age group (young vs. old, as between factor) x 2 encoding condition (self vs. other, as within factor) mixed-model ANOVA was conducted on the corrected scores (hits – FA). The results of the main effect of age group showed a trend for older adults to recognise fewer items [F (1,58) = 3.11, p = .08, η_p^2 = .05]. No other comparisons were significant [condition: F (1,58) = .404, p = .52, η_p^2 = .007; condition x group: F (1,58) = 667, p = .41, η_p^2 = .011]. Table 6.9 shows the means and standard deviations for the proportion of hits and FA.

Table 6.9. Means and standard deviations (SD) for the proportion of hits and FA during the performance of the younger and the older groups.

	Younger	Older
	Mean (SD)	*Mean (SD)*
Self (Hits)	.70 (.15)	.63 (.18)
Others (Hits)	.68 (.14)	.63 (.18)
FA	.18 (.13)	.22 (.23)
Hits - FA (self)	.52 (.20)	.41 (.24)
Hits - FA (Other)	.50 (.20)	.41 (.24)

FA = false alarms

6.3.2.2.3. Additional analysis

A further additional analysis was conducted that included two older groups: a young-old group (age range = 60 – 74 years) and an old-old group (age range = 75- 81 years). A 3 group (young, young-old and old-old) x 2 conditions (self vs. other) was conducted on the corrected memory scores (hits-FA). The analysis showed that the main effect of condition [F (1,57) = 1.1, p = .29, η_p^2 = .019], group [F (2,57) = 1.56, p = .21, η_p^2 = .052] and interaction [F (2,57) = 2.35, p = .10, η_p^2 = .076] was not significant.

6.3.2.2.4. Confidence ratings

A 2 age group (young vs. old, as between factor) x 2 encoding condition (self vs. other, as within factor) mixed-model ANOVA was performed on the confidence ratings for words judged old. The analysis showed a significant main effect of group [F (1,58) = 4.36, p = .003, η_p^2 = 1.40] with younger adults reporting higher confidence ratings than older adults. The main effect of condition and the group x condition interactions were not significant [F (1,58) = .000, p = .99, η_p^2 = .000; F (1,58) = 2.42, p = .12, η_p^2 = .040]. An independent t-test conducted on the confidence ratings for the FA committed showed that the two groups did not differ in their level of confidence reported for the FA committed [t (57) = .141, p = .88*,* d = 04]. Table 6.10 shows the means and standard deviations of the confidence ratings.

Table 6.10. Means and standard deviations (SD) for the confidence ratings for the hits and FA for younger and the older groups.

	Younger	Older
	Mean (SD)	Mean (SD)
Self (Hits)	3.4 (.38)	2.8 (.88)
Others (Hits)	3.4 (.39)	2.9 (.90)
FA	2.4 (.85)	2.4 (1.0)

FA = false alarms

6.3.3. Discussion

In the current experiment, the ownership effect was investigated in younger and older adults. Participants were administered a shopping game where they were presented with a series of objects that were catergorised as belonging to either themselves or a close friend or relative. The results of a subsequent surprise recognition memory task showed no significant difference in the speed they encoded and responded self and other related items. In line with this finding, no difference emerged in the proportion of items correctly recognised, which were related to the self or to a relative/friend.

The lack of statistically significant difference in responding to items associated to self and a close other person support the inclusion of a well known other into the self-representation (Aron et al., 1991). The result is in line with previous investigations that did not report any RT difference in relation to self and a close other (Heatherton et al., 2006).

One potential reason for the failure to find a memory advantage for self related information (SRE) in both age groups compared to the findings of Cunningham et al. (2008) and Van den Bos et al. (2010) may be the fact that this study asked individuals to imagine the other person to be a close friend or relative whereas in the previous Cunningham et al. (2008) and Van den Bos et al. (2010) studies, participants interacted with an non-close other or were instructed to imagined a fictitious other person named John. Previous work has suggested that the concept of the self may extend to include a representation of a close other person (Aron et al., 1991) and encoding information in relation to a close other person may determine a memory advantage similar to the one determined by referring to the self (Miall et al., 1986). The inclusion of a close other into a person's representation of the self has also manifested itself in faster response latencies when individuals are asked to make descriptiveness judgements about a series on personality traits that were common for the self and another person (descriptive/not descriptive of both target persons), (Aron et al., 1991). Furthermore, Mashek et al.

(2003) found greater confusion on a source memory task where participants were instructed to indicate whether a series of traits had been previously rated for the self or non-close other. More recently, Hamami, Serbun and Gutchess (2011) presented younger and older participants with common objects and asked them to indicate whether they themselves, a close other or Albert Einstein would buy them (e.g. "Is this an object you would buy?"; "Is this an object your close other would buy?"; "Is this an object Albert Einstein would buy?"). During the recognition phase two days later, participants were either presented with the same object, an image of the same object but which differed from the image presented at encoding in terms of visual details (e.g. colour, shape, number orientation) or a new object and indicate whether the object was the same, similar or new. The results showed that referring to the self and a close other person at encoding enhanced both general and detailed memory in both younger and older participants compared to the non-close other, although the younger group were overall more accurate than older participants.

The younger and older groups did not significantly differ in their recognition memory performance on the shopping task. Other studies have also reported that older participants show recognition memory performance comparable to that of younger adults. Park et al. (1986) presented younger and older participants with photographs taken from magazines that depicted complex scenes, actions and contained at least one person. The study phase was followed by an immediate recognition memory task and again after 4 weeks delay. The results showed that younger participants recognised more images than older adults after 4 weeks delay. However, no difference emerged between younger and older group in the immediate recognition. Chalfonte et al. (1996) presented younger and older participants with a grid that displayed images of common objects, in different location and displayed with different colours. Half participants were instructed to focus during the study phase either on the items, the colour of the items or their location. The other half instead was instructed to focus on two features of each object: specific items and their colour or the specific items and their location. The results of a subsequent recognition task showed that older participants were impaired compared to younger adults in recognising specific locations and bond information (item-colour and item-location), whereas their memory for specific items and colours was intact. Authors concluded that older participants did not have a general memory deficit and that they might be impaired specifically in binding features rather than remembering specific information.

The present study also found that older participants rated their confidence lower compared to younger adults. Despite the similarity in terms of memory performance for self and others items among the age groups, lower confidence rates might relate to qualitatively different memories (as discussed in Experiment 7 in the current Chapter).

Our sample of older participants recruited for the study were characterised by high intellectual functions, as measured by IQ (mean = 116.2, SD = 5.5). Moreover, in terms of speed of processing, although the older participants performed poorer on the coding subtest, this effect may have been due to reduced motor functions. In contrast, on the free recall subtest of the DS task, the performance of older participants did not differ compared to younger participants, suggesting that they successfully encoded the symbols. Speed processing performance has been suggested to measure the amount of cognitive resources available to an individual and individuals with reduced speed processing abilities showed reduced SRE (Gutchess et al., 2007a). Therefore, our younger and older adults may demonstrate a strong SRE, which incorporates close others due to their high intellectual function and intact speed of processing abilities.

6.3.4. Conclusion

In conclusion, the present experiment the SRE did not emerge in younger nor older individuals. In addition no difference emerged in the memory for objects owned by the self and a close other person, suggesting perhaps that both younger and older participants included the representation of a well known other into the self-concept.

6.3.5. General conclusion of Chapter 6

The results of experiments 7 and 8 indicate that self referential effect (SRE), that is the memory advantage provided by encoding information in relation to the self compared to another person emerged in both younger and older adults during performance of the personality task, in line with previous ageing studies (Gutchess et al., 2007a; Glisky et al., 2009; Rosa et al., 2010). The intact SRE has been shown to involve VMPFC (Kelley et al., 2002; Schmitz et al., 2004; Heatherton et al., 2006), thought to be less affected by aging than other brain areas (Phillips et al., 2002). In contrast no difference emerged between self and other on the shopping game, in line with the view that close others might be included into the self-representation (Aron et al., 2001).

The retrieval of detailed information is typically impaired in older individuals (Levine et al., 2002; Piolino et al., 2002) and relies on DLPFC (Gilboa et al., 2004). In line with this evidence, older participants showed overall poorer memory compared to younger adults on the personality task. In contrast no difference emerged between younger and older participants on the shopping game. Intact memory in older participants might relate to the material employed. Although every effort was made to use matching pictures (e.g. lemon, lime, orange) in the different conditions, some images depicted different items (e.g. tea, coffee, milk). In contrast, the trait words used in the previous choice task experiment were more likely to convey similar meaning (e.g. kind, gentle). Therefore, the use of familiar objects with low levels of similarity may have determined higher memory performance in older adults.

Chapter 7. Confabulation, self and others

7.1. Introduction

In the Self Memory System model, Conway et al. (1996; 2000; 2005) claim that self-knowledge is strongly connected to retrieval of autobiographical memories (AM). In particular, the memories retrieved are evaluated by control processes associated with the frontal areas of the brain. As a result of damage involving the frontal lobes, the self would be disconnected from autobiographical memories. In this case the self-representation and its related goals would not be grounded on the basis of accurate past memories. In support of this claim, Conway et al. (1996) described a confabulating patient, OP, who sustained a brain injury following a road accident. The CT scans showed brain damage that affected the OFC and the temporal areas. The patient's confabulations emerged during spontaneous conversations where she would refer to her confabulations in order to explain and justify the non-supportive behaviours of her relatives towards her after the accident, rendering their indifferent behaviour more acceptable. In the Conway et al. study (1996), these confabulations emerged when patient OP was asked to retrieve specific past episodes. The aim of the current study is to determine whether deficits in processing self-related information emerge on tasks where someone who confabulates is required to make self-descriptive judgements.

As previously discussed, the VMPFC is involved in processing self-related information (Kelley et al., 2002) and it is involved in making inferences about others' mental states (e.g. affective ToM; Stone et al., 1998; Hynes et al., 2006). On the basis of this evidence, it might be expected that brain damage in the VMPFC would produce deficits on self-related tasks as well as on affective ToM tasks.

7.2. Confabulation

The term confabulation refers to the production of erroneous memories that can be entirely false or a distortion of true memories (Gilboa & Moscovitch, 2002). Confabulations can be either spontaneously produced (or fantastic) or provoked in response to direct questioning (Berlyne, 1972; Kopelman, 1987). Confabulations have been reported in Korsakoff's syndrome (Kopelman, Ng & Van Den Brouke, 1997), following the rupture of an aneurysm of the anterior and posterior communicating artery (ACoA and PCoA, respectively), (Stuss, Alexander, Lieberman & Levine, 1978; De Luca, 1993; Dalla Barba, Cappelletti, Signorini & Denes, 1997a; Dalla Barba, Boissé, Bartolomeo & Bachoud-Levi, 1997b), traumatic brain injury (Moscovitch & Melo, 1997), fronto-temporal dementia (FTD, Nedjam, Dalla Barba & Pillon, 2000), Alzheimer's disease (AD, Nedjam et al., 2000), and herpes simplex encephalitis (Moscovitch et al., 1997). Gilboa et al. (2002) reviewed 79 cases of patients with confabulations and showed that confabulating symptoms often emerge following brain damage that involves the VMPFC. Other brain areas reported to be associated with confabulation are the basal forebrain, the DLPFC, the diencephalic and the temporal areas (Gilboa et al., 2002).

Confabulation has been reported in relation to both episodic and semantic memory. Dalla Barba (1993) reported the case of a 75-year-old patient who confabulated in response to autobiographical questions (e.g. what did you eat for dinner yesterday?). Kopelman et al. (1997a) described the case of a patient (AB) that confabulated following infarction in the temporo-parietal areas and with a diagnosis of Korsakoff's syndrome in response to both autobiographical as well as general semantic questions. In the same investigation a patient with bilateral frontal damage confabulated only in response to personal semantic questions. Since frontal damage was not demonstrated in the confabulating patient, the researchers suggested that damage to the frontal areas is not always necessary for confabulation to emerge. Furthermore, the findings indicate that frontal damage is not sufficient to determine confabulation for episodic events.

