The impact of normal human aging and Parkinson's disease on theory of mind.

by

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ABSTRACT

Although the majority of research in theory of mind (TOM) has focused on young children or individuals with autism, recent investigations have looked at TOM throughout the lifespan and in other neurologic and psychiatric populations. The proposed common connection between these groups is some degree of frontal dysfunction, often detected by measures of "executive function". This study investigated the effects of both normal human aging and Parkinson's disease on TOM. The relationship of TOM performance to measures of "executive function" and social decentering was also examined. The results suggested that a decline in TOM ability occurs with normal human aging and that this decline is magnified by the onset of Parkinson's disease. TOM performance was related to executive function. The implications for our understanding of the brain mechanisms underlying TOM as well as the impairments of Parkinson's disease are discussed.

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INTRODUCTION

"Theory of mind", sometimes described as "mindreading", refers to one's ability to infer the mental states of others and to predict behaviours based on these states (Premack & Woodruff, 1978). The notion of a "theory of mind" represents a unique coming together of many different disciplines within psychology. In reviewing the literature one will notice that researchers in different areas of psychology have been discussing issues related to theory of mind for many years. Although the jargon varies from area to area, the widespread interest in the notion of some "mindreading" ability gives credit to its relevance for human behaviour. In the past two decades, since Premack and Woodruff (1978) coined the phrase "theory of mind", the notion of a theory of mind per se, has transgressed areas of psychology including child development, abnormal psychology and psychopathology, social psychology and social cognition, cognitive psychology, and communication theory.

Much of the focus of human research has examined the development of a theory of mind in young children, and the possible impairment of theory of mind in individuals with autism. Researchers have argued that theory of mind deficits may underlie some of the fundamental social impairments which are characteristic of autism (Benson, Abbeduto, Short, Nuccio & Maas, 1994; Ozonoff, Pennington & Rogers, 1991a; Perner, Frith, Leslie & Leekam, 1989).

Recently, motions have been made toward moving "theory of mind" into the realm of neuropsychology. It has been suggested that individuals with autism may have some degree of dysfunction of the prefrontal brain region. Many of the impairments exhibited by autistic individuals are similar to those exhibited by patients with frontal lobe damage (Bishop, 1993). If theory of mind impairments are related to physiological or structural damage of the prefrontal region in autism, then the question is raised as to whether theory of mind impairments are present in other pathologies related to the frontal cortex, such as Parkinson's disease. A handful of recent studies have examined theory of mind in other neurologic (e.g. frontal-lesioned adults) and psychiatric populations (e.g. schizophrenia), and have suggested that theory of mind impairment is not a phenomenon restricted to autism.

A strong relationship between performance on theory of mind and executive function tasks has been shown in studies of autistic individuals. It has been suggested that impairments in theory of mind and executive function might both be explained in terms of prefrontal dysfunction (Bishop, 1993; Ozonoff et al., 1991a). Given these findings, it is reasonable to hypothesize that Parkinson's patients might also exhibit theory of mind deficits, in addition to impairments of executive function, related to dopamine depletion in the prefrontal cortex. This is particularly interesting in light of the social impairments reported after the onset of Parkinson's disease, and also the premorbid personality characteristics associated with Parkinsonian individuals.

The results of a study of theory of mind in Parkinson's disease would have implications for our understanding of the neuroanatomical and neurochemical mechanisms underlying theory of mind, as well as our understanding of the nature of the impairments in both autism and Parkinson's disease. Such knowledge would be beneficial in the development of remediation strategies for both of these disorders.

The proposed study will examine theory of mind and executive function behaviours in Parkinsonian individuals. It will attempt to shed light on the performance of these individuals relative to both young and elderly non-Parkinsonian participants. It is hypothesized that Parkinsonian participants will perform more poorly on tasks requiring executive function (than the non-Parkinsonian participants), and that this performance will be significantly related to their performance on tasks involving theory of mind.

In the beginning: A child's theory of mind

In perhaps the largest body of research in theory of mind, developmental psychologists have explored the emergence and subsequent development of theory of mind in early childhood. Perner and Wimmer (1983) first developed tasks such as the Sally Ann (or Maxi) story, in order to contrast the performance of three- and four-year old children. Years later, there is some contention among researchers as to the exact point in development at which a theory of mind is first expressed. Research has shown that, between the ages of two and a half, and three years old, children begin using mental state

terms such as "pretend", "believe", "want", and "think" to express an attitude or relation towards some proposition, e.g. Sally *thinks* the 'chocolate is in the cupboard' (Shatz, Wellman & Silber, 1983). Leslie (1987) has argued that since all theory of mind tasks require the acquisition of some metarepresentational ability, we may view pretend play (pretense) as an early stage in the development of a theory of mind.

The four year old child has come to represent a hallmark in the development of theory of mind. At this age, children are able to predict the behavioural consequences of someone having a false belief. Wimmer and Perner (1983) explained that understanding that a person can hold a false belief "requires explicit representation of the wrongness of this person's belief in relation to one's own knowledge, " (p.103). It has been argued that children younger than four years old may be unable to predict behavior based on a false belief, because they have trouble thinking of mental states as abstract entities that can have concrete causes and effects (Leslie, 1987). Understanding intentional deception is also considered a good marker of the development of a theory of mind, because it requires "conceptualization of the deceived person's wrong belief as a subgoal in one's planning strategy" (Wimmer & Perner, 1983, p.104). The ability to intentionally deceive (i.e. to create a false belief in another person), also emerges around the magical fourth year.

Perner (1992) argued that a child may possess a reasonably good understanding of the mind without understanding the notion of representation. This rudimentary type of awareness has limitations, which can be observed in specific circumstances. It explains

why it is possible for younger preschool children (two- to three-year olds) to use mental state words, before they are able to comprehend notions such as intentional deception and false belief.

Several paradigms have been developed in order to assess theory of mind, and to observe its development in various groups. Standard tasks tap such skills as the appearance-reality distinction, deception, and the understanding of false beliefs. Researchers have also distinguished between those tasks which require *first-order* or *second-order attributions.* First-order attributions require the subject to attribute a mental state to some person (i.e. he *thinks* it is in the cupboard), and to correctly predict that person's behaviour based on it. Second-order attributions are more complex in that the subject must infer how one person would attribute a mental state to a second person (i.e. she *thinks* that he *knows* where it is hidden). One example of a third-order attribution has been given by Happé (1994), in the form of a "double bluff" scenario (i.e. he *knows*, they *think*, he will *lie*).

There has been some criticism of the tendency of developmental researchers to focus on the four-year old's theory of mind. Some have referred to the four-year old research focus as the "one miracle" approach (Chandler & Lalonde, in press; Wellman, 1990). The "one miracle" refers to the acquisition of false-belief understanding at four years of age, after which a child is presumed to possess the maximal level of skill in understanding mental states. Critics of this approach have primarily taken two forms: (a) those who agree with an underlying metarepresentational structure in the development of theory of mind, but

who argue that a single "miracle" is not sufficient to explain our understanding of mental states; and (b) those who argue that the metarepresentational approach itself is insufficient to explain the reported phenomena.

