Chapter Number

Social Cognition in Epilepsy

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1. Introduction

There is a paucity of research which has investigated social cognition in epilepsy, this is surprising given the abundance of evidence that exists in relation to the difficulties that people with epilepsy (PWE) have in relation to social functioning (McCagh et al., 2009).

The study of social cognition in epilepsy will lead to a greater understanding of the social cognitive deficits of the epileptic condition. This may in turn lead to more effective psychological interventions to enable the smoother functioning of people with epilepsy in society.

The aim of this chapter is to provide a detailed critical review of research which has investigated socio-cognitive functioning in people with epilepsy to date. Throughout the chapter, the impact of epilepsy related variables in relation to socio-cognitive processing will be considered.

The final part of the chapter will explore why people with epilepsy may have social cognitive deficits and will go on to summarise limitations in past research. The chapter will conclude by providing the rationale and aims of the author's current research in this area and suggestions for future work.

Abbreviations

AED	Antiepileptic drug
BF	Bifrontal
EEG	Electroencephalogram
EI	Emotional intelligence
FHI	Frontal Head Injury
FL	Frontal lobe
FLE	Frontal lobe epilepsy
FSIQ	Full Scale Intelligence Quotient
HADS	Hospital Anxiety and Depression Scale
HC	Healthy Controls
IGE	Idiopathic generalised epilepsy
IQ	Intelligence Quotient
LT	Left temporal lobe
LTLE	Left temporal lobe epilepsy
LF	Left frontal lobe
LFT	Left fronto-temporal
LH	Left hemisphere
MME	Mini Mental State Examination

MTLE	Medial temporal lobe epilepsy
MRI	Magnetic resonance imaging
NC	Normal control group
QoL	Quality of Life
NC	Normal control group
OFC	Orbito-frontal cortex
PHT	Phenytoin
QoL	Quality of life
PFC	Prefrontal cortex
PWE	People with epilepsy
RF	Right frontal lobe
RFT	Right fronto-temporal
RH	Right hemisphere
RT	Right temporal lobe
RTLE	Right temporal lobe epilepsy
TASITS	The Awareness of Social Inference Task
ToM	Theory of mind
TL	Temporal lobe
TLE	Temporal lobe epilepsy
WAIS	Wechsler Adult Intelligence Scale
WTAR	Wechsler Test of Adult Reading
VM PFC	Ventromedial prefrontal cortex

2. Social cognition

Essentially social cognition is concerned with how people process social information and how they use this information in social situations. Social cognitive processing involves the perception and interpretation of social information and the ability to provide an appropriate response to it.

2.1 Theory of mind (ToM)

The ability to comprehend social information and to participate effectively in social interactions is reliant on 'the adequate functioning of a mental mechanism termed theory of mind (ToM)' (Mazza et al., 2007, p.257). This term was first established by Premack and Woodruff (1978). It is the socio-cognitive ability which normally functioning individuals have and which allows them to effectively infer the thoughts, beliefs and intentions of other people and to appreciate that people's thoughts and behaviour may be based upon beliefs and knowledge that are different from their own. This skill facilitates successful social communication and interaction and the cohesive functioning of individuals in society. ToM skills enable people to interpret their own mental states as well as the mental states of others, consequently one can understand and make predictions about behaviour. ToM is used to understand what another person intends or means in social situations where these may not be immediately clear. For example, when someone makes an ironic statement, drops a hint or tells a joke.

ToM is seen to consist of both 'cold cognition' the ability to make inferences about others' cognitive states such as knowledge, desires and beliefs and 'hot cognition' the ability to make inferences about the affective states (the emotions and preferences) of other persons (Brothers & Ring, 1992; Stone, 2000).

2.2 Assessment of theory of mind

Researchers have used a variety of assessment techniques to tap into ToM functioning. The most common measures and those which are most relevant to the studies which will be discussed in this chapter will be outlined.