Confabulation has also been related to executive dysfunctions. Kapur and Coughlan (1980) reported the case of a patient with damage to the medial sector of the left frontal lobe who confabulated both spontaneously and in response to direct questioning. The spontaneous confabulation resolved within a few months, whereas the provoked confabulation remained in response to direct questions about his recent past. The remission of the spontaneous confabulations was accompanied by improvement on classic frontal executive tests (e.g. the WCST and the cognitive estimates test). However, there are patients who confabulate who show no deficits on frontal executive tasks (Dalla Barba, 1993). For example, Delbecq-Derouesné, Deauvois and Shallice (1990) reported the case of a patient who developed confabulation following an aneurysm of the ACoA that affected the frontal pole bilaterally. He was not impaired on most tests of frontal executive dysfunction, such as the Weigl's sorting test, the Tower of London, Trial making Test and the WCST. This is not surprising given that traditional executive tests are thought to be sensitive to dorsolateral prefrontal damage and may not detect impairments due to damage of the medial prefrontal cortex (Cunningham, Pliskin, Cassisi, Tsang & Rao, 1997). Therefore, confabulating patients with damage involving the medial sector of the PFC might be impaired on tasks thought to rely on MPFC functions, while no deficits might emerge for tasks that depend on DLPFC brain areas.

Three main account of confabulation have been proposed:

1: Source monitoring deficits. This explanation refers to impairments in distinguishing between the origin or source of memories (i.e. where and when memories have been coded) and whether these memories were externally (real) or internally (imagined) generated (Johnson et al., 1993). Janowsky, Shimamura and Squirret (1989) investigated source memory in a group of frontal damaged patients and both younger and older healthy controls. During the learning phase participants were presented with a series of facts: the experimenter spoke statements in response to a question to which participants did not know the answer. Participants were instructed to remember the information. At test all participants were asked the same questions. If they remembered the answer they were instructed to indicate the last time they encountered the information. The results showed a similar level of memory for the previously presented facts across all groups. However, frontal patients were significantly impaired compared to both younger and older adults in remembering the source of information. However, it has been suggested that source monitoring is not the only mechanism involved in the production of confabulation. For example, Johnson, O'Connor & Cantor (1997) demonstrated that source monitoring was equally impaired in a patient who confabulated following the aneurysm of the ACoA and in patients with frontal damage who did not confabulate. A male or a female experimenter read aloud a list of 30 items (nouns or sentences). Patients were then presented with a list containing items previously heard and new items. Their task was to indicate which items had been read in the previous session and who read them. The results showed that both the confabulator and non-confabulators were impaired on speaker identification indicating that the confabulator patient was no more impaired than frontal controls on source monitoring tasks.

2: Temporal confusion. This accounts states that confabulations result from confusion of the temporal order of memories (Dalla Barba et al., 1997a). Dalla Barba et al. (1997a) reported the case of a patient, GA, who developed confabulations following rupture of the ACoA. The patient's confabulation concerned acts she used to perform in the past. Similarly, the patient GA (Dalla Barba et al., 1997a) relied on memories of her past habits when she answered question of her past as well as her future. For example, when asked what she did the day before, she responded according to an act she used to perform in the past (e.g. she claimed she went out for shopping). When asked what she would do in a few minutes, she claimed she would prepare a meal for her family.

The temporal order confusion explanation of confabulation relates to Schnider, Von Danike and Gutbrod's (1996) temporal–context confusion (TCC) theory, suggesting that confabulations are due to deficits in inhibiting memory traces irrelevant to the current situation. To assess this, Schnider et al. (1996) devised a continuous recognition task where participants were shown a series of item (e.g. images) one after the other. In the first run, some items were shown repeatedly while others were shown only once; participants had to simply say whether they had seen the item before or not. In successive runs, the same sets of items were employed but different items were selected to be repeated. Participants then had to indicate for each item whether they had seen it previously in the same run, ignoring the fact that they may have already seen it in previous runs. Schnider et al. (1996) and Schnider and Ptak (1999) investigated the performance of spontaneous confabulators, non-confabulators and healthy controls and found that confabulators differed from both non-confabulators and healthy controls in that target items from previous runs were falsely recognised as a repeated item in successive runs. The authors suggested that confabulators fail to suppress old information which is not relevant to the current task which had been relevant in the past but not at present.

3: Strategic Retrieval. Retrieval theories state that confabulations emerge due to retrieval deficits (Gilboa et al., 2002; Moscovitch et al., 1997). Burgess and Shallice (1996) proposed that retrieval difficulties would relate to three different components of the strategic retrieval:

- a descriptor (or search) component, that specifies the type of memory trace required by the task. Impairment that involves this component of the model would lead to the intrusion of generic or repeated experiences not related to any particular context. Burgess and McNeil (1999) reported the case of a patient who showed confabulation following rupture of the ACoA. The patient's confabulation mainly concerned a past routine (e.g. going to perform a stocktaking, as he used to do before the illness).

- a memory editing (or verification) process, which checks that the memories retrieved fit each other. Burgess et al. (1996) reported the comment made by a participant trying to remember an event: "I completed a major sale...No…I did not…because I remember looking at the board and it was blank". Burgess et al. (1996) cited the work of Mercer, Wapner Gardner and Benson (1977). In Mercer et al.'s study, patients with severe or mild confabulation and non-confabulators were asked a series of questions which included personal semantic and orientation questions, questions about recent personal events (e.g. reason for current hospitalisation) and questions that typically elicited "don't know" responses in neurologically healthy individuals (e.g. the winner of the Superbowl last year). The results showed longer response latencies and more frequent self-corrections in the non-confabulator and the mild confabulator patients compared to patients with severe confabulation, suggesting that confabulators did not verify and edit their responses.

- a mediator process, which checks for the plausibility of the memory retrieved. Kapur et al. (1980) showed that the occurrence of spontaneous confabulation relates to impairment of frontal lobe functions. Burgess et al. (1996) claimed that an impairment of the mediator process would lead to fantastic or bizarre confabulations. In line with this view, the fantastic confabulations of the patient described by Kapur et al. (1980)

disappeared in a few months as his performance on the Cognitive Estimates task improved.

According to the strategic account of confabulation, memory impairment would be more evident when the task requires retrieval of a memory in response to non-specific cues. In line with this account, Moscovitch et al. (1997) compared the performance of confabulators, brain damage non-confabulating patients and healthy controls on the Crovitz-cue word test where they were presented with a cue word (e.g. angry) and asked to retrieve a personal memory related to that word. The results showed that both confabulators and non-confabulators produced fewer memories than controls; however confabulators benefited more from prompting than the amnesic group. Prompts not only increased the number of memories retrieved, but also the number of confabulations produced, suggesting poor monitoring of the retrieved memories.

More recently, researchers have proposed a motivational account of confabulation (see Conway et al., 1996; Fotopoulou, Solms & Turnbull, 2004; Fotopoulou, Conway & Solms, 2007a). The motivational account of confabulation aimed to explain the content of the confabulating reports along with monitoring and retrieval impairments According to this account, the false memories constructed by confabulators are driven by their emotional and motivational biases. In line with this view, studies have shown that personal habits and personally significant themes may guide memory retrieval (Burgess et al., 1999; Dalla Barba et al., 1997a). For example, Dalla Barba et al. (1997a) showed that personally relevant past memories affect the content of confabulations. The researchers described a patient with confabulation following rupture of the ACoA. The patient's confabulation related to activities and habits that characterised her life before the pathology (e.g. she claimed she went for shopping the day before and that she would go home and prepare a meal after the testing session). Similarly, Burgess et al. (1999) described the case of a patient whose confabulations regarded a important aspects of his personal past in relation to his job (e.g. he would wake up everyday and dress formally to perform a stock take for a shop). These reports suggest that the content of confabulation might represent wishful distortion of reality.

As previously discussed in the current chapter, Conway et al. (1996) showed that the concept of self plays a role in determining the content of confabulations following brain damage of the OFC. Recent studies have shown that confabulating reports often describe a patient's circumstances as being more pleasant than their actual situation (Conway et al., 1996; Fotopoulou et al., 2004; 2007a; Turnbull Berry & Evans, 2004). Fotopoulou et al. (2004) described a patient (ES) who developed confabulation following the removal of a meningioma in the pituitary and suprasellar region. An MRI investigation showed changes involving the temporal areas associated with the craniotomy, but it was assumed that the patient sustained peri-surgical damage that involved the site of the meningioma (i.e. the basal forebrain). His confabulations were characterised by deficits in the temporal order of events and a lack of perceptual details. He appeared therefore to have deficit in accessing past memories. He also showed deficits in monitoring the outcome of memory, as he did not recognise that the memories retrieved were implausible. The patient, however, could remember some facts related to his professional experience and the goals and feelings associated with those memories, such as his professional success prior to the pathology. Therefore, the impaired retrieval and monitoring was associated with preserved knowledge of wishes and goals that were considered real events, in that they were not constrained by his past autobiographical knowledge. In a further study, Fotopoulou et al (2007a) showed that confabulating patients were more likely than non-confabulators to consider past and imagined events as currently relevant. In a preliminary interview, all patients were instructed to generate self-relevant statements in relation to their past, present and future. For each life period, they were required to produce both pleasant and unpleasant sentences. Another set of statements was created with information collected by the patient's relative. All sentences were then presented to the patients in the first person and in the present tense. Patients were instructed to indicate for each sentence whether it was true or false in their current life. The results showed that the confabulators recognised more false events as currently relevant and produced more errors in response to pleasant than unpleasant statements compared to non-confabulators. These results indicate that both past events as well as events that had never happened can be misattributed to the current situation.

The effect of confabulation on the self-concept has been investigated in two studies. Fotopoulou, Conway, Griffiths, Birchall and Tyrer (2007b) instructed their participants to retrieve self-defining memories (discussed in Chapter 2) to determine whether confabulation would enhance the self-view. They described a confabulating patient who suffered an aneurysm of the ACoA. The patients and 5 healthy controls were asked to describe self-defining events in relation to several past experiences (e.g. a pleasant/sad experience, turning points in their life, an important childhood/adulthood event and recent events, a memory that showed a stable attribute of the self, memories for goals). The responses were scored for their overall emotional valence (positive vs. negative) and for their self-representation valence. The overall emotional valence score indicated the valence of the memories retrieved as being positive or negative. The self-representation valence score included statements that conveyed information about the self (e.g. I always gave my family everything). The results showed that the patient's accurate memories were more negative than the controls' memories, whereas his confabulations were more positive. The number of self-representations mentioned by the patient was also greater than the control group. For example, while controls reported social events (e.g. a relative's wedding), the patient never reported events centred on others; rather he reported events that focused on himself. In his reports, he provided only a few contextual details of the experience itself, and rather focused on the positive view of himself he wanted to convey. His self-description related to his determination in achieving goals, and in his superior intellectual attributes. He did not express positive feelings about other and described the self as the active agent in different situations (e.g. he was the person that loved or hurt others rather then being loved or hurt by others). In short, the positivity bias emerged only in relation to the self. In a further study, Fotopoulou, Conway, Solms, Tyrer and Kopelman (2008) instructed confabulating, non-confabulating amnesic patients and healthy controls to recall positive and negative stories where they were the protagonist (self-referent) or someone else was (other-referent). The results showed that both patient groups performed significantly more poorly than healthy controls. However, the confabulators recalled the negative stories in a more positive way when they were the protagonist of the story compared to the non-confabulating amnesic and the healthy control groups.

The above studies demonstrate that confabulation is associated with the self-concept and is often aimed at enhancing the self-view (Fotopolou et al., 2007b). Self-processing has been shown to involve the VMPFC (Kelley et al., 2002; Heatherton et al., 2006; Ruby et al., 2009; Feyers et al., 2010), the same frontal region that confabulation has been often associated with (Gilboa et al., 2002). Therefore, it would be reasonable to expect to find deficits in making self-related judgements in patients who confabulate.

However, it has been shown that self-knowledge includes knowledge of past episodes as well as abstract self-related knowledge (e.g. self related traits and attributes, previously discussed in Chapter 1) and that the abstract self is independent from episodic memory (Klein et al., 2002a). Previous studies have demonstrated that abstract self related knowledge and self knowledge of past episodes can be dissociated, as knowledge for past episodes has been found to be impaired in patients who have suffered brain anoxia, TBI and in autistic patients, whereas the abstract self has been found to be preserved (Tulving, 1993; Klein et al. 1996; 1999). In contrast, knowledge of episodic self-related information (behaviours) has been found to be impaired in FTD patients (Ruby et al., 2007). It may be, therefore, that confabulation does not affect abstract self-knowledge (i.e. as in the traits and attributes), but that a deficit would emerge in the behaviour prediction task, which may rely on more general memory function (Ruby et al., 2007).