Researchers in the first group have based their arguments on empirical findings that children continue to make progress and gain sophistication in their understanding of mental states well into middle childhood years (Chandler & Lalonde, in press; Wellman, 1990). Chandler and Lalonde (in press) argued that the source of misunderstanding in the "one miracle" account stems from a mistaken view that false-belief understanding is tantamount to having a fully developed interpretive theory of mind. These authors contended that:

> ...young preschool children first come to the view that minds are pure accommodation-side devices that simply "copy" a world that is assumed to be under no reciprocal obligation to do any "fitting" of its own. Not until some years later...do somewhat older school-age children first begin to move toward any real understanding of the mind as a two-way street that also fits or assimilates the world to its own nature, (p.119).

Chandler and Lalonde (in press) found that many children aged five- to seven-years old who were able to successfully complete standard false-belief tasks, were unsuccessful on more interpretive theory of mind tasks. In both tasks the children were shown a set of cartoon-type drawings called Droodles. In the false-belief portion of the task, the children were shown the whole picture and then the picture was covered so that only a small portion of the drawing was visible through a cut-out window. They were then asked what a puppet would think the picture was of, given that they only saw the cut-out window

portion. In the interpretation task, participants were then asked what another puppet would think the picture was, if it didn't think it was the same thing as the first puppet. The results showed that while a majority of the children were able to complete the false-belief task, these same children were unable to recognize that a second puppet could have a different interpretation of the same stimulus. Chandler and Lalonde (in press) concluded that the emergence of false-belief understanding is a necessary but not sufficient condition for the attainment of a more constructive or interpretative view of mental processes. Recent investigations using second-order attribution paradigms have also supported the notion that children's understanding of mental state terms and relationships becomes more sophisticated with age (Homer & Astington, 1997). When asked to justify their responses as to why a character behaves in a particular way, younger children (ages five to six years) tended to give vague responses which relied on factual information from the story, while older children (ages seven and eight years) were able to give more explicit answers using mental state terms (Homer & Astington, 1997).

Although the present study followed closely from the metarepresentational explanation of theory of mind, it is nonetheless important to acknowledge critics of this approach altogether. Hobson (1991) argued that not only is the metarepresentational explanation insufficient to explain our understanding of mental states, but he also maintains that it is improper to conceive of this process as a "theory" per se. For an entity to be considered a theory, Hobson pointed out that it must meet certain criteria. One of these criteria is that,

> when theorists derive hypothetical terms and "entertain" a theory, they critically review how far the available evidence supports or refutes their position, and anticipate that in light of new evidence they may have to modify or abandon the theory in favour of an alternative view of the way things are, (p.36).

He draws attention to the fact that a theory is "used" by a person, rather than operating at a subpersonal level. According to this perspective, a child who is entertaining a "theory" of mind must already have some concept of mind, and understand what it means to theorize. Moreover, Hobson argued that there is no evidence that would persuade us to give up our conviction that other people have minds, and therefore it is a *fact* to us that people have minds -- not a theory. Hobson proposed an alternative approach to the metarepresentational explanation. He suggested that, "a child arrives at knowledge about the nature of persons, i.e. people with bodies and minds, through experience of affectively charged interpersonal relations," and that "there are biological foundations for such relations in innate propensities to 'perceive' and relate towards the bodies of others with coordinated patterns of action and feelings," (p.44).

Regardless of which theoretical stance one adopts, it is clear that one must consider not only that theory's ability to conceptualize the notion of a theory of mind in normal human development, but also in situations where theory of mind is impaired (e.g. autism).

Autism, executive function and theory of mind

Autism is pervasive developmental disorder, diagnosable under the Diagnostic and Statistical Manual - 4th edition (DSM-IV). It is characterized by impaired peer relationships, poor social skills and emotional reciprocity, and stereotyped movements (e.g. hand flapping). Biological and neuropsychological models of autism have noted the similarities between individuals with autism and adults with damage to the frontal lobes, basal ganglia and limbic system (Happé & Frith, 1996; Gillberg, 1988; Damasio & Maurer, 1978). Damasio and Maurer (1978) described these disturbances in terms of four categories: motility, communication, attention and perception, and ritualistic and compulsive behaviours. Disturbances of motility reported in autism include: (1) bilateral or unilateral "striatal" toes, which are also commonly seen in Parkinson's disease; (2) involuntary dyskinesias of the mouth and extremities, as well as other involuntary "tic-like" movements; and (3) abnormal posture and gait, sometimes resembling a Parkinsonian-type gait. The authors pointed out that all of these disturbances are classical neurological signs of basal ganglia (especially the neostriatum) and frontal lobe dysfunction (mesial aspect).

Disturbances of communication reported in autism include mutism in many cases, or speech production which is marked by immediate or delayed repetition (echolalia). These communication disorders do not resemble any fluent or nonfluent acquired aphasias caused by damage to the dominant hemisphere language areas; however, they do resemble deficits exhibited by mesial frontal-lesioned patients during recovery, including a lack of

initiative and cognitive organization due to damage to the supplementary motor area or cingulate gyrus. Damasio and Maurer (1978) concluded that the communication deficits in autism likely arise from dysfunction of related structures of the periallocortex of the mesial frontal lobe and neostriatum.

Regarding the attentional and perceptual disturbances in autism, the authors pointed out that the limbic system is necessary in "executive control", which modulates responses according to "goals" (p.780). Finally, ritualistic and compulsive behaviours in autism are marked by a maladaptive response to unfamiliar settings, stereotyped and ritualistic behaviours, and perseveration. These types of behaviours have also been reported in frontal patients, particularly early onset. The authors also reported that animal studies have shown that lesions of the striatum and mesolimbic structures produce similar stereotyped behaviours.

Based on the similarities between the deficits in autism and in frontal-lesioned patients, Damasio and Maurer (1978) concluded that autism is likely related to dysfunction of the mesial aspect of the frontal and temporal lobes, including the supplementary motor area, cingulate gyrus, entorrhinal areas, parahippocampal gyrus and the neostriatum. The mesial frontal lobes are cytoarchitecturally distinct because they are formed of a transitional type of cortex called periallocortex (or mesocortex), and also because the frontal area and neostriatum are both termination sites of dopaminergic neurons arising in

the mesencephalon. In light of this information, Damasio and Maurer (1978) argue that the neural dysfunction in autism could be anatomical or neurochemical.