The most established and validated measure of ToM has utilised the concept of false belief. Dennett (1978) argued that the best evidence for an understanding of other people's minds is the ability to attribute a "false belief" to another person. Detection of false belief requires that you can appreciate that another person has misconceived an event as a result of incorrect reasoning. Many subsequent empirical tests of ToM are based on this criterion and assessment of false belief is regarded as the 'litmus test' of ToM functioning. This method is widely used and validated because it establishes whether an individual can attribute beliefs to others that may differ from their own. As Astington (2001) highlights, false belief is 'an unequivocal marker of mentalistic understanding' (p.685).

Typically false belief has been assessed at first order and second order levels of intentionality. Appreciation of first order false belief usually develops by the age of four and by the age of seven, children should be able to pass second order false belief tasks (Perner & Wimmer, 1985; Wellman et al., 2001; Wimmer & Perner, 1983). Often such tests are developed within the context of ToM stories, which are often accompanied by story boards to aid the participant in following the story. First order stories involve a character having a false belief about the state of the world. The tasks require the individual to understand that another person may not have access to information about the world which they themselves have and as a consequence that the other person's viewpoint is mistaken. Typically first order stories involve a protagonist leaving an object in one location and then leaving a room upon which the object is moved to a new location. Demonstration of intact first order false belief would involve the participant appreciating that the protagonist will look for the object in the old location on re entering the room. To master first order false belief the participant must appreciate that reality and another person's perception of reality can be different.

Second order stories are more complex and involve one character having a false belief about the belief of another character in a story. The age of developing false belief skills has been shown to be the same across cultures and continents (Avis & Harris, 1991; Wellman et al., 2001; Wellman & Lagattuta, 2000). Generally adults score at ceiling on both first and second order false belief tasks (Stone et al., 1998a) so designing tests which tap in to ToM in adults can be challenging.

Deception has also been used as another way of testing mentalising ability. As Baron-Cohen (2000) proposes, deception is important in understanding another's mind as it involves trying to make a person believe something that is untrue. It involves being aware that beliefs can be manipulated and people will base these beliefs on knowledge derived from what they have heard or observed.

More advanced tests of ToM involve being able to appreciate non–literal language or figurative speech. An appreciation of the pragmatics of language is needed to understand such things as sarcasm, irony, humour, metaphor and hinting and consequently paradigms using these concepts have been applied to assess ToM performance. By reference to contextual information, the listener must go beyond the literal meaning of the words that are used and comprehend the intentions of the speaker and the meaning they are trying to convey.

A number of paradigms have been used in studies to assess these higher order ToM abilities. These include: appreciation of irony (Shamay-Tsoory et al., 2003; Shamay-Tsoory et al., 2005a), sarcasm (Shamay-Tsoory et al., 2002; Shamay-Tsoory et al.,2005 a; Shamay-

Tsoory et al., 2005 b), hinting (Corcoran et al., 1995; Corcoran & Frith, 2003), faux pas (Farrant et al.,2005; Schacher, et al., 2006; Shaw et al.,2007; Stone et al., 1998a; Shamay-Tsoory et al., 2005 a) humour (Winner et al.,) and metaphor (Van Lancker & Kemper, 1987) to name a few.

Another unconventional ToM task that has proved popular was developed by Baron-Cohen et al. (1997). The Reading the Mind in the Eyes task (RME) involves the participant identifying complex mental states (emotions) by looking at photographs of the eye region only. Participants are provided with four words depicting emotions and are required to select the word corresponding to the emotion expressed by the eyes.

2.3 Testing considerations

In order to make sure that measures reflect ToM functioning and not other cognitive skills, a number of control measures need to be considered when assessing ToM. Most studies incorporate a measure of general cognitive ability (such as an IQ test) to make sure that apparent deficits in ToM are not a simple consequence of general cognitive dysfunction. To minimise the load on working memory, tasks utilize devices such as pictorial story boards (in ToM stories) or participants are allowed to refer to the relevant text/stimuli throughout testing. As well as questions which assess ToM ability, tasks usually incorporate 'reality' or comprehension questions to ensure that the relevant prose has been understood and to guard against the possibility that poor performance on the task simply reflects memory or comprehension difficulties. In order to achieve this, tasks will typically include some questions requiring general inferential ability (such as making inferences about physical states). These complement the key questions which assess the participant's ability to make inferences about the mental states of others. All these precautions are designed to ensure that the impairments that are observed reflect ToM difficulties