In the following experiment, the self-concept will be investigated in a confabulating patient who have suffered a subarachnoid haemorrhage following the rupture of the ACoA, which often results in damage to the VMPFC brain areas. These patients have been described as having memory loss, confabulation, deficits of executive functions and personality changes such as impulsivity, dishinibition and apathy (De Luca, 1993). Previous investigations of the self-concept in confabulating patients instructed participants to retrieve past episodes or to recognise currently relevant information (Fotopoulou et al., 2007a;b). The results of these studies showed impairment in the ability to accurately retrieved self-related information. In contrast, the following study investigates whether the current self-concept of a confabulating patient has changed compared to the self-view that they possessed before the pathology. An impaired performance on the self-related tasks would indicate that previous results emerged as deficit in accurately processing the self-concepts, In contrast, an intact performance would instead indicate that the self-representation is unaffected in confabulation patients and that the changes in the self-concepts previously reported emerged as consequence of the task demand (e.g. memory retrieval). The study also investigates whether the patient is impaired in his ability to make judgements in relation to a close other person and in their ability to take another person's perspective of the self. The patient is expected to be less accurate than healthy controls in processing self-knowledge, taking another person's perspective as well as on a series of tasks thought to measure functions typically associated with VMPFC brain areas (e.g. affective ToM) due to their damage to the VMPFC. Such a result would also give support to the idea that processing self-knowledge and making ToM inferences rely on a common brain network (Nickerson, 1999).The performance of the confabulating patients will be compared with a groups of healthy controls and a groups of non confabulating ACoA patients. This latter comparison has been included in order to determine whether changes in the self concepts are specific to confabulation.

7.3. Experiment 9: Confabulations, self and others

In the following experiment, the ability to make behavioural and personality judgements in relation to the self and a close other person was investigated in a confabulator patient, a group of non-confabulating patients and healthy controls. The study was approved by the Research Ethic Committee, Lothian NHS Board, Scotland.

7.3.1. Methods

7.3.1.1. Participants

7.3.1.1.1. Confabulating patient

TH was a 66-year old right-handed man. He lived in London and, 6 months before the present investigation, suffered the rupture of an aneurysm of the anterior communicating artery (ACoA). The CT scan showed that he developed hydrocephalus. The patient underwent an initial coiling treatment that failed and so this was followed by a right craniotomy and successful clipping intervention. At hospital admission, he presented with dysarthria, impaired attention and concentration, memory deficits, disorientation, confabulation and dishinibition. Physical deficits included coordination, balance and planning of movements. He was tested at the Blackheath Brain Injury Rehabilitation Centre, London. The patient showed both spontaneous and provoked confabulation during the assessment. His confabulations were semantically plausible and involved member of his family. For example, when he was asked "What did you do yesterday?" he answered that he went to see his grandsons; but this did not ever happened. As another example, he spontaneously claimed that the day after he might not be able to attend the testing session and that he would go with his wife to a different hospital for further examinations. TH showed preserved knowledge of semantic personal facts, such as where he was born and where he lived. His behaviour was always appropriate and collaborative.

7.3.1.1.2. Non-confabulating control patients

The non-confabulating patient group included 8 patients who had suffered the rupture of an aneurysm of the ACoA. All patients were right handed and were recruited at the Western General Hospital, Division of Clinical Neuroscience, Edinburgh. The mean number of days since the aneurysm rupture was 217.1 days (SD = 322.6). All ACoA patients underwent successful coiling treatment. None of these patients showed spontaneous confabulation and did not appear to confabulate in response to any question. Seven patients did not show any previous history of subarachnoid haemorrhage (SAH) nor of other neurological problems. However, one patient suffered a SAH in the 1980's and a stroke in the 1990's of which no records have been found. Her current notes indicated that no remaining deficit was evident. This patient was included as she did not show any sign of reduced intellectual abilities compared to the other ACoA patients.

7.3.1.1.3. Healthy control group

TH's performance was compared with the performance of a group of 14 healthy adults (Control 1) who did not significantly differ in terms of age [t (13) = .805, p = .43] or years of full-time education [t (13) = - 1.89, p = .07], based on the single case analysis program developed to assess whether or not a patient exhibits a statistically significant deficit from a control group (Crawford & Howell, 1998; Crawford & Garthwaite, 2002).

The ACoA group was compared with a different group of 8 healthy controls (Control 2) who did not significantly differ in terms of age [t (14) = -.502, p = .62, d = .25] or years of full-time education [t (14) = -.633, p = .53, d = .31]. Table 7.1 shows the demographic information for the patient and control groups.

Table 7.1. Demographic data for the patients and the control groups.

	TH *(M = 1)*	Control 1 *(M = 4; F = 10)*	Non Confabulators *(M= 5; F = 3)*	Control 2 *(M= 5; F = 3)*
N	1	14	8	8
Age	66	63.50 (3.00)	50.88 (12.05)	53.63 (9.72)
Education	10	13.57 (1.78)	13.00 (2.72)	13.88 (2.80)
Time since illness (days)	197	N/A	217.12 (322.6)	N/A

M = Male; F = Female; N/A = not applicable

7.3.1.2. Materials

7.3.1.2.1. Neuropsychological Background

7.3.1.2.1.1. Intelligence and general cognitive abilities

The Wechsler Abbreviated Scale of Intelligence (WASI: Wechsler, 1999) was administered as a measure of the level of general intelligence. Participants performed the vocabulary and the reasoning subscales and an IQ score was obtained by the sum of the scores of the two subscales. Participants were also administered the Addenbrooke's Cognitive Examination-Revised (ACE-R, Mioshi et al., 2006). From the ACE-R, a Mini Mental State Examination Test (MMSE) score was also derived.

7.3.1.2.1.2. Frontal tests

Both patients and controls were administered a series of tasks thought to tap frontal lobe functions. The self ordered pointing task (SOPT; Petrides & Milner, 1982) is a supra-span short-term visual memory task used to assess working memory and monitoring abilities. See Chapter 3 for the administration of this task. Phonemic verbal fluency was assessed using the Controlled Oral Word Association Test (letters F, A and S; Spreen & Strauss, 1998) as a measure of initiation. During verbal fluency, participants were asked to generate as many words as possible beginning with the letters F, A and S. One minute was allowed for each letter. The ability to recognise emotions from facial expressions was assessed using the Ekman 60 subset from the Facial Expression of Emotion: Stimuli and Test (FEEST; Young et al., 2002), previously described in Chapter 5. Finally, the Faux Pas task (Stone et al., 1998) consists of a series of short stories where a character may have committed a faux pas. Participants were instructed to indicate whether someone said something they should not have said. The task has been extensively described in Chapter 5.

7.3.1.2.1.3. Verbal learning abilities

The participant's verbal learning abilities were assessed using the Rey Auditory Verbal Learning Task (RAVLT, Rey, 1964). This task has been described in Chapter 3.

7.3.1.2.1.4. Language abilities

Language functions were assessed using the Graded Naming Test (GNT, McKenna & Warrington, 1983). Participants were presented with a series of 30 black and white line drawings of different objects and asked to name them aloud (e.g. kangaroo, corkscrew, etc).

7.3.1.2.1.5. Confabulation Questionnaire

All patients and control participants were administered a shortened version of Dalla Barba's Confabulation Questionnaire (Dalla Barba, 1993). The questionnaire consists of a series of questions that investigate temporal and spatial orientation and episodic memory (e.g. what did you do last Christmas?). The responses to the episodic memory items provided by all participants were checked with a close relative (e.g. what did your relative do last Christmas?). Following Dalla Barba (1993), the percentage of correct, wrong, "don't know" and confabulation responses were recorded. For the temporal orientation section, incorrect answers to questions regarding the year, season, month, day of the week and hour of day were considered confabulations when they were wrong by more than 10 years, 1 season, 3 months, 15 days or 6 hours (respectively), whereas responses within these time periods were simply considered incorrect. Answers provided to the episodic questions were scored as incorrect when they did not match the responses provided by the relatives. Inaccurate distortions without inserting new information were considered to be incorrect while greater discrepancies were coded confabulations.

7.3.1.2.2. Experimental Tasks

All participants performed the behaviour prediction task and the personality judgement task previously described in Experiments 1a and 1b (see Chapter 3). The participants' relative/friends were asked to fill in a questionnaire and to indicate their own and the participant's behaviour/personality at the present time and five years ago as described in Chapter 3.

7.3.1.3. Analysis

The responses were scored according to the degree of consistency between the responses provided by the participant and a relative/friend as previously described in chapter 3. The higher the score, the higher the congruency between the two individual's responses. Separate comparisons of patient TH's congruency scores with the healthy controls' scores and with the non-confabulating group were analysed using the single case analysis (Crawford et al., 1998; Crawford et al., 2002). Scores for the congruency measures for non-confabulating patients and their healthy controls were compared using either ANOVA or t-tests as described in Experiments 1a and 1b.

7.3.2. Results

7.3.2.1. Neuropsychological Background

7.3.2.1.1. Intelligence and general cognitive functions

Means and standard deviations for IQ, ACE-R and MMSE are provided in Table 7.2. TH had a significantly lower IQ compared to both the non-confabulators [t (7) = -3.30, p = .01] and healthy controls (Control group 1) [t (13) = -5.31, p = .000]. TH's performance was also significantly impaired on the ACE-R and the MMSE compared to both the non-confabulators [t (7) = -6.47, p = .000; t (7) = -7.45, p = .000, respectively] and the healthy controls [t (13) = - 10.88, p = .000; t (13) = - 14.32, p < .000, respectively]. No significant difference in terms of IQ or MMSE score emerged between the non-confabulators and their healthy control group [t (14) = -1.88, p = .08, d = .94; t (7.00) = -1.67, p = .14, respectively], although the non-confabulators performed significantly more poorly than healthy controls on the ACE-R [t (14) = -2.59, p = .02, d = 1.29].

Table 7.2. Means and standard deviations (SD) for the performance on tests of intelligence and general cognitive abilities for the confabulator, non-confabulating group and the control groups.

	TH	Control 1 *(mean; SD)*	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
IQ	83	114.38 (5.73)	107.88 (7.10)	113.88 (5.56)
ACE-R (max score = 100)	58	96.64 (3.43)	90.75 (4.77)	95.63 (2.36)
MMSE (max score = 30)	21	29.86 (0.53)	29.38 (1.06)	30.00 (0.0)

7.3.2.1.2. Frontal tests

TH performed significantly more poorly than both the non-confabulators [t (7) = 3.20, p = .01] and healthy controls on the SOPT [t (13) = 2.41, p = .03]. On VF, he produced significantly fewer words than healthy controls [t (13) = -2.82, p = .01]. The performance of the non-confabulators did not significantly differ from the healthy controls on either the SOPT or the VF [t (14) = .338, p = .74, d = .17; t (14) = -1.63, p = .12, d = .82 respectively]. Table 7.3 shows the means and standard deviations for the performance on the SOPT and VF of all participants.

Table 7.3. Performance on the SOPT and VF for patient TH, the non-confabulators and healthy control groups.

	TH	Control 1 *(mean; SD)*	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
SOPT errors	15	8.71 (2.5)	7.43 (2.2)	7.0 (2.8)
VF (number of words produced)	11	51.0 (13.0)	39.0 (13.2)	50.5 (14.8)

No significant difference emerged between TH and the ACoA group in the identification of the emotions assessed using the FEEST [anger: t (7) = -.816, p = .44; disgust: t (7) = 1.11, p = .30; fear: t (7) = -1.06, p = .32; happiness: t (7) = .377, p = .71; sadness: t (7) = -1.10, p = .30; surprise: t (7) = -1.60, p = .15]. In contrast, TH was impaired compared to healthy controls in his ability to recognise anger [t (13) = -2.85, p = .01] and surprise [t (13) = -2.19, p = .04] and showed a trend to perform more poorly at recognising fear [t (13) = -2.10, p = .05]. No other comparison was significant [disgust: t (13) = 1.38, p = .18; happiness: t (13) = .49, p = .62; sadness: t (13) = -1.38, p = .19]. The results on the FEEST are reported in Table 7.4.

The ability to recognise facial expressions of emotions in the ACoA group was investigated using a 2 (group: ACoA vs. Controls) x 6 (emotions) ANOVA. The results showed a significant main effect of emotion [F (5, 70) = 9.73, p = .000, η_p^2 = .41]. Post hoc pairwise comparisons indicated that happiness was better recognised than anger (p < .05), fear (p < .01) and sadness (p < .05); and surprise was better recognised than fear

(p < .01). No other comparison was significant. The main effect of group was also significant with ACoA patients correctly recognising significantly fewer emotions than controls [F (1, 14) =8.61, p = .01, η_p^2 = .38]. The interaction group x emotion was not significant [F (5,70) = 2.17, p = .06, η_p^2 = .13].