Further research has provided evidence for frontal involvement in the impairments of autism. Using brain imaging techniques, such as MRI and CT scannings, researchers have discovered cerebral blood flow (CBF) abnormalities in autism participants, as compared to non-autistic control participants. George, Costa, Kouris et al. (1992) found that an autistic adult group had regionally decreased flow in the right lateral temporal and right, left and midfrontal lobes, as compared to controls. It has been suggested that CBF patterns detected in children with autism reflect a delayed frontal maturation, which is consistent with the clinical data and cognitive performance of autistic children, including theory of mind (Zilbovicius, Garreau, Samson, Remy, Barthélémy et al., 1995).

Many researchers have suggested that an impaired theory of mind may underlie some of the fundamental social impairments which are characteristic of autism, including abnormal social relationships, and the lack of understanding and use of social conventions (e.g. Perner et al., 1989; Ozonoff et al., 1991a; Benson et al., 1994). Social impairments commonly reported in autism include impaired play development (Roeyers & van Beckelaer-Onnes, 1994; Leslie, 1987), poor turn-taking ability (McEvoy, Rogers & Pennington, 1993; Mundy, Sigman, Ungerer & Sherman, 1986), impaired social interactions (Buitelaar, 1995) and impaired joint attention behaviours (McEvoy et al., 1993). Theory of mind tasks were designed to tap the deficiency in attributing mental

states which presumably underlie these social/interactive deficiencies. The tasks themselves do not measure actual social inadequacies, rather it is inferred that failure on such tasks reflects the underlying source of such social impairments. Studies have shown that autistic individuals are typically impaired on first- and second-order false-belief tasks (Benson et al., 1994; Ozonoff et al., 1991a; Perner et al., 1989), appearance-reality tasks and mental-physical distinctions (Ozonoff et al., 1991a), and first- and second-order deception tasks (Happé, 1994; Tager-Flusberg & Sullivan, 1994), as compared to age-matched controls, and to IQ matched Down syndrome children. Correlations between social and pragmatic communication behaviours, and theory of mind tasks, provide some support for the relationship between theory of mind and social skills performance (Happé, 1993; Dawson & Fernald, 1987).

It should be noted that there is some controversy among researchers concerning whether theory of mind is the primary deficit in autism, or merely one of several impairments (Bishop, 1993; Ozonoff et al., 1991a). The issue has been compounded by recent reports suggesting that all individuals with autism are not equally impaired in theory of mind performance. Several studies have suggested that verbal ability may play a crucial role in theory of mind impairments, since autistic children with higher verbal mental ages tended to perform better on theory of mind tasks, and in many cases successfully completed them (Dahlgren & Trillingsgaard, 1996; Sparrevohn & Howie, 1995; Happé, 1995). It is unknown, however, whether higher verbal ability is necessary for theory of mind development, or if some theory of mind ability underlies more sophisticated language

acquisition (Happé, 1995). Further, these authors have been quick to point out that successful completion of theory of mind tasks does not necessarily imply normal development in these children. As was first addressed by Perner (1989), it is possible that autistic children who possess higher verbal ability may be able to compensate for their poor mindreading ability by using other (more cumbersome) cognitive strategies to complete the tasks. Nonetheless, the fact remains that some autistic children, as well as healthy preschool-aged children, show consistently poor performance on such tasks, and these findings remain a challenge for theorists to explicate.

Brain mechanisms and pathology in theory of mind

In terms of explaining the underlying mechanisms of theory of mind, several explanations have been forwarded. Some investigators have argued that impairments in theory of mind are in truth impairments in pragmatic language comprehension rather than conceptual impairments in theory of mind (Siegal, Carrington & Radel, 1996). These researchers have argued that failure on theory of mind tasks occurs because individuals are unable to interpret the pragmatic aspects of communication, which are present in such tasks.

Others have argued that theory of mind is, in fact, a conceptual skill controlled by a broad cognitive module which processes socially-relevant information, including faces and nonverbal gestures (Brothers & Ring, 1992). Brothers and Ring (1992) have argued that what results from selective damage to this module would represent an impaired theory of

mind. Support for this hypothesis has come largely from animal models of intentionality which have identified single neurons with selective responsivity to features of the behaviour of others individuals (Brothers & Ring, 1993; Brothers, Ring & Kling, 1990). Much of the focus of such research has been on the limbic system, and in particular, the amygdala, as playing a crucial role in the representation of mind (Brothers & Ring, 1992). According to these authors, the main difficulty in applying such a theory to human social cognition is accounting for "the infamous plasticity of social judgments and responses based on cultural learning and social experience" (Brothers & Ring, 1992, p.115). Nonetheless, some support for such a model in humans has been provided by Karmiloff-Smith, Klima, Bellugi, Grant & Baron-Cohen (1995) who showed that theory of mind performance was impaired in children with autism, but preserved in those with William's syndrome. They argued that this dissociation provides some evidence for the existence of a broad cognitive module which is responsible for processing socially relevant information, and that this module develops progressively during the early years, to become ultimately an automatic processor.

Regardless of which theoretical explanation one chooses, there has been increasing evidence to suggest that theory of mind performance (by whichever process) might be subserved by areas in the prefrontal brain region. In autism this has been inferred from the observed correlations between theory of mind and executive functions. It has been suggested that impaired performance on theory of mind tasks may be related to executive dysfunction in autism (Happé, 1994; Bishop, 1993; Ozonoff et al., 1991a). Executive

function denotes the ability to maintain an appropriate problem-solving set for the attainment of some future goal (Welsh, Pennington & Grossier, 1991). Example of tasks which are thought to tap executive function include the Wisconsin Card Sorting Task (Grant & Berg, 1948), and Self-Ordered Pointing (Petrides & Milner, 1982). Many studies have reported impairments in executive function in individuals with autism (Bennetto, Pennington & Rogers, 1990; Ozonoff et al., 1991a; Ozonoff & McEvoy, 1994; Hughes, Russell & Robbins, 1994). Aside from autism, researchers in several areas have implicated the prefrontal cortex in executive function behaviour. For example, phenylketonuria (PKU) is an inherited metabolic disorder in which there is a depletion of dopamine in the prefrontal cortex due to a defective enzyme. Studies of children with PKU have shown that they can exhibit specific executive function deficits (i.e. without other cognitive dysfunction, and preserved intellectual functioning), and it has been hypothesized that this is due to the depletion of dopamine in the prefrontal area (Diamond, Ciaramitaro, Donner, Dhali & Robinson, 1994; Ris, Williams, Hunt, Berry & Leslie, 1994; Welsh et al., 1990). The "prefrontal dysfunction" hypothesis has been projected in several other disorders, including Parkinson's disease (Brown & Marsden, 1990). Studies have also suggested that executive dysfunction may occur as a result of normal human aging (Parkin & Lawrence, 1994).