Table 7.4. Performance on the FEEST of patient TH, the non-confabulators and healthy control groups.

	TH	Control 1 *(mean; SD)*	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
Anger	4.00	8.14 (1.4)	6.25 (2.6)	8.75 (.70)
Disgust	10.00	8.28 (1.2)	7.75 (1.9)	8.62 (1.0)
Fear	3.00	7.35 (2.0)	5.25 (2.2)	7.5 (1.7)
Happiness	10.00	9.64 (.74)	9.60 (1.0)	9.62 (.74)
Sadness	6.00	8.0 (1.4)	7.75 (1.5)	7.87 (1.2)
Surprise	7.00	9.07 (.91)	8.87 (1.1)	9.25 (.70)

Max Correct = 10

On the FP task, no significant differences emerged between TH and both the ACoA and the healthy control groups in terms of the correct detection of FP [t (7) = .99, p = .35; t (13) = 62, p = .54, respectively], accuracy on the subsequent clarifying questions [t (7) = .03, p = .97; t (13) = -.79, p = .44, respectively] and the empathy scores

[t (7) = .22, p = .25; t (13) = .27, p = .78, respectively], (means and standard deviations are reported in Table 7.5). In addition, TH made only one error on the non-FP stories and no significant differences emerged on the control questions for the FP stories between TH and healthy controls [t (13) = .69, p = .50], while his performance was worse than the ACoA group [t (7) = -3.01, p = .01]. No significant difference emerged on the control questions for the non-FP stories.

The results of the non-confabulators and the control groups in terms of Faux Pas accuracy (maximum score = 40), the non Faux Pas control questions (maximum score = 10) and the empathy questions (maximum score = 10) were converted into proportions and then entered into a MANOVA. A separate analysis was conducted on the correct responses associated with the control questions for the FP and non-FP stories. The results showed that neither the MANOVA on FP performance [Wilks's Λ= .80, F (3, 12) = .97, p = .44, η_p^2 = .12], nor the univariate analyses were significant [accuracy: F (1,14) = .20, p = .65, η_p^2 = .014; non-FP rejection: F (1,14) = 1.0, p = .33, η_p^2 = .067; empathy: F (1,14) = .98, p = .33, η_p^2 = .06]. Similarly, no significant difference emerged for the MANOVA performed on the control questions for both types of stories [Wilks's Λ= .82, F (2,13) = 1.34, p = .29, η_p^2 = .17] or the univariate analyses [F (1,14) = 1.3, p =.27, η_p^2 = .08; F (1,14) = 1.00, p = .33, η_p^2 = .06, respectively].

Table 7.5. Performance on the Faux Pas task of TH, the non-confabulators and healthy control groups.

	TH	Control 1	Non Confabulators	Control 2
		(mean; SD)	*(mean; SD)*	*(mean; SD)*
FP Detection (max score = 10)	10	9.29 (1.13)	8.63 (1.30)	9.0 (1.19)
Non FP rejection (max score = 10)	9	10 (0.0)	10 (0.0)	9.88 (.35)
Clarifying Questions (max score = 30)	23	25.86 (3.48)	22.88 (3.56)	24.25 (4.65)
FP control questions (max score = 10)	8	9.07 (1.49)	9.63 (.51)	9.13 (1.12)
Non FP control questions (max score =10)	10	10 (0.0)	9.88 (0.35)	10 (0.0)
Empathy (max score = 10)	9	8.42 (2.02)	7.31 (1.36)	8.0 (1.41)

7.3.2.1.3. Verbal learning

The means and standard deviations for the performance on the RAVLT are reported in Table 7.6. The results showed that TH was impaired in terms of delayed recall compared to both non-confabulators [t (7) = -2.49, p = .04] and healthy controls [t (13) = -3.34, p = .004]. In addition, TH performed significantly more poorly on the recognition task compared to non-confabulators [t (7) = -4.55, p = .002] and healthy controls [t (13) = -6.04, p = .000]. No significant differences emerged between the ACoA and the control groups in term of both delayed recall and recognition [t (14) = -1.86, p = .08, d = .93; t (14) = -2.08, p = .056, d = 1.08, respectively].

Table 7.6. Performance on the RAVLT of TH, the non-confabulators and healthy control groups.

	TH	Control 1 *(mean; SD)*	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
Delayed Recall	1	12.0 (3.1)	9.0 (3.0)	11.87 (3.13)
Delayed Recognition	2	13.07 (1.7)	12.0 (2.0)	13.75 (1.1)

Max correct = 15

7.3.2.1.4. Language

The difference on the GNT between TH (correctly identified objects = 15 out of 30) and the non-confabulating ACoA patients (μ = 21.38, SD = 2.6) approached significance [t (7) = -2.30, p = .054].

7.3.2.1.4. Confabulation Questionnaire

Table 7.7 shows the means and standard deviations for the percentage of correct responses for Dalla Barba's Confabulation questionnaire. All the healthy control participants performed at ceiling on the temporal and spatial orientation questions. TH made significantly more errors on both types of orientation questions than the ACoA group [temporal questions: t (7) = 3.58, p = .008]. The ACoA group performed at ceiling on the place orientation questions. On the episodic memory questions, the ACoA and the two healthy control groups did not produce any confabulations while TH confabulated on 50% of the questions. In addition, TH made more non-confabulating errors on the episodic questions than the healthy controls [*t* (13) = 2.81, *p* = .01]. No difference emerged on the number of non-confabulating errors between TH and the non-confabulating patients [*t* (7) = .37, *p* = .72]. The number of "Don't Know responses did not differ between TH and both healthy and non-confabulating group [*t* (14) = -.11, *p* = .91; *t* (7) = -.46, *p* = .65, respectively].

Table 7.7. Means and standard deviations for performance on Dalla Barba's Confabulation Questionnaire for TH, the non-confabulators and healthy control groups.

	TH *(mean)*	Control 1 *(mean; SD)*	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
Orientation Time Incorrect (%)	40	0	5 (9.2)	0
Orientation Place Incorrect (%)	20	0	0	0
Orientation Don't Know (%)	0	0	0	0
Orientation Confabulations (%)	0	0	0	0
Episodic Incorrect (%)	25	3.7 (7.3)	19.2 (14.7)	5.6 (11.8)
Episodic Don't Know (%)	12.5	14.3 (15.8)	17.62 (10.3)	14.5 (16.7)
Episodic Confabulations (%)	50	0	0	0

7.3.2.2. Experimental tasks

7.3.2.2.1. Behaviour prediction task

7.3.2.2.1.1. Behavioural change

Patient TH did not differ compared to healthy control on the on the amount of self-change reported by self and by a relative. Means, standard deviations and test results of the behaviour prediction task are reported in Table 7.8.

Table 7.8. Performance on the behaviour prediction task of patient TH and healthy control groups

	TH	Control 1	single case t-test	
		(mean; SD)	*t (13)*	*p*
Self Perceived Change	7	6.71 (1.9)	0.14	*.88*
Other Perceived Change	6	7.14 (1.0)	-1.1	*.29*
Self Awareness	7	5.64 (1.0)	1.13	*.10*
Other Awareness	5	5.21 (1.1)	-0.18	*.85*
Participant Stereotypical Ratings	5	5.14 (1.2)	-0.11	*.91*
Relative Stereotypical Ratings	7	5.85 (1.6)	0.69	*.49*
Reliance on past behaviour	5	5.28 (1.5)	-0.18	*.85*

Max score = 8

Similarly, the results of a 2 judgement x 2 groups on the behavioural change in the ACoA and healthy controls showed no significant difference [judgement: F (1.14) = .020, p = .88, η_p^2 = .001; group: F (1,14) = .011, p = .91, η_p^2 = .001; group x judgement interaction: F (1,14) = .504, p = .48, η_p^2 = .03]. Means and standard deviation of the behaviour prediction task of the ACoA and the healthy control groups are reported in table 7.9

Table 7.9. Performance on the behaviour prediction task of ACoA and healthy control groups

	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
Self Perceived Change	6.62 (1.5)	7.0 (1.7)
Other Perceived Change	6.85 (1.4)	6.6 (1.0)
Self Awareness	5.37 (1.3)	5.5 (.92)
Other Awareness	5.62 (1,4)	4.8 (1.3)
Participant Stereotypical Ratings	5.25 (1.8)	4.5 (2.0)
Relative Stereotypical Ratings	5.25 (2.1)	4.8 (1.9)
Reliance on past behaviour	5.0 (1.3)	5.0 (1.5)

Max score = 8

7.3.2.2.1.2. Behavioural awareness

Awareness of self and others' behaviour did not differ between TH and healthy controls (Table 8). Similar, the results of a 2 target (self vs. other) x 2 group ANOVA on behavioural awareness showed no difference between the ACoA and healthy controls [target: F (1) = .236, p = .63, η_p^2 = .01; group: F (1,14) = .39, p = .59, η_p^2 = .02; group x target: F (1,14) = 1.28, p = .27, η_p^2 = .08]. Means and standard deviation are reported in table 7.9

7.3.2.2.1.3. Stereotypical ratings for the participant's behaviour and the relative/friend's behaviour

No difference emerged between patient TH and healthy controls on self and others stereotypical ratings (Table 8). Similarly, the results of a 2 condition x 2 groups ANOVA on self and other stereotypical ratings showed no difference between the ACoA and healthy controls [condition: F (1,14) = .011, p = .91, η_p^2 = .001; group: F (1,14) = .35, p = .73, η_p^2 = .02; group x condition: F (1,14) = 0.12, p = *.93*, η_p^2 = .001]. Means and standard deviation are reported in table 7.9

7.3.2.2.1.4. Reliance on the past

No difference emerged between TH and healthy controls in terms of reliance on the past (Table 8). Similarly, no difference emerged between ACoA and healthy control group [t (14) = .000, p = 1.0]

7.3.2.2.2. Personality judgement task

7.3.2.2.2.1. Personality Change

The means, standard deviations and results for the performance of patient TH and the healthy controls on the personality judgement task are reported in Table 7.10. Patient TH produced significantly lower scores on the self perceived change measure compared to healthy controls, indicating that he perceived that he had experienced a higher change between his past and present personality compared to the controls. The change in patient

TH's personality reported by his wife (other perceived change) was also significantly greater than the change reported by the relatives of the control.

A further investigation compared the performance of the non-confabulators and their healthy control group (control group 2). The means and standard deviations for the ACoA and the healthy controls are reported in Table 7.11. Personality change ratings provided by the participants and by their relatives were entered into a 2 (group: ACoA vs. controls) x 2 (measure of change: perceived by self and perceive by others). The main effect of change approached significance with higher scores for the change rated by the relative than the change rated by the patients. [F (1,14) = 4.61, p = .050, η_p^2 = .24]. The main effect of group and the group x measure of change interaction was not significant [F (1,14) = .587, *ns*, η_p^2 = .04; F (1,14) = .310, *ns*, η_p^2 = .02].

7.3.2.2.2.2. Awareness and Perspective Taking

Patient TH showed a reduced ability to rate his wife's current personality taking his own perspective (other awareness) (Table 10). No difference emerged on the self-personality awareness compared to healthy controls.

Two additional congruency scores were calculated. The relative's rating of her current personality was compared with her rating of her past personality (R1 Now vs. R1 Before). The results showed that the patient's relative rated her present personality as being different from her past personality [t (13) = -2.12, p = .05]. A further analysis was conducted on the congruency score obtained by comparing the relative's current personality as assessed by the patient (S2 Now) and the relative's past personality as assessed by the relative. The result was not significant.

Table 7.10. Means and standard deviations for the performance of patient TH and healthy controls on the personality judgement task.

	TH	Control 1	*single case t-test*	
	(mean)	*(mean; SD)*	*t* (13)	*p*
Self Perceived Change	10	15.64 (2.4)	-2.27	.04
Other Perceived Change	10	17.79 (2.4)	-3.13	.007
Self Awareness	8	13 (3.7)	-1.3	.21
Other Awareness	4	12.29 (2.8)	-2.86	.01
Different Perspectives of Self	12	13.21 (2.7)	-0.433	.67
Different Perspectives of Relative	10	12.79 (2.4)	-1.12	.28
Participant Stereotypical Rating	10	12.14 (3.1)	-0.667	.51
Relative Stereotypical Ratings	12	11.36 (3.2)	-0.193	.84
Reliance on Past Personality	8	13.57 (3.3)	-1.63	.12
R1 Now vs. R1 Before	12	16.17 (1.9)	-2.12	.05
S2 Now vs. R1 Before	10	12.17 (2.5)	-0.839	.41

The performance of patient TH was then compared with the performance of the non-confabulators. The means and standard deviations for the non-confabulators are reported in Table 7.11. As in the previous analysis, TH performed significantly more poorly than the non-confabulators when making judgements about his wife's current personality taking his own perspective (other awareness) [t (7) = -3.71, p = .005]. His ability to judge his wife's personality taking her own perspective (different perspective of relative approached significance [t (7) = -2.24, p = .06]. The additional congruency scores were computed for the non-confabulator group (R1 Now vs. R1 Before: μ = 17.13, SD = 2.2; S2 Now vs. R1 Before: μ = 12.63, SD = 2.4). No significant difference emerged between TH and non-confabulators on these measures [t (7) = -2.19, p = .07; t (7) = -1.03, p = .33].

Self and other awareness taking either the first or third perspective was investigated in the ACoA group with a 2 group (ACoA vs. controls) x 2 target (self vs. other) x 2 perspective (first vs., third) mixed-model ANOVA. No significant differences emerged for the main effect of target [F (1,14) = 3.25, p = .93, η_p^2 = .18], the main effect of perspective [F (1) = 1.08, p = .31, η_p^2 = .07], the main effect of group [F (1,14) = .615, p = .44, η_p^2 = .04], the group x target interaction [F (1,14) = .097, p = .76, η_p^2 = .007], the group x perspective interaction [F (1,14) = 3.75, p = .07, η_p^2 = .21], the target x perspective interaction [F (1,14) = 2.13, p = .16, η_p^2 = .01] and the target x perspective x group interaction [F (1,14) = .237, p = .63, η_p^2 = .01].

7.1.2.2.2.3. Stereotypical ratings for the participant's personality and the relative/friend's personality

TH did not differ compared to healthy control on measures of stereotypical ratings (Table 10). A 2 groups (ACoA vs. control) x 2 stereotypical ratings ANOVA showed no significant difference in terms of stereotypical ratings [F (1,14) = .004, p =

.94, η_p^2 = .000], main effect of group [F (1,14) = .033, p = .85, η_p^2 = .002] and group x stereotypical rating interaction [F (1,14) = .108, p = .74, η_p^2 = .008].

7.3.2.2.2.4. Reliance on the Past

No difference emerged between TH and healthy control in terms of reliance on past personality (Table 10). No significant difference emerged difference emerged for measure of reliance on the past personality as investigated with a t-test between the ACoA and the healthy control groups [t (14) = -.958, p = .35, d = .48].

Table 7.11. Means and standard deviations for the performance of the non-confabulators and the healthy controls.

	Non Confabulators *(mean; SD)*	Control 2 *(mean; SD)*
Self Awareness	12.0 (3.5)	12.13 (4.1)
Other awareness	13.11 (2.2)	13.12 (1.3)
Self Perceived Change	12.63 (2.6)	14.00 (2.8)
Other Perceived Change	14.75 (3.3)	15.25 (2.7)
Participant Stereotypical Ratings	12.12 (3.4)	11.37 (2.6)
Relative Stereotypical Ratings	11.87 (3.1)	12.00 (2.1)
Different perspective on self	12.25 (3.4)	11.25 (3.1)
Different perspective on relative	15.37 (2.2)	13.25 (3.4)
Reliance on past personality	10.12 (4.5)	12.37 (4.8)
R1 Now vs. R1 Before	17.13 (2.2)	16.0 (1.89)

7.4. Discussion

The study investigated the ability to make behavioural and personality judgements in relation to the self and another person in patient TH, who is both a spontaneous and provoked confabulator after the rupture of an anterior communicating artery aneurysm (ACoA). The CT scan showed the presence of hydrocephalus. The brain damage following rupture of the ACoA typically involves medial sector of the PFC, although the damage may not involve all of the MPFC and may extend to other brain areas as effect of vasospasm and hydrocephalus (Bottger, Prosiegel, Steiger & Yassouridis, 1998). His performance on a series of neuropsychological tests and the experimental measures was compared with a group of healthy controls who did not significantly differ in terms of age and years of full time education and a group of ACoA patients who did not confabulate but who were significantly younger and had significantly more years of education than patient TH.

In terms of performance on the background measures, patient TH had a significantly lower IQ and general intellectual function compared to both ACoA patients and healthy controls. He showed a severe deficit in the ability to learn new information. Similar impairment on a verbal learning task has been previously reported in confabulating patients (Simard, Rouleau, Brosseau, Laframboise and Bojanowsky, 2003). TH's semantic knowledge was relatively intact. Previous studies also showed intact semantic knowledge performance of confabulating patients task (Dalla Barba et al., 1997a; Burgess et al., 1999). Patient TH also demonstrated deficits on the tests thought to measure frontal lobe function (i.e. the SOPT, the VF). Both the SOPT and the VF are thought to rely on the functioning of DLPFC brain areas (Frith, Friston, Liddle & Fracowiak, 1991; Petrides, Alivisatos, Evans & Meyer, 1993) and, critically, ageing studies have shown poorer performance of older individuals on both tasks compared to younger adults (Bolla, Grey, Resnick, Galante & Kawas, 1998; Lamar et al., 2004). However, other investigations report instead intact performance of older individuals on the VF task (Lamar et al., 2004). Furthermore, neuroimaging studies showed involvement of both the VMPFC and the DLPFC (Ravnkilde, Videbech, Rosenberg, Gjedde & Gade, 2002) suggesting that the VMPFC areas might be recruited during the task performance.

Impaired performance of confabulating patients has been previously reported on both the VF (Dalla Barba et al., 1997a; Fotopoulou et al., 2004) as well as on the SOPT (Burgess et al., 1999).

TH showed also impaired recognition of facial expression of emotions (anger, surprise and fear). In line with this result, Heberlein et al. (2008) showed that VMPFC damaged patients, mostly caused by rupture of an AcoA, rated facial expression of emotions (fear and surprise) less intense than DLPFC damaged patients and healthy controls.

Both TH and the ACoA group performed well on the faux pas, indicating that their ability to understand other peoples' mental states and the empathic understanding of anther person was not impaired. The FP is considered a measure of the affective ToM (Kalbe et al., 2007) and evidence indicates that older adults perform well on the FP task (MacPherson et al., 2002). Furthermore, VMPFC damaged patient are impaired in their ability to detect a FP (Stone et al., 1998; Shamay-Tsoory et al., 2005b).

On Dalla Barba's Confabulation questionnaire, patient TH showed impaired spatial and temporal orientation compared to both control groups, however he did not confabulate on any of these questions. Previous investigations have also described confabulation patients as being well orientated in time and space (Kapur et al., 1980; De Luca & Cicerone, 1991). Dalla Barba et al. (1999) claimed that the past, present and future are distinct structures and, therefore, it is plausible that distinct responses might be provided to episodic, present and future tasks.

In contrast to the performance on orientation questions, TH provided more confabulating reposes to the episodic memory questions compared to both the control groups. The results suggest that his past memories are weak or difficult to access, however TH did not confabulate in order to fill in a gap in his memories, as the percentage of the episodic question to which TH answered "I don't know" was similar to the responses provided by both healthy and non-confabulator controls.

The ability to process self related information has been shown to involve VMPFC (Kelley et al., 2002) in both younger and older individuals (Ruby et al., 2009; Feyers et al., 2010). Since damage following rupture of AcoA involves medial sector of the PFC, TH was expected to perform poorly on tasks that require processing of self-related information. In contrast to this prediction, TH was unimpaired in making self related behavioural and personality judgements.

In terms of performance on the behaviour prediction task where individuals had to state how they would react in possible real life situations, patient TH did not perceive any significant differences in his behavioural change since his illness compared to controls as indicated by his own (self perceived change) and his wife's (other's perceived change) ratings of his behaviour at the present time and in the past. In fact, no significant differences emerged on any of the congruency scores compared to the control groups. One potential reason why there were no significant differences between TH's and the controls' congruency scores on this task may be that TH did not consider the situations described as being relevant to the self (e.g. having a car accident). TH's confabulations related to a member of his family and his current situation. Therefore, instead of answering in terms of his potential emotional reaction to the situation, TH may have responded on the basis of general knowledge of his behaviour and how people are supposed to behave in these situations. In line with this claim, TH showed preserved knowledge of semantic personal facts. Furthermore, TH showed preserved social understanding of behaviour, as evidenced from his performance on the faux pas task, indicating that his emotional understanding of others was intact. It might be that the brain damage did not include areas previously reported to be critical to making self and other judgements and that TH might have responded on the basis of an intact knowledge of how himself or people generally behaved and of their emotional responses in social situations.

On the other hand, on the personality judgements task where participants were required to judge how well a given adjective described themselves or their relative/friend at the present time and five years ago, the changes reported by TH's wife was significantly more than the changes reported by relatives/friends regarding the control group participants. However, TH did not seem impaired in his ability to rate his current personality, as he also reported more changes in his own personality over the past 5 years compared to both the healthy. His knowledge of his personality was therefore unaffected by his deficits in recalling past memories and in learning new information. These results are in line with previous studies such as Tulving (1993), who described the case of patient KC who could not retrieve any episode from his past following a motorcycle accident, suffered severe anterograde memory deficits and showed marked personality changes and yet showed intact self awareness of his current personality. More recently, Klein et al. (2002a) described a patient (D.B.) who suffered severe retrograde and anterograde memory deficits due to brain anoxia following a heart attack and showed impaired knowledge of semantic personal and non-personal facts, yet his ratings of his own personality matched with the ratings provided by his daughter. Together, these results suggest that abstract self knowledge does not require access to episodic memories and that a person's current personality can be updated despite him or her having deficits in recalling past memories and learning new information.

The results also revealed that patient TH had significantly less congruence between his ratings of his wife's personality now and her own ratings of her personality now compared to both healthy and patient control groups. This result is also in line with the results of previous patient studies which have shown significant differences between the ratings of the current personality of a person close to the participant provided by the participant and the relatives (Klein et al., 2002a; 2003; 2004a). Klein et al. (2002a) reported the case of a patient D.B. who showed intact self-trait knowledge. However, he was impaired in rating his daughter's personality. Klein et al. (2003) described a woman (K.R.) with a diagnosis of probable Alzheimer's disease. Since the onset of the disease she showed personality changes. Her rating of her current personality matched with the rating provided of her by her daughter. Yet, she accurately made trait judgements on her daughter's personality. The authors reasoned that K.R. relied on old non-updated knowledge of both self and others. In a further investigation, Klein et al. (2004a) showed intact self knowledge and impaired trait knowledge of close others in an autistic patient (K.J). These findings suggest that the representation of self and close others are separate.

Typically, the relatives of a patient are not asked to rate their own personality in the past, as it is assumed that they would not change. In the present study, however, TH's wife was asked to rate herself both at the present time and in the past. The results showed that she reported greater changes in the last five years compared to the relatives of healthy control participants. The ratings provided by patient TH regarding his wife's current personality, however, aligned with her past personality as rated by herself. These results would suggest that TH did not update the personality changes of a person he knew well.

At the same time, however, and in line with his intact understanding of other people's mental states and emotions as measured using the faux pas task, patient TH was able to rate both his own as well as his wife's personality taking a different person's perspective. Surprisingly he showed intact awareness of his wife's personality when taking her own perspective. His impaired performance taking his own perspective when assessing his wife's personality, thus, may be due to how the questions were asked. In the first perspective, participants were asked to indicate the extent to which a trait adjective described a well known other person. This question may result in greater confusion between the self and others in contrast to questions that instruct someone to take another person's perspective. In line with this view, it has been suggested that the self may expand to include the representation of close others (Aron et al. 1991). Since both TH and his wife are thought to have changed in the last 5 years, it may be that the first person perspective caused greater confusion between the self and others, leading TH to rely on his knowledge of his wife's past personality. In addition, more recently Ames, Jenkins, Banaji and Mitchell (2008) instructed their participants to describe a person taking either a first person perspective (e.g. imagine that you are that person and that you can see through their eyes) or a 3rd person perspective (e.g. imagine what the other person may think). In a subsequent fMRI investigation, participants were instructed to make judgements about opinions and preferences in relation to the self and the person they had previously described taking either their own or a different perspective. Self-judgements activated the VMPFC to a greater extent than judgements about others. However, judgements made about the person previously described by taking a first person perspective activated the VMPFC to a greater extent than the judgements made about the person they described taking a 3rd person perspective, supporting the view that the first person perspective increases self-based judgements.