Several studies have revealed correlations between the level of performance on tasks of executive function and theory of mind, in autistic samples (e.g. Happé, 1994; Ozonoff et al., 1991a). Leslie (1987) proposed that theory of mind and executive function are similar

in that they require the use of already existing information in either problem-solving or prediction. The possibility that deficits in executive function could explain deficits in theory of mind is unlikely, however, based on findings in high functioning children with autism, and those with Asperger's syndrome. While Asperger's syndrome is also classified as a Pervasive Developmental Disorder (DSM IV, 1994), individuals with Asperger's do not manifest the same impairments in language and social behaviours, as are evident in autism. Ozonoff, Rogers and Pennington (1991b) compared the performance of children with Asperger's syndrome to that of children with autism, on theory of mind and executive function tasks. The results suggested that, while both groups were significantly impaired on the executive function tasks, children with Asperger's were unimpaired on the theory of mind tasks, compared to age, sex and VIQ-matched control subjects. The authors concluded that there cannot be a causal relationship between executive function and theory of mind performance, based on this dissociation.

Alternatively, Ozonoff, Pennington and Rogers (1991a) suggested that a widespread prefrontal impairment could be responsible for the impairments in both executive function and theory of mind. They noted that, while dorsolateral prefrontal damage has been shown to cause deficits in executive function such as perseveration, planning and impulsivity (Stuss & Benson, 1984), orbitofrontal damage often leads to social isolation, impaired social communication and lack of appreciation of social rules (Damasio & Van Hoesen, 1983). Price, Daffner, Stowe and Mesulam (1990) also found that early prefrontal damage in non-autistic populations leads to deficits in interpersonal role taking.

A recent investigation in neuroimaging supported these inferences by demonstrating prefrontal activation during theory of mind tasks in normal human adults and individuals with autism (Baron-Cohen, Ring, Moriarty, Schmitz, Costa & Ell, 1994). Investigations of other neurological and neuropsychiatric populations thought to be associated with some prefrontal pathology, (i.e. schizophrenia and conduct disorder) have also found impairments in the attribution of mental states (Frith & Corcoran, 1996; Happé & Frith, 1996). Together these findings lend support to the notion that theory of mind ability is likely related to prefrontal functioning. Thus, regardless of one's theoretical orientation, the question is raised as to the specificity of theory of mind dysfunction in autism, or whether such impairments may be present in other prefrontal pathologies.

Parkinson's disease: An overview of cognitive impairments

Several cognitive deficits have been reported in individuals with Parkinson's disease, including impaired "internal" control of attention, temporal order, set shifting and planning (Brown & Marsden, 1990; Taylor, Saintl-Cyr & Lang, 1986). Like autism, many of these behaviours resemble deficits in patients with frontal-lobe lesions, and are such that might be labeled "executive function" behaviours (Taylor et al., 1986).

Brown and Marsden (1990) discussed two theories which have been advanced in explanation of the deficits in Parkinson's disease. According to the "black box approach",

humans have a limited capacity to perform "mental work". There is a limited capacity central processor which supervises and allocates mental resources (e.g. the Central Executive, in working memory literature), such that a dysfunction in this Central Executive would result in the frontal-type impairments observed in patients with Parkinson's disease. The second theory ("frontal caudate loop" theory), provides a more anatomical base of evidence. In Parkinson's disease, degeneration of the substantia nigra leads to a depletion of striatal dopamine. There is also a degeneration of cells in the ventral tegmental area, which could lead to depletion of dopamine in the prefrontal cortex. Based on the functional significance of these pathways and systems, determined through lesion studies and physiological recordings in animals, and our understanding of the organization of the neuronal system, as provided by animal studies, Brown and Marsden (1990) contend that the dopamine depletion hypothesis could provide a reasonable explanation for the prefrontal-type deficits in individuals with Parkinson's disease. This suggestion has been supported by a number of other studies which have likened the poor performance of individuals with Parkinson's disease (on measures of executive functions) to that of patients with mixed frontal aetiology (Bondi, Kaszniak, Bayles & Vances, 1993; Litvan, Mohr, Williams, Gomez & Chase, 1991; Levin, Llabre & Weiner, 1988; Taylor et al., 1986).

In addition to frontal-type impairments, patients with Parkinson's disease are sometimes reported to have memory impairments. In a recent study, Bondi et al. (1993) acknowledged that these patients have deficits in multiple cognitive domains, however

they argued that, "when the relative impairments in such functions are assessed...frontal system dysfunction apparently accounts for many of the failures in other task domains," (p.98).

Social and Emotional Impairments in Parkinson' disease

Several studies have suggested the existence of a premorbid personality type associated with individuals who later develop Parkinson's disease. Eatough, Kempster, Stern and Lees (1990) reported significant differences in psychological mindedness and flexibility between patients with Parkinson's disease and non-Parkinsonian control subjects, such that Parkinson's patients were less flexible and more cautious. They also reported that these patients tended to be more conventional and stereotyped in their thinking. Individuals with Parkinson's disease have also been suggested to be greater social conformists and more deferential to authority, with a more rigid personality (Eatough et al., 1990; Poewe, Karamat, Kemmler & Gerstenbrand, 1990). Poewe et al. (1990) indicated that individuals with Parkinson's disease are more socially alert, more apprehensive, self-reproaching, tense, driven, restless, skeptical and cautious. These findings confirmed the notion of a premorbid personality style in individuals with Parkinson's disease, marked by introversion, rigidity and inflexibility. Poewe et al. (1990) suggested that these traits may be linked to early difficulties in conceptual shifting and bradyphrenia, and may be a reflection of early dopamine depletion.

In addition to these impairments, depression, forgetfulness and reduced spontaneity are common characteristics reported by individuals with Parkinson's disease. Depression is the most common form of emotional disturbance, although depressed mood, anxiety and fatigue have also been reported (Rao, Huber & Bornstein, 1992). Starkstein, Preziosi et al. (1990) found that particular subtypes of cognitive dysfunction (including deficits in verbal fluency and executive function) were associated with depressive symptoms, as was age at the onset of the disease (early or late). Mayberg, Starkstein, Sadzor et al. (1990) found that "none of the depressed patients [in their sample] and all of the non-depressed patients showed an error-free performance on the Trail Making Test part B" (p.59), a frontal-lobe related task. This is particularly interesting in light of the same study's finding of "relative hypometabolism involving the caudate and orbital-inferior area of the frontal lobe in depressed compared with non-depressed patients with Parkinson's disease," (p.61).

Masked facial features are also a classic symptom of Parkinson's disease. Borod, Welkowitz, Alpert, Brozgold et al. (199) found that patients were impaired in expressing facial emotions, but could express the same emotions vocally. Visual perception and recognition of emotion was also intact.