Alternatively it may be that patient TH became more aware of his wife's changes when taking a third perspective. In a study that investigated anosognosia for plegia, Marcel, Tegner and Nimmo-Smith (2004) instructed hemiplegic stroke patients to indicate how well they would perform a series of actions, included bimanual and bipedal actions (e.g. tie a knot). They were also asked to indicate how well the experimenter would perform the same actions if he/she was in the patient's state. The results showed that between 15% and 50% of patients with right hemisphere damage indicated that they would perform the task better when they answered taking their own rather the experimenter's perspective, suggesting that awareness of a deficits may emerge when patients take a different perspective. Since the awareness for the self and others are independent (Klein et al., 2002a; 2004a), it may be that awareness of others improves when taking a different perspective.

It has also been reported that poor performance on affective ToM is associated to poor emphatic understanding, defined as the ability to represent and respond to others' mental state and emotional reactions (Shamay-Tsoory et al., 2005b; 2007a). Furthermore, the simulation theory claims that individuals understand others' mental states on the basis of their own experiences and by imaging themselves in the same situation. Shamay-Tsoory et al. (2005b; 2007a) suggested that the affective TOM is in fact an empathic response to another person's affective mental state. In the present experiment, both TH and the ACoA group performed well when instructed to make self-related judgements suggesting that they might have used their intact self representation to accurately understand another person's emotions.

A further distinct possibility is that the brain damage of TH may have extended to other brain areas (Bottger, Prosiegel, Steiger & Yassouridis, 1998) and that may have spared VMPFC brain areas. TH was unimpaired in making self-related judgements, in taking a third-person perspective on both self and his wife and in his performance on the Faux Pas task. In contrast, he showed a deficit in making judgements about his wife when taking his own perspective. Ochsner et al. (2005) showed that making judgements about a close other in younger adults relies on greater DLPFC activity than making self-related judgements. It may be that TH relied on greater inferential processing to make judgements about his wife when taking a first perspective. In addition TH performed poorer on the SOPT, thought to rely on DLPFC functions (Petrides et al., 1993).

The performance of patient TH on both self-related tasks and tasks tapping the VMPFC resembles the performance of older individuals (Chapters 3 and 5). Older adults are known to perform more poorly than younger individuals on episodic memory tasks (Spencer et al., 995) and to rely on the retrieval of semantic self-knowledge to a greater extent than younger participants (Piolino et al., 2002; Levine et al., 2002). Furthermore, it has been reported that semantic self-knowledge is sufficient to support accurate self-representations (Rathbone et al., 2009). These results indicate that TH, despite his episodic memory deficits, makes accurate self-judgements, even on a task thought to rely on episodic retrieval (i.e. behaviour prediction). On the basis of TH's deficit on episodic memory, it might be assumed that his judgements relied on semantic self-knowledge. Furthermore, similarly to older individuals, TH performed as accurately as healthy controls on the faux pas task, supporting the view that making self and other-judgements relies on common brain areas.

7.5. Conclusion

The results of the this study suggest that the ability to judge the self is independent from the ability to judge another person when taking the first perspective and that self knowledge does not require access to episodic memories. In line with previous investigations where self related judgements were performed well despite impaired episodic retrieval and confabulation (Klein et al., 2002a), the patient assessed in this study showed confabulation in response to episodic questions but showed no deficits in making self-related trait judgements. The results also suggest that despite deficits in learning new information, the ability to update the self in terms of trait judgements and behaviour remains intact.

Chapter 8: General Discussion

The self can be defined as the knowledge of one's own abilities, personality traits and attitudes. As people become older they face several changes, such as reduced physical strengths, cognitive decline and a reduction in the number and frequency of social interactions (Brandtstädter & Greve, 1994; Sneed et al., 2005). The negative beliefs related to the ageing self and the cognitive decline that older individuals possess might affect their performance on cognitive tasks (i.e. memory; (Levy et al., 2002a;b). In fact, the negative view of ageing is associated to reduced well being (e.g. hypertension, depression) which negatively affect cognitive functions (Lupien et al., 2004). In contrast, a positive view of the ageing process has been associated to healthy behaviours, well being, longevity, improved satisfaction and cognitive functions (Lupien & Wan 2004),

The ability to process self-related information appears not to decrease with age. This effect might be related to the brain areas involved in processing self-knowledge. In fact, neuroimaging investigations showed that processing self-related information involves activation of the VMPFC brain area which is less affected by ageing at least until much later compared to other brain regions, such as the DLPFC (Phillips et al., 2002). The VMPFC has also been associated to the ability to understand others' thoughts and beliefs (Stone et al., 1998; Hynes et al., 2006) and some ageing studies show that the performance on tasks thought to tap VMPFC functions (e.g. the Faux Pas) is relatively spared in older individuals (MacPherson et al., 2002; Lamar et al., 2004). The aim of the current study was to investigate the ability to process the self and other-related information in younger and older adults in relation to distinct task demands (e.g. episodic vs. semantic retrieval) as well as in relation to the cognitive functions thought to be associated with distinct frontal regions (VMPFC and DLPFC). For this reason, the same group of participants who performed the processing of the self-tasks thought to rely on VMPFC function (Kelley et al., 2002) also performed a series of tasks thought to measure cognitive functions typically associated with the VMPFC and DLPFC. Older participants were expected to perform well on both the self and the VMPFC tasks, while some differences might emerge on tasks thought to tap DLPFC functions.

The results supported the view that cognitive functions associated with the VMPFC are spared in older adults. The ability to process self-related information and the memory advantage provided by encoding information in relation to the self (SRE) did not decrease in the current sample of older adults. Older individuals performed as accurately as younger participants when instructed to make personality and behavioural self-related judgements as well as when instructed to make inferences about self-related mental states. Furthermore, the performance of older adults did not differ from that of younger participants when they were required to make judgements in relation to a close other person, supporting the view that the self concept may extend to include important others (Aron et al., 1991). In addition, in line with some ageing studies (Guthcess et al., 2007a; Glisky et al., 2009)) both older adults showed higher memory for self-encoded information (SRE) compared to information encoded in relation to another person, indicating that encoding information in relation to the self improved memory retrieval in both younger and older individuals.

Despite these results, age differences emerged on some aspects of self-processing thought to rely on episodic retrieval (e.g. the behavioural task). When instructed to indicate their own or a close other's possible reaction to certain social situations, older participants provided the same response for the self and close other person more than younger individuals. In contrast to the behaviour prediction task, no age difference emerged when participants relied on semantic self-related knowledge as investigated using the personality judgements task. These results are in line with evidences, which showed that self-related knowledge could be either semantic or episodic (Klein et al., 1989) and that episodic memory is affected by ageing to a greater extent then semantic memory (Spencer et al., 1995). The current study expands these early results by showing that age differentially affects semantic and episodic components of the self in the same sample of older adults. The study suggests that processing episodic (e.g. behavioural judgements) and semantic (e.g. personality judgements) self-related information may rely on separate mechanisms. As episodic retrieval involves DLPFC activity (Gilboa, 2004), the findings indicate that an age effect might emerge in relation to episodic component of the self-processing in a sample of highly educated older participants. This view is further supported by the results that older adults, despite the intact SRE, overall performed poorer then younger participants when instructed to recognise previously presented information.

A further result of the study was that older participants performed as accurately as younger adults on a series of tasks thought to be sensitive to VMPFC functions (i.e. affective ToM) providing further support to the view that cognitive functions associated to this area of the PFC are relatively preserved in older population (MacPherson et al., 2002). Age differences only emerged on those tasks thought to depend on functions of the DLPFC brain areas (i.e. SOPT, cognitive ToM and the Ultimatum Game). The age-related differences on tasks traditionally associated to DLPFC functions provide further support for the dorsolateral prefrontal cortex theory of ageing (MacPherson et al., 2002; Phillips et al., 2002) and extend it by showing that those aspects of the self-processing associated to VMPFC involvement (semantic) do not decrease with age. Furthermore, the lack of age effects on tasks associated with the VMPFC (self and ToM) suggests that the cognitive mechanisms responsible for processing the self-knowledge partially overlaps with those involved in performing affective ToM tasks. This view is supported by some neuroimaging studies, which showed that making inferences on self and other involves partially overlapping brain areas (Mitchell et al., 2005; 2006; Jenkins, et al., 2008). In line with this view, in the current study the same sample of older adults who performed well on self-related tasks, show intact performance when instructed to make mental state inferences on another person.

In the final experiment (Experiment 7), the ability to process self-related information was investigated in a patient who developed confabulation following the rupture of an aneurysm of the ACoA. This type of lesion is thought to damage the medial region of the PFC. It might therefore be expected that this patient demonstrates a deficit in processing self-related information. In contrast to this view, the patient did not show any deficit in detecting self-related changes and in making self-descriptive judgements. This result suggests that the ability to process self-related information as measured with the behaviour and the personality tasks is not impaired in this confabulating patient. The changes in the self which have been reported in previous patient studies in relation to confabulation, such as a greater focus on the self and an enhanced view of the self (Fotopoulou et al., 2007b; 2008) emerged in relation to the memory demands of the task employed (episodic retrieval) which required patients to explicitly retrieve past personal events. Therefore, it can be assumed that the self-related changes emerged as a consequence of the cognitive effort associated with the retrieval of autobiographical memory. In contrast to those studies, patient TH showed an intact self-concept as investigated using less demanding tasks. Yet, the patient was impaired in rating a close other person. This deficit emerged as an impairment in updating the old view the patient held of his wife's past personality, suggesting that processing the self and others relies on partially separate mechanisms. Support to this view comes from lesion studies, which reported intact self but not other-related judgements in autistic individuals (Klein et al., 1999; 2004) in a case of brain anoxia (Klein et al., 2002a).

8.1. Caveats and future directions

The current study assessed whether age differences would emerge in terms of self-processing skills, which involve brain areas that are relatively spared in older individuals compared to other brain areas (Phillips et al., 2002). Therefore, the study tested whether the Null Hypothesis (H_0: no age effect) was true. Howvere, the lack of a statistically significant effect does not always mean that the H_0 is true. The results might instead indicate that the effect is too small to be detected and therefore a significant difference would emerge in a bigger sample of participants.

However, the sample size adopted in the current study appears to be large enough for a significant difference to emerge. A priori power analysis conducted with G*Power showed that a sample of 58 participants would be sufficient to detect a medium effect size (Cohen's $f = .25$) with a test power of 75% (which is the minimum power required in order to detect a significant effect, Kinnear & Gray, 2010) when running a mixed-model ANOVA with 2 group x 2 repetitions (levels in the within subjects factor). In the current study the sample consisted of 60 participants, suggesting that the sample size was large enough to detect an effect if it existed.

Furthermore, in the current study, older participants show intact ability to attribute mental states to other people. As processing of the self and understating another person's thoughts and emotions may involve common brain areas which include the VMPFC (Kelley et al., 2002; Hynes et al., 2006), the possibility that participants responded on the basis of their beliefs about how people generally react cannot be excluded (e.g. behaviour prediction task, ToM inferences). This might be the case even when the task specifically required participants to consider self-related behaviours. In fact, some sentences used in the current study might have described situations that were not self-relevant (i.e. they never occurred in the case of some participants) and therefore participants might have answered on the basis of their general knowledge of how people would behave in those situations (e.g. You g=have a collision in your car). Therefore future investigations should employ tasks that can discriminate between information that is self-relevant and not self-relevant to each of the participants.

A further limitation of the study is related to the specific sample of participants recruited. The sample of younger and older adults was characterised by a high level of education and cognitive abilities. The younger sample consisted of university students and the older participants were recruited from the panel of volunteers at the University of Edinburgh. Therefore, they were likely to have taken part in previous research studies, which might have affected their performance on the current tasks as well as on the neuropsychological background tests. For example, older adults typically show impaired recognition of negative emotions such as anger, fear and sadness (Malatesta et al., 1987; Phillips et al., 2002b; Calder et al., 2003; Wong et al., 2005; Keightley et al., 2006). However, in the current study they performed as accurately as younger adults during the recognition of both positive and negative emotions. The participants may have been well-practised in recognition of the emotional stimuli due to other studies of emotion having been run in the department. A similar explanation might explain the intact performance of the current sample of older individuals on the Verbal Fluency. This task is thought to rely on DLPFC brain areas (Frith et al., 1991) and older adults have been shown to perform more poorly on this task compared to younger individuals (Bolla et al., 2004). However, the task is widely used as measure of frontal lobe functions. Therefore, the task might not be a good measure to detect decline of frontal lobe functions if participants have performed it before.