THE CURRENT STUDY: PREDICTIONS

A strong relationship between performance on theory of mind and executive function tasks has been shown in studies of autistic individuals. It has been suggested that impairments

in theory of mind and executive function might both be explained in terms of prefrontal brain dysfunction (Bishop, 1993; Ozonoff et al., 1991a). Given these findings, it is reasonable to hypothesize that Parkinson's patients might exhibit impairments in theory of mind, in addition to executive function, related to dopamine depletion in the prefrontal cortex. This is particularly interesting in light of the social impairments reported after the onset of Parkinson's disease, and also the premorbid personality characteristics associated with Parkinsonian individuals.

There has also been some suggestion in the scientific literature that executive functions tend to decline with age. Because of the nature of the control groups in this study (i.e. healthy older adults and younger University-aged students), it is within the scope of this investigation to have a preliminary glance at the performance of elderly individuals in the area of theory of mind. One might suspect that impairments in executive functioning would be related to difficulties in "mindreading", although this hypothesis has never been explored previously.

Specifically, the following hypotheses were made: (1) On measures of executive function and theory of mind, it was predicted that individuals with Parkinson's disease would perform more poorly than the healthy elderly participants; (2) It was expected that the performance of the elderly participants would be poorer than that of the university-aged participants; (3) For all groups, it was predicted that performance on measures of theory of mind would be significantly related to measures of executive function; (4) It was

predicted that measures of theory of mind might be related to ratings given on the Social Decentering Scale, and (5) that ratings given on this scale might differ between the elderly control and Parkinson's groups.

METHODS

Participants

Three groups of subjects participated in this study. The first group consisted of twelve non-demented individuals with Parkinson's disease. These individuals were referred to the study by their neurologist, or alternatively, responded to a presentation given at a meeting of the Victoria Parkinson's Society. The second group consisted of eight healthy elderly individuals who were matched to the group of individuals with Parkinson's on the basis of age, sex and IQ. Participants in this group included mainly spouses of the experimental subjects. The third group consisted of nine healthy university-aged students who participated in this study as part of their course requirement. Demographics for these groups are presented in Table 1.

Table 1. Summary data for the groups.

	Parkinson's	Elderly Control	University Control
Age (years)			
Mean	70.98	71.61	20.87
SD	13.43	9.42	2.53
Range	48.00 - 84.83	49.50 - 79.67	18.58 - 25.91
Sex			
M	6	3	3
F	5	5	6
Education (years)			
Mean	12.80	12.75	13.11
SD	0.79	2.05	0.86
Range	12 - 14	10 - 17	12.5 - 15.0
Vocabulary (Age SS)			
Mean	12.45	12.13	11.44
SD	2.81	1.89	2.40
Range	8 - 17	9 - 15	7 - 15

Individuals in all three groups were screened for general level of cognitive functioning using the Mini Mental Status Exam MMSE; Folstein et al., 1975, prior to inclusion in this study. All participants scored well above the recommended cut-off for dementia (all above 26), and therefore, no one was excluded from the study on this basis. Participants were also screened for depression using the Geriatric Depression Inventory (Yesevage & Brink, 1983) for the two elderly groups, and the Beck Depression Inventory (Beck & Beck, 1972) for the university students. Individuals were not excluded from the study on the basis of elevations on either of these scales. However, these measures were included

as covariates in several of the statistical analyses in order to ensure that any differences between the groups did not impact on the overall results.

All participants completed the Vocabulary subtest of the Wechsler Adult Intelligence Scale - Revised edition (WAIS-R; Wechsler, 1981). This information was used to ensure that the three groups fell within the average level of conceptual ability, and that there were no differences between the groups. Age-adjusted scaled scores were recorded.

Measures

Executive Functions

The California Card Sorting Task (Delis et al.,1992) is a relatively new sorting task designed to "isolate and measure specific components of problem-solving ability". The test consists of two sets of stimulus cards. Each set is made up of six cards with a single word printed on each card. The cards can be sorted in two equal piles according to various rules (e.g. shape, size, colour of the card). For each set, the participants completed two sorting conditions. In the *free sorting* condition, participants are instructed to sort the cards into two piles, with three cards in each pile. After each sort, subjects were asked to explain how the piles were different. Participants were instructed to continue sorting the cards as many different ways as they could until the time limit (three minutes) had expired. In the *structured sorting* condition, the examiner sorted the cards into two equal piles according to eight different rules. Participants were given one minute to explain how the two piles differed. Several measures were recorded from these

two conditions. From the free sorting condition, participants were evaluated on the total number of correct sorts, and the total points awarded for their verbal responses. In the structured condition, participants were scored on their verbal responses only.

In the verbal fluency task (letters F,A,S), participants were given one minute to generate as many words as they could, for each of the letters, "F", "A", and "S", excluding proper names (e.g. Frank), names of places (e.g. France), or numbers (e.g. five). The total number of words recounted for all three letters was recorded.

The five-point fluency task (also called figural fluency) required participants to make as many different designs by joining the five dots (like on a dice) as they could in three minutes. The total number of original designs and the number of repetitions were recorded.

Theory of Mind Tasks

Participants heard two short false-belief stories: one first- and one second-order attribution task (Happé, 1994), followed by a series of questions. Participants were read the story aloud, but also were presented with a typewritten copy of the story in front of them, to follow along. Participants were allowed to keep the typewritten copy of the story in front of them while answering the questions, in order to minimize memory requirements. Following each story, participants were asked three types of questions. First, the memory question asked the participant to recall some piece of factual

information from the story. This question served as a check to determine whether participants were unable to complete the task because of memory difficulties. Second, the prediction question required the subject to make some kind of prediction regarding the behaviour of one of the characters in the story, based on the available information. The answer to this question was not explicitly available within the body of the story, but rather required the subject to infer such information based on the mental states and actions of the characters. Third, in the justification question, participants were asked why they made a particular prediction, and to give a short explanation of their reasoning. On each of the three questions, participants received a score of zero or one (incorrect or correct) for a maximum score of six on the two stories combined.

In the Droodles Task (Chandler & Lalonde, in press), participants were shown a cartoon-type picture which was taped inside an 8.5 x 11 cm filing folder. For the first folder/picture, participants were shown only the cut-out window portion of a picture, and asked to provide as many possible guesses as to the true picture content. For the remaining four folders/pictures, participants were first shown and asked to describe the whole picture. Then, the picture was covered so that only a small portion was visible through a cut-out window. Participants were asked to predict what another person (Bill, who has not seen the entire picture) would think that picture was. Then, participants were asked to predict what a second person (Roberta) would think the picture was, if she didn't think the same thing as Bill. Participants received a score of zero or one (incorrect or correct) for their predictions of Bill and of Roberta, for a total score of four points for

Bill's responses (first-order attribution), and four points for Roberta's responses (interpretation).