Furthermore, the majority of participants in both the younger and older groups were female and it is known that self-processing might be affected differently in men and women. For example, changes in neuroticism have been reported in women from their 30s, whereas little change emerged in men as they become older (Srivastava et al., 2003). It has also been claimed that the self-representations that individuals possess depend upon their gender. The self-concepts of men focuses on uniqueness, autonomy and independence from others. In contrast, the self-representations of women are socially oriented and characterised on the basis of their relationship with others (Cross & Madson, 1997). This suggests that women might pay more attention to their relationship with others than men. The greater focus on the relational aspects of the self in women might have resulted in the high accuracy that emerged in the current study when rating the self and others.

Gender differences have also been reported in terms of brain atrophy. For example, evidence exists indicating that the effect of age on frontal atrophy might be more prominent in men than women (e.g. Gur, Mozley, Resnick, Gottlieb, Kohn, Zimmerman et al., 1991). This further suggests that gender might differentially affect the ability to process self related information and that the current sample of older adults might have not been fully representative of the older population. Moreover, in the current study, our older participants had a high level of education and did not show impairment on tasks typically thought be affected by age (e.g. verbal fluency). It may be that our older participants were representative of a subsample of older adults, specifically those with high cognitive functions. In research where age effects are reported, the inclusion of highly educated older adults is less of an issue as it is likely that lower educated individuals would simply show this age effect to a greater degree. However, when age effects are not found in highy educated individuals, one cannot be certain that lower educated individuals might show an age effect.

It is also known that cognitive functions might be affected by other aspects of ageing that have not been controlled for in the current study, such as changes in the neurochemical system and health-related issues that are known to affect cognitive performance in older individuals. In terms of neurochemistry, it is known that increased levels of glucorticoids (e.g. cortisol) negatively affect cognitive function (e.g. attention, memory) in both healthy individuals as well as patients with Alzheimer's disease, Korsakoff Syndrome, Schizophrenia and cerebrovascular disease (Belanoff, Gross, Yager & Schatzberg, 2001). In terms of ageing, glucorticoids are often used for the treatment of various medical situations including allergic, rheumatologic and neurologic disease. For example, glucorticoids are often administered to older people as anti-inflammatory agents (Martignoni, Costa, Sinforiani, Liuzzi, Chiodini, Mauri et al. 1992). Furthermore, some studies have reported changes in the levels of glucorticoids as people become older (Lupien, Roch Lecours, Lussier, Schwartz, Nair et al., 1994; Belanoff et al., 2001) where the level of cortisol in older people can either increase or decrease over time (Lupien et al., 1994). Increases in cortisol have been related to impaired cognitive functions (Kirschbaum, Wolf, May, Wippich & Hellhammer, 1996; O'Brian, Schweitzer, Ames, Tuckwell & Mastwyk, 1994; Lupien, Gaudreau, Tchiteya, Maheu, Sharma, Nair et al., 1997; Kalmijn, Launer, Stolk, de Jong, Pols, Hofman et al., 1998;

Adler & Jajcevic, 2001), whereas intact cognitive performance on tasks measuring attention and memory emerged in older participants whose level of cortisol reduced over time (Lupien et al., 1994; Belanoff et al., 2001). It is therefore possible that impaired attention and memory as a consequence of increased levels of cortisol might affect the ability to process and retrieve self-related information. As previously discuss, the self is supported by memory retrieval consistent with the view of the self that individuals possess (Higgins and Tykocinski, 1992; McAdams et al., 1997; Conway et al., 2004a). In the current study an age effect emerged on component of the self-processing that rely on episodic retrieval, As increased level of cortisol have been associated to reduced cognitive performance (e.g. memory retrieval) future investigations would investigate the effect of cortisol changes on the aspects of the self processing that rely on greater cognitive effort (e.g. episodic retreval).

High levels of cortisol have also been associated with exposure to stressful situations and chronic stress (Kirschbaum et al., 1996; Lupien et al., 1997). It could be argued that the testing situation is stressful, increasing the level of cortisol and resulting in poorer performance in our older adults on more cognitively demanding task. However, as high levels of education have been associated with lower levels of stress (Ruberman, Weinblatt, Goldberg & Chaudhary, 1984) and the current sample of older participants had a high level education and perform similarly to younger adults on most measures of the self, it might be speculated that they can implement successful strategies to cope with stressful situations. As such, their levels of cortisol might not have increased during the potentially stressful testing session, reducing the possible negative effect on their cognitive functions.

Reduced cognitive functions (e.g. maintenance and manipulation, memory, inhibition, attention) have also been associated with decline in the function of the dopamine (DA) system, which interacts with the DLPFC (Volkow, Gur, Wang, Flower, Moberg, Ding et al., 1998; Bäckman, Ginovart, Dixon, Wahlin, Wahlin, Halldin et al., 2000; Braver et al., 2001). For example, changes of the DA system have been associated with impaired performance on tasks thought to be sensitive to DLPFC deterioration (e.g. Wisconsin Card Sorting Test, Stroop Task; Volkow et al., 1998). As previously discussed, the processing the self has also been related to activity in the dorsal region of the PFC, especially in younger adults (Ruby et al., 2009). Specifically, involvement of dorsal areas in terms of self-related information have been reported when taking a third perspective on the self (D'Argembeau et al., 2007) as well as during the retrieval of detailed self-related past memories (Gilboa, 2004). Furthermore, DLPFC brain areas appear to be involved to a greater extent when making other rather than self-related judgements (Ochsner et al., 2005) and during cognitive rather than affective mental state attributions (Flethcer et al., 1995). As this evidence suggests that the DLPFC is involved in certain aspects of self processing, future studies might investigate the effect of DA changes on the processing of the self and other-related information.

Other health-related issues should also be considered. For example, it has been proposed that different diseases (e.g. diabetes mellitus, respiratory disease, sensory impairments) might negatively affect the cognitive performance of older adults (e.g. speed performance, memory, flexibility; Van Boxtel et al., 1998). It may be that the current sample of older adults had a healthy lifestyle that contributed to slower cognitive decline. In fact, a high level of education has been associated with healthy habits (Mirowsky & Ross, 1998). Overall, these considerations indicate that future investigations should take into consideration certain featuress that might negatively affect cognitive ageing including the level of cortisol and the ability to cope with stressful situations as well as the presence of other diseases.

On the basis of the above considerations, the current sample of participants might not be representative of the general older population. The results of the current study might instead apply to a specific subgroup of highly educated older individuals with high cognitive skills. Since the concept of the self was investigated in healthy adults with high cognitive abilities, it cannot be ruled out that older participants had an intact ability to retrieve episodic past events, which might have helped them to make accurate judgements and retrieve information encoded in relation to the self. Therefore, future investigation might determine what type of information individuals retrieve when making self-judgements and whether it differs in younger and older adults. For example, it has been shown that younger individuals recruit brain areas involved in inferential reasoning and episodic retrieval more than older adults when making self-related judgments, whereas older adults rely on their very well established knowledge of both the self and others (Ruby et al., 2009; Feyers et al., 2010). This suggests that the self-concept they possess might be supported by different types of information. Support for this view come from a recent study which showed that the concept of self could be accurately supported by abstract and semantic information (Rathbone et al., 2009). The authors investigated the concept of the self in a patient with severe retrograde amnesia. The self-concept was investigated with the "I AM" task, which requires participants to generate self-identities (e.g. I am a teacher) and to retrieve episodic memories associated with each self that is generated. The results showed that the patient was able to produce self-statements in a similar manner to control subjects. The self-identities produced were, however, sustained by semantic memories, whereas healthy controls reported more episodic self-knowledge to support their self-representation. These results suggest that self-semantic knowledge can be used to maintain a coherent sense of the self.

In terms of lesion studies, the current investigation showed that the ability to make self-related judgements was not impaired in patients with damage to the medial region of the PFC. Despite this result, it is not clear what type of information TH retrieved in order to make self-descriptive judgements. As previous studies have shown, the ability to retrieve episodic self-related information is impaired in confabulating patients (Dalla Barba, 1993; Conway et al., 1996; Fotopoulou et al., 2007b; 2008). Therefore, it may be the case that patient TH made accurate self–judgements on the basis of semantic-self information. Future work should determine the types of information that support the self-view. It should also be considered that the cognitive profile of patient TH (e.g. intact self, emotion recognition, intact affective ToM) resembles the cognitive decline expected for DLPFC brain damaged patients (e.g. impaired SOPT). As discussed, it might be that the VMPFC area was intact and that the brain damage involved other brain areas (e.g. DLPFC). On the basis of the view that self and ToM involve similar brain areas (Frith et al., 2003), it could be assumed that damage to the VMPFC would impair the processing of self-related information as in the performance on ToM tasks. In contrast, the performance of a DLPFC damaged patient might not differ compared to the performance of healthy controls. Such a result would provide support for the view that the PFC is not unitary and that distinct functions associated with the PFC can be separately affected by brain damage.

Finally, in order to better understand the neural correlates of self-processing and its relation to the ability to understand others' mental states and behaviour, future studies should investigate the way various components of the self are differentially affected by different diseases. For example, the self consists of different components (e.g. sense of agency, physical self; Gillihan & Farah, 2005). The physical self refers to awareness of self-related body parts, such as one's own face and it is known to involve the PFC, temporal and parietal regions (Kircher, Senior, Phillips, Benson, Bullmore, Brammer et al., 2000; Platek, Keenan, Gallup & Mohamed, 2004). Deficits of the physical self include autotopagnosia (e.g. a deficit in pointing to different body parts of the self and others) and asomatognosia, which manifests as the patient's belief that a paralysed arm does not belong to them (Feinberg, 2001). The sense of agency i.e. the awareness that one's own body is performing a given action relies on activation of parietal areas as well as sensorimotor and premotor cortex, the insula and the occipital region (Farrer & Frith, 2002; Farrer, Franck, Georgieff, Frith, Decety & Jeannerod, 2003). Impaired self-action recognition has been reported in schizophrenic patients as a delusion of control and in patients with parietal damage, where the movements of the arm are perceived as involuntary (Kircher & Leube, 2003; Bundick & Spinella, 2000). As the ability to make ToM attributions has been suggested to involve self-related knowledge (Frith et al., 2003), it might be expected that a deficit in processing self-related information would be accompanied by a deficit in making ToM attribution and in discriminating between the self and others. In line with this view, a recent fMRI investigation showed that the VMPFC, known to discriminate between the self and others (Kelley et al., 2002) is not preferentially involved when making self vs. other-judgements in a group of autistic patients (Lombardo, Chakrabarti, Bullmore, Sadek, Paso, Wheelwright et al., 2010b). This result would suggest that autistic individuals, known to be perform poorly on ToM task (Baron-Cohen et al., 1994; 1999) may also have deficits in discriminating between self and others. However, evidence indicates that this is not always the case and that, despite ToM deficits, some components of self-processing are intact in autistic individuals. For example, the sense of agency (e.g. awareness that I am executing an action) has been considered to be a precursor for the ability to mentalise in that it requires individuals to discriminate between the self and others (David, Gawronski, Santos, Huff, Lehnhardt, Newen et al., 2008). However, if this were true, a deficit in discriminating between the self- and othersperformed actions would be accompanied by a deficit in mentalising. This prediction was tested in a group of high functioning autistic individuals (David et al., 2008). In this study the ability to mentalise was investigated with a verbal (ToM stories; Happé et al., 1996) and a visual (Reading the mind in the eye task; Baron-Cohen et al., 1999) ToM task. The sense of agency was investigated with a joystick task: the participants were instructed to move a joystick to reach a visual target on a screen and they were provided with either real or false visual feedback (e.g. matching or non matching the movement they've just executed). Participants indicated whether they themselves or another person performed the movement on the screen. The results showed that the autistic group performed significantly more poorly than healthy controls on both ToM tasks. Yet, their performance on the agency task and their ability to discriminate between the self and others were intact. These results indicate that despite their intact awareness of self-performed action, autistic individuals are impaired when required to understand another person's mental state. This finding might indicate that self-agency and the self/other discrimination at the level of executed action is not a precursor of mentalising. In addition to the intact sense of agency, other studies (as discussed in Chapter 2) show that autistic individuals are not impaired in making accurate self-descriptive judgements (e.g. personality traits) whereas they show deficits in making other-trait judgements (Klein et al, 1999). Yet, not all self-related processing appears to be unimpaired. For example, autistic individuals do not show a memory advantage for personality traits encoded in relation to the self (SRE; Toichi, Kamio, Okada, Sakihama, Youngstrom, Findling et al., 2002), whereas the SRE emerged for self-executed actions (Williams & Happé, 2009), suggesting that different components of the self rely on different brain areas and can be dissociated in terms of different illnesses.

In contrast to the autistic individuals who appear to be unimpaired in processing some components of the self, other psychiatric syndromes (e.g. schizophrenia) are instead characterised by a deficit in relation to the self and, yet, their ability to mentalise appears to be intact (Frith et al., 1996). For example, it has been claimed that schizophrenic patients with symptoms of delusion of control or thought insertion would manifest impairment in attributing intentions to self, whereas symptoms of persecution would reflect a deficit in representing others' mental state (Frith et al., 1996). In their study, Frith et al. (1996) compared the performance of a group of schizophrenic patients with distinct symptoms (e.g. delusion of insertion, persecution) with that of healthy controls on ToM stories. Their results showed that those patients with delusions of control (thought to relate to impairment in attributing intention to the self) performed well on the ToM task, whereas those with symptoms of persecutions performed more poorly on mental state attribution. Altogether these studies show that different components of the self might be selectively impaired (e.g. self judgements and SRE). In order to better understand self-related functions and which brain areas support different self-components, future studies should investigate how different component of the self relate to one another and to ToM and how self-related impairments changes across different diseases.

In conclusion, the current study showed that processing components of the self thought to rely on greater cognitive effort such as episodic retrieval is affected by ageing in a sample of highly educated older participants. In contrast, ageing appears not to affect semantic self-related information. The results might be explains in terms of the greater deterioration of the DLPFC, traditionally associated to effortful retrieval (Gilboa, 2004). The same sample of older adults perform well on a series of task thought to rely on VMPFC activity, providing support to the view that this area of the PFC is less affected by age than DLPFC.

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Appendix 1: Invitation letter for participants

Psychology

SCHOOL *of* PHILOSOPHY, PSYCHOLOGY and LANGUAGE SCIENCES

The University of Edinburgh

7 George Square

Edinburgh EH8 9JZ

Telephone +44 (0) 131 650 9862

Fax +44 (0) 131 650 3230

Email sarah.macpherson@ed.ac.uk

Dear (Name)

I am writing to invite you to take part in a research study we are conducting at the Universitity of Edinburgh.

You have been chosen as you are a volunteer on the participant panel of the Department of Psychology, University of Edinburgh.

The study requires you to perform a series of tests, some of which take place on a laptop computer and some of which are paper and pencil. It is estimated that the interview is 3 hours long which can be divided into different sessions if you prefer. You will be paid £ 6.00 per hour. If you need a break at any time you are free to do so. The tasks would be carried out at the Department of Psychology, University of Edinburgh, 7 George Square at a time of your convenience.

As part of the study, we would also ask that a relative or friend who knows you well fills in three questionnaires about your personality and their own personality which you will bring the day of your appointment. This will take approximately 15 minutes and could be posted out to them. Any responses given to us by your relative/partner/friend will remain confidential and we will not reveal them to you. You will also be asked to fill out these questionnaires about yourself. We will not tell your relative/partner/friend how you responded to any of the questionnaires. You and your relative/partner/friend will be interviewed separately.

You will find more details in the enclosed information sheets.
In the next few days you will be phoned and given further information about the present study.

Yours sincerely

Alessandra Girardi

Appendix 2: Information sheet for participants

Psychology

SCHOOL *of* PHILOSOPHY, PSYCHOLOGY and LANGUAGE SCIENCES

The University of Edinburgh

7 George Square

Edinburgh EH8 9JZ

Telephone +44 (0) 131 650 9862

Fax +44 (0) 131 650 3230

Email sarah.macpherson@ed.ac.uk

Information Sheet for Control Participants

Study title: "Changes in Thinking and Behaviour after Subarachnoid Haemorrhage"

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

Following subarachnoid haemorrhage, some individuals show changes in their memory, thinking and behaviour. Using psychological tests and questionnaires, we hope to investigate these changes that individuals may experience. The performance of participants who have had a subarachnoid haemorrhage will be compared with control participants who have not had a subarachnoid haemorrhage.

Why have I been chosen?

You have been chosen as you are a volunteer on the participant panel of the Department of Psychology, University of Edinburgh. We will be seeing a total of 25 control participants. We will also be seeing a total of 75 patients.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

The study requires you to perform a series of tests, some of which take place on a laptop computer and some of which are paper and pencil. It is estimated that the interview is 3 hours long which can be divided into different sessions if you prefer. You will be paid £ 6.00 per hour. If you need a break at any time you are free to do so. The tasks would be carried out at the Department of Psychology, University of Edinburgh, 7 George Square at a time of your convenience.

As part of the study, we would also ask that a relative or friend who knows you well fills in three questionnaires about your personality and their own personality. This will take approximately 15 minutes and could be posted out to them. Any responses given to us by your relative/partner/friend will remain confidential and we will not reveal them to you. You will also be asked to fill out these questionnaires about yourself. We will not tell your relative/partner/friend how you responded to any of the questionnaires. You and your relative/partner/friend will be interviewed separately.

During the interview, there are tests in which we would like to audio record you. This is because the tests require you to tell us the answers out loud. By recording your answers, we do not need to write everything down immediately as you say it which saves time. We will ensure, however, that these recordings will be stored on a password protected computer and they will be destroyed once your answers have been written down and scored.
Your skin conductance response will also be recorded while you perform the Ultimatum Game task. This is a non-invasive technique which simply involves attaching electrodes to your fingertips and recording the changes in your skin moisture.

What do I have to do?

Firstly, the researcher would go through the information sheet with you and give you the opportunity to ask any questions. If you agree to take part, you would be asked to perform some tasks in the form of questionnaires, “paper and pencil” tests and computer tests. These tests are similar to word games and puzzles. The instructions for each test would be explained to you beforehand. All tests use materials presented in spoken, read or picture form and your responses are spoken, written or button presses.

What are the possible disadvantages and risks of taking part?

There are no known risks of the study. However, your participation in the study is entirely voluntary and you are free to decline to enter or to withdraw from the study any time without having to give a reason.

If you feel distressed at any time during the interview, it is important that you let the interviewer know straight away. If you feel distressed after the interview, please contact Dr Sarah MacPherson on (0131) 650 9862.

In the event that something unusual was found through your participation in the study, we would contact your GP.

Also, on receiving new information the researcher might consider it to be in your best interest to withdraw you from the study. If this is the case, he/she will explain the reasons to you.

What are the possible benefits of taking part?

There will be no direct benefit to you by taking part, and your individual results will not be revealed to you. However, we will make any future publications of the findings available to you. If you wish to obtain a copy of the results of the study, you should contact Ms Alessandra Girardi or Dr Sarah MacPherson, whose contact details are provided at the end of this information sheet. It is hoped that this research will improve our understanding of the changes in thinking and behaviour that people with stroke experience and may influence care practices in the future.

What if something goes wrong?

Whilst we do not anticipate any adverse effects from taking part in this study, if you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms should be available to you.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you will have your name and address removed so that you cannot be recognised from it. You will be allocated an anonymous ID code during testing which will be used in place of your name on any future publications.

What will happen to the results of the research study?

The results of the research will be published in appropriate peer-reviewed scientific journals for distribution to other healthcare professionals. Talks and presentations may be made at meetings and conferences. In all cases, your name and personal details will not be identified.

Who is organising the research?

The study is being organised by Dr Sarah MacPherson, Dr Christopher Butler, Dr Peter Keston, Dr Rustam Al-Shahi Salman and Professor Sergio Della Sala from the University of Edinburgh. The study is being carried out for educational purposes as a PhD study.

Who has reviewed the study?

This study has been reviewed and granted ethics approval by the South East Scotland Research Ethics Committee 2.

Contact for further information

If you wish to ask anything further, please contact Ms Alessandra Girardi or Dr Sarah MacPherson via the address below:

Department of Psychology, PPLS

7 George Square

Edinburgh, EH8 9JZ

Or via the following telephone number or email address:

Ms Alessandra Girardi on 0131 650 3426 (Alessandra.Girardi@ed.ac.uk)

Dr MacPherson on 0131 650 9862 (sarah.macpherson@ed.ac.uk)

Thank you for reading this information sheet. You will be given a copy to keep. If you have understood the contents of this sheet and wish to take part, please complete the consent sheet on the next page. If you have any questions please feel free to ask them now.

Appendix 3: Consent form for participants

Study Number: ******

Control Identification Number for this trial:

CONSENT FORM - Confidential

Title of project: **Changes in Thinking and Behaviour After Subarachnoid Haemorrhage**

Name of Researcher: **Dr Sarah MacPherson**

Please initial box

1. I confirm that I have read and understand the information sheet dated 06.08.09 (version 2) for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that my voice will be audio taped for the purpose of the study. ☐

4. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

1 for control; 1 for researcher

Appendix 4: Information sheet for control volunteer's partner/relative/friend

Psychology

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The University of Edinburgh

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Edinburgh EH8 9JZ

Telephone +44 (0) 131 650 9862

Fax +44 (0) 131 650 3230

Email sarah.macpherson@ed.ac.uk

Information Sheet for Control Volunteer's Partner/Relative/Friend

Study title: "Changes in Thinking and Behaviour after Subarachnoid Haemorrhage"

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

Following a subarachnoid haemorrhage, some individuals show changes in their memory, thinking and behaviour. Using psychological tests and questionnaires, we hope to investigate these changes that individuals may experience. The performance of participants who have had a subarachnoid haemorrhage will be compared with control participants who have not had a subarachnoid haemorrhage.

Why have I been chosen?

You have been chosen as your partner/relative/friend is a volunteer on the participant panel of the Department of Psychology, University of Edinburgh and has taken part in this study. We will be seeing a total of 25 control participants. We will also be seeing a total of 75 patients.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you decide to take part we would like you to complete two written questionnaires relating to your own personality and your partner/relative/friend's personality. The questionnaire can be filled in at home at your own convenience. This questionnaire should take approximately 15 minutes. The answers you give will be treated confidentially and we will not reveal them to your partner/relative/friend.

What are the possible disadvantages and risks of taking part?

If you feel distressed at any time during the interview, it is important that you let the interviewer know straight away. If you feel distressed after the interview, please contact Dr Sarah MacPherson on (0131) 650 9862.

What are the possible benefits of taking part?

There will be no direct benefit to you by taking part, and your individual results will not be revealed to you. However, we will make any future publications of the findings available to you. If you wish to obtain a copy of the results of the study, you should contact Ms Alessandra Girardi or Dr Sarah MacPherson, whose contact details are provided at the end of this information sheet. It is hoped that this research will improve our understanding of the changes in thinking and behaviour that people with stroke experience and may influence care practices in the future.

What if something goes wrong?

Whilst we do not anticipate any adverse effects from taking part in this study, if you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms should be available to you.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you will have your name and address removed so that you cannot be recognised from it. You will be allocated an anonymous ID code during testing which will be used in place of your name on any future publications.

What will happen to the results of the research study?

The results of the research will be published in appropriate peer-reviewed scientific journals for distribution to other healthcare professionals. Talks and presentations may be made at meetings and conferences. In all cases, your name and personal details will not be identified.

Who is organising the research?

The study is being organised by Dr Sarah MacPherson, Dr Christopher Butler, Dr Peter Keston, Dr Rustam Al-Shahi Salman and Professor Sergio Della Sala from the University of Edinburgh. The study is being carried out for educational purposes as a PhD study.

Who has reviewed the study?

This study has been reviewed and granted ethics approval by the South East Scotland Research Ethics Committee 2.

Contact for further information

If you wish to ask anything further, please contact Ms Alessandra Girardi or Dr Sarah MacPherson via the address below:

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Dr MacPherson on 0131 650 9862 (sarah.macpherson@ed.ac.uk)