The "spy" model task was adapted from the hide-and-seek task introduced by Chandler, Fritz and Hala (1989) and Hala, Chandler & Fritz (1991), to control for memory and verbal components in theory of mind performance. The "game board" for this task consisted of an 18 x 24 inch white erasable board as the base, with pieces of miniature wooden furniture placed on top to simulate an office setting. In this task, participants took the role of a "spy/detective" whose goal it was to retrieve a secret document without getting caught. Participants were informed that because of an unfortunate thunderstorm, they were automatically considered "dripping wet", and therefore they would leave a trail of watermarks everywhere they walked (simulated by tracing their pathway around the model with a blue pen). Participants were instructed to figure out the best way to steal the document from the filing cabinet without anyone knowing that they had taken it. Participants were given the option of demonstrating their plan by moving with the pen around the model, or by explaining their plan verbally. Possible solutions to this puzzle included wiping up the tracks with paper from the garbage, or making more than one set of tracks to confuse the police. Any solution that demonstrated an understanding that they must hide their path to the cabinet was accepted. Participants were scored either Pass (one point) or Fail (zero points).

In the Knower/Guesser ("egg cup") task, adapted from Povinelli, Nelson and Boysen (1990), participants were shown four egg cups which had been turned upside down. They were told that a paperclip would be hidden underneath one of the cups. While the clip was being hidden, a cardboard screen was placed in front of the cups, such that the participant could see that the clip was *being* hidden, but not *where* it was hidden. Subjects were told that after the clip was hidden the screen would be removed. At this point, the examiner and her confederate (another graduate student) simultaneously pointed to the location where she *thought* the clip was hiding. The participants were instructed that the examiner and the confederate would point honestly and would not try to deceive them in any way. Subjects were informed that, in order to make the task more difficult for the confederate, she would cover her eyes with a blindfold, while the clip was being hidden. The participants were then given eight trials in which they had to figure out the location of the clip. If at any point the participant verbally indicated that they understood that the clip was always in the location where the examiner was pointing, the procedure was terminated and the participant was given credit for the remaining trials. At the end of eight trials, participants were asked how they knew where the clip was hiding, or if they used any strategies for locating it. Participants were scored on the number of correct guesses they made.

A summary score indicative of one's overall performance on the four measures of theory of mind, was assigned to each participant (TOM composite score). Participants received

one point for each theory of mind task they successfully completed (maximum = 4 points). Success on the tasks was determined as follows:

1. Stories - the participant answered all questions correctly;
2. Model - the participant was able to provide one or more possible solutions;
3. Knower/Guesser - the participant was able to recognize that the examiner was manipulating the hiding location, and that following the lead of the examiner would ensure success;
4. Droodles - the participant was able to give the correct first-order and interpretive answers for all items.

Social Decentering

This scale (Redmond, 1995), consists of 35 short statements to which participants are asked to respond on a five-point Likert-type scale (5=strongly agree, 1=strongly disagree). The content of the questions included mainly issues of interpersonal relations, mental representation, and cognitive and emotional responses to various situations. Each statement is coded along three dimensions, according to the following "mapping sentence" :

> When a person (X) considers another person's response (Y) to a given situation (Z) that person (X) might draw
>
> upon (A) (a1 experience-based) information applied to
> (a2 fantasy-based)
>
> (b1 self)
> or derived from (B) (b2 a specific other) producing (C)
> (b3 generalized other)
>
> (c1 cognitive) response
> (c2 affective)

Summary scores for each of a1 through c2 are calculated for each subject.

Procedure

Both the elderly and Parkinson's participants were contacted by the author and invited to participate in the study, either in their homes, or at the University of Victoria. Participants were given a brief description of the study over the phone, and again before signing the consent form. Each person was given an opportunity to ask questions about the study and procedure before signing the form. The protocol was completed in one session, lasting from one-and-a-half to two hours, taking breaks as needed by the participant. Half of the participants were tested by the author, and the other half by a trained graduate student. Upon completion of all of the tasks, participants were given a stamped, self-addressed return envelope, containing the Social Decentering Scale. The experimenter briefly reviewed the questionnaire with the participant, and asked the participant to please complete it at his/her convenience, and return it to the University by mail. The experimenter answered any further questions about the study and thanked the subject for his/her participation.

University of Victoria students were invited to participate in this study as part of their course work in an Introductory Psychology class. Testing was carried out at the University of Victoria, and was identical to the protocol used with the other participants, except that the students were not required to complete the Social Decentering Questionnaire.

Statistical Analyses and Design

Group comparisons of theory of mind performance were conducted initially on the TOM composite score. This procedure was chosen in order to limit the number of analyses being carried out on a small sample, and thereby reducing the probability of committing a Type I error. Subsequently, group comparisons were computed for each dependent variable individually, for more exploratory purposes. These results should be interpreted within the context of this small sample, and may not be generalizable to the larger population.

The data were analyzed using ANOVA with planned comparison tests according to the first two questions under investigation. These analyses were one-tailed, based on the specific predictions that individuals with Parkinson's disease would be impaired compared to the elderly, and that the elderly would be impaired compared to the younger control subjects. In addition, planned comparisons were performed for the subject groups' mean age, education and WAIS-R Vocabulary scores (as shown in Table 1). Other than a significant difference in age between the young and older (elderly and Parkinson's) groups, no significant differences were found for these planned comparisons. These analyses were two-tailed.

Pearson product-moment correlations were used to investigate the relationship of theory of mind performance to executive functions.

RESULTS

Prior to the analyses, the data were examined for the presence of missing data and outliers. One statistically significant outlier was identified in the group of individuals with Parkinson's disease, based on exceptionally good performance on all tasks. This participant (female) was, therefore, excluded from the analyses, leaving eleven participants with Parkinson's disease.

Because the assumption of homogeneity of variance was nonsignificant, the variances for the three groups were pooled to give an overall estimate for the purpose of the planned comparisons. Thus, the reported degrees of freedom for these comparisons is based on the entire sample (N=28; df = 25).

While initially it was thought to be necessary to account for the effects of depression in individuals with Parkinson's disease by covarying this score in the analyses, very few participants actually scored within the clinical range on this measure. A single significant correlation between the score on the Geriatric Depression Inventory and the Droodles measure was found. Each analysis was rerun using the GDI as a covariate, in order to determine its impact on the results, and no significant differences were found when this was carried out. Therefore, the results presented here are the originals, without covarying for the scores on the depression rating scale.

The results of the comparisons between individuals with Parkinson's disease and their elderly counterparts are presented in Table 2. The performance of individuals with Parkinson's disease on the TOM composite measure was significantly poorer than that of the controls ($t(25) = 1.742$, $p < 0.05$). This signifies that, in general,

Table 2. Comparison of participants with Parkinson's disease and elderly control subjects on measures of theory of mind and executive function.

Measure	Parkinson's	Elderly control	t	p
Stories (total score; max=6)				
Mean	4.55	5.37	-1.594	0.062
SD	1.63	0.74		
Model (score 0 or 1)				
Mean	0.55	1.00	-2.962	0.004
SD	0.52	0.00		
Guesser/Knower (# correct; max=8)				
Mean	4.27	5.50	-1.294	0.104
SD	2.61	2.07		
Droodles (interpretive score; max=4)				
Mean	3.64	4.00	-1.026	0.157
SD	1.21	0.00		
TOM Composite Score (max=4)				
Mean	2.27	3.00	1.742	0.047
SD	1.10	1.07		
California Card Sort (total correct sorts)				
Mean	7.73	7.50	0.225	0.412
SD	2.80	1.93		
Five-point fluency (total correct)				
Mean	18.27	24.00	-1.428	0.083
SD	6.47	6.82		
Verbal fluency (total)				
Mean	30.73	40.63	-1.898	0.035
SD	10.70	12.86		

participants with Parkinson's disease were unsuccessful on a greater number of theory of mind tasks (maximum = 4) than were their controls. Looking at the theory of mind measures individually, it appears that the greatest differences between these two groups occurred on the deception "spy" model ($t(25) = -2.962$, $p < 0.005$) and the false-belief stories ($t(25) = -1.591$, $p = 0.062$), although the latter difference was only marginally significant. Within the overall score for the stories, further analyses revealed that all participants correctly answered the memory questions. However, participants with Parkinson's disease had significantly greater difficulties than the controls in correctly predicting the behaviour of the agent in the story ($t(25) = -2.677$, $p = 0.013$).

On the measures of executive functions, individuals with Parkinson's disease had more difficulty generating words in a phonemic category than did their elderly counterparts ($t(25) = -1.898$, $p < 0.05$). They also tended to produce slightly fewer designs in total, on a measure of nonverbal (five-point) fluency ($t(25) = -1.428$, $p = 0.083$).

Table 3 shows the results of the comparisons between the elderly controls and the university-aged students. Again, there was a significant group difference on the TOM composite score, such that the older participants performed more poorly than the younger ones ($t(25) = 2.291$, $p = 0.016$). On the individual measures of theory of mind, the older adults showed significant impairment on the Knower/Guesser task ($t(25) = -1.848$, $p < 0.05$), as compared to the university-aged students. Once again, all participants were able

to successfully answer the memory component of the false-belief story task; however, the older participants showed a trend towards having difficulty in providing a reasonable justification for why a particular behaviour would occur (elderly, mean score = 1.38, SD = 0.74; university-aged, mean = 1.89, SD = 0.33; $t(25) = -1.502$, $p = 0.073$).

In terms of executive functions, the older adults generated significantly fewer correct sorts than the younger adults on the California Card Sorting Test ($t(25) = -3.835$, $p < 0.001$). Moreover, they had greater difficulty in verbally identifying the principles by which they had sorted the cards (elderly, mean points = 14.00, SD = 4.41; university-aged, mean = 19.89, SD = 3.98; $t(25) =$, $p < 0.005$). On the measure of nonverbal (five-point) fluency, the older participants generated fewer original designs overall ($t(25) = -4.346$, $p < 0.001$). They also made a significantly higher number of repetitions than the younger group (elderly, mean = 5.88, SD = 7.49; university-aged, mean = 1.89, SD = 1.83; $t(25) =$ 1.913, $p < 0.05$). The elderly group did not differ significantly from the university students on the measure of verbal fluency. It is worth noting that the mean score achieved by the university students was somewhat lower and more variable than has been reported previously in studies with greater sample sizes (Yeudall, Fromm, Reddon & Stefanyk, 1986; N = 73; females aged 21-25, mean score = 44.89 , SD = 6.86; males aged 21-25, mean score = 45.24, SD = 6.32). This may be due to the small sample size.

Table 3. Comparison of elderly participants with university-aged participants on measures of theory of mind and executive function.

Measures	Elderly controls	University students	t	p
Stories (total score; max=6)				
Mean	5.37	5.89	-0.942	0.165
SD	0.74	0.33		
Model (score 0 or 1)				
Mean	1.00	1.00	--	--
SD	0.00	0.00		
Knower/Guesser (# correct; max=8)				
Mean	5.50	7.33	-1.848	0.038
SD	2.07	0.87		
Droodles (interpretive score; max=4)				
Mean	4.00	4.00	--	--
SD	0.00	0.00		
TOM Composite Score (max = 4)				
Mean	3.00	4.00	2.291	0.016
SD	1.07	0.00		
California Card Sort (total correct sorts)				
Mean	7.50	11.56	-3.835	0.000
SD	1.93	1.33		
Five-point fluency (total correct)				
Mean	24.00	42.22	-4.346	0.000
SD	6.82	11.82		
Verbal fluency (total)				
Mean	40.63	39.56	0.196	0.420
SD	12.86	10.28		

The relationship between executive functions and theory of mind performance was examined for the three groups as a whole (n = 28). Moderate correlations were found between the summary measure of theory of mind, and each of the measures of executive

function: verbal fluency ($r = 0.47$, $p < 0.02$), five-point fluency ($r = 0.48$, $p = 0.01$), and the California Card Sorting test, number of correct sorts ($r = 0.43$, $p = 0.02$).

The correlations between individual measures of theory of mind and the measures of executive function are presented in Table 4. These results suggest a moderately strong relationship between performance on the measures of theory of mind and executive functions. In particular, the Guesser/Knower task appeared to have a highly significant relationship to performance on all three measures of executive function.

Table 4. Correlations between measures of theory of mind and executive functions for the entire sample.

	Droodles	Stories	Model	Knower/Guesser
Verbal Fluency	0.3565 p = 0.063	0.2889 p = 0.136	0.3711 p = 0.052	0.5976 p = 0.001
Five-point Fluency	0.1259 p = 0.523	0.3025 p = 0.118	0.3476 p = 0.070	0.5204 p = 0.005
California Sorting Task - correct sorts	0.3417 p = 0.075	0.3186 p = 0.099	0.0495 p = 0.802	0.4515 p = 0.016

On the measure of social decentering, a marginally significant difference was found between the elderly control group and individuals with Parkinson's disease, on the index which indicates a "use-of-self" as the basis for information processing. Individuals with Parkinson's disease tended to endorse these statements (e.g. *The way I think and behave serves as my general basis for understanding how people in general think and behave.)*

more highly than the elderly control subjects ($t_{14} = 1.995$, $p = 0.066$). None of the indexes generated from the Social Decentering Scale were significantly correlated with any of the measures of theory of mind.

DISCUSSION

Research over the past fifteen years has introduced to psychology some new terminology, namely 'theory of mind'-- the ability to attribute mental states to oneself and to others. While the term 'theory of mind' may yet be in its infancy, the concepts of metacognition *(thinking about thinking)* and social cognition, have been the focus of social and cognitive psychologists for many years. With a much narrower focus than in the past, developmental psychologists and those studying childhood psychopathology, have examined theory of mind as an entity possessing unique developmental progressions, and explored the possibility of specific impairment when this development is deficient. Some researchers have made the claim that theory of mind is a modular entity, controlled by specific brain systems (Brothers & Ring, 1992; Karmiloff-Smith et al., 1995). Damage to such a module would produce specific impairments, not only during its developing stages, but at any point during the lifespan. Many researchers have offered the frontal lobes and potentially its connections with the limbic system, as likely sources of this ability. These postulations have been supported by many studies which have shown theory of mind performance to be fairly well correlated with other behaviours believed to be frontally-

based. However, few studies have shown theory of mind impairments to exist in individuals other than those with autism.

The results of the present study suggest that theory of mind impairment is not specific to individuals with autism. Individuals with Parkinson's disease showed clear and somewhat surprising difficulties with these same tasks -- ones which are routinely achieved by the average five-year old child. These findings contribute another result to recent investigations which have reported theory of mind impairments in children and adults with schizophrenia (Frith & Corcoran, 1996) and conduct disorder (Happé & Frith, 1996).

Further, the results of this study indicate that theory of mind impairment is not restricted to childhood. While much has been documented on the early development of theory of mind abilities, there seems to be a progression in the development of theory of mind throughout the normal human lifespan, such that healthy older adults exhibit difficulties in the same areas as very young children. These findings coincide with the suggestions of Chandler, Lalonde and others, that theory of mind is not a "single miracle" occurring at four years of age. The results emphasize the need to expand the concept of theory of mind to include later development and raises the question of the relevance of theory of mind ability for human behaviour and human interactions throughout the lifespan.

The results of this study are in support of the notion that specific brain damage can lead to theory of mind impairments. This is an important requirement if one is going to accept

theory of mind as existing within some social module. This study does not provide direct comparisons to other areas of functioning (except executive functions) in individuals with Parkinson's disease. However, one can draw on the literature to show that the impairments in non-demented individuals with Parkinson's disease are not global (e.g. Taylor et al., 1986). Although the nature of any memory impairments in Parkinson's disease is unclear, memory requirements likely did not contribute significantly to the results of this study. By using tasks that minimized memory demands, and the finding that all participants were able to correctly answer the story memory questions, suggests that poor performance on these tasks was not due to confounding memory difficulties. Thus, it appears that individuals with Parkinson's disease, and healthy elderly individuals exhibit somewhat specific theory of mind deficits in the face of normal levels of intelligence and other relatively intact systems (e.g. memory, language). This study, therefore, provides some preliminary support for the idea of modularity of theory of mind (social?) function in the brain. The results also support the suggested involvement of the limbic and prefrontal areas, and the necessary condition that damage to these areas can lead to specific impairment, since these regions have been implicated in the both Parkinson's disease and normal human aging.

The significant relationship of theory of mind ability to executive function, which has previously been reported in individuals with autism, and preschool-aged children, was supported by all three groups of participants in this study. A regression analyses predicting theory of mind performance (TOM composite) from executive function (verbal fluency

score) and group membership revealed that executive function did not account for a significant amount of the overall variance, once group membership had been entered into the equation. This may suggest that the relationship between theory of mind and executive function is not likely causal, but could be mediated by a third factor (e.g. prefrontal functioning), as suggested by Ozonoff et al. (1991a).

Recent interest has been expressed over the relationship of verbal ability to theory of mind performance. It has been suggested that lower verbal ability may be a limiting factor in the development of higher-level theory of mind. However, it is also possible that failure to develop a normal theory of mind may limit the development of more sophisticated language ability. Although, in the present study, there was a somewhat restricted range of verbal ability (Vocabulary age scaled scores from 8 to 17), the relationship of these scores to theory of mind performance was not significant. In fact, the results of this study clearly demonstrate poor theory of mind performance, in the face of verbal abilities which fall within the average to superior range. This seems to suggest that lower levels of verbal ability are not a necessary condition for the occurrence of theory of mind deficits. However, it does not address the relationship of theory of mind and higher verbal ability in early development, nor the role that verbal ability and theory of mind have on each other's developmental progression.

Another area of recent and growing interest in theory of mind is the role of theory of mind in everyday living. The present study did not find a significant relationship between theory

of mind performance and a self-report measure of social decentering. It is important to note that the social decentering scale does not measure performance *in vivo*. Some investigators have distinguished between on- and off-line performance, emphasizing that learned knowledge may not always translate into behaviour in practical and novel situations (Ozonoff & Miller, 1995). Further, Chandler and Lalonde (in press) have found that autistic children were able to follow social conventions, despite poor theory of mind performance. It may be the case, in this study, that years of experience have afforded inviduals with Parkinson's disease the ability to answer such questionnaires in a socially conventional way. What does this say, then, about the impact of poor performance on theory of mind tasks, in the everyday lives of individuals with Parkinson's disease? Perhaps it is true that previous life experience acts as a compensatory mechanism at the point when theory of mind abilities decline. Consider, a 72-year old person with Parkinson's disease who has been married to the same spouse for over 40 years. One could consider this person with Parkinson's disease somewhat of an "expert" at knowing his/her spouse's thoughts and feelings. Attributing mental states to a spouse of forty years perhaps should not be considered a "novel" task, and therefore impairments in these types of attributions may not be seen in such everyday situations. Perhaps the difficulties in theory of mind, which are clearly evident in the laboratory setting, are only present in novel life situations? Further research is necessary to understand the true impact of these isolated laboratory findings.

Results of this study suggest that it is time to expand our notion of theory of mind from its limited role in childhood and autism to include the entire lifespan and other neurological disorders. In some ways this has already begun in other areas of psychology which use terms such as "referential communication" and "consciousness". It is important to draw from this literature to begin to understand the impact of theory of mind performance in everyday life. Are there natural levels of skill in theory of mind as there are in other cognitive abilities? How does that translate into everyday capability? What advantage does a person with superior theory of mind have over one with poorer theory of mind? For which everyday situations is theory of mind important ? Parenting? Certain professions? School success? Relationships/marriage?

We need to begin to examine more closely what is being defined by theory of mind and what kinds of behaviours it encompasses. To some extent theory of mind has been defined by its measures and these have become standard in the study of mental state awareness in children and individuals with autism. Once an individual can successfully complete these measures they are said to possess a theory of mind; hence, the "one miracle approach". What does more sophisticated theory of mind behaviour look like? Are the tasks all measuring the same construct? Elderly and participants with Parkinson's disease did not perform uniformly on all measures of executive function and theory of mind in this study. This may be due, in part, to the small sample size in the present study, however, it raises the important question as to the homogeneity of these tests and whether they are, in fact, measuring the same construct. Perhaps they are measuring aspects within theory of

mind, in much the same way that investigators are beginning to acknowledge the heterogeneity of measures of executive function. These questions remain for future research.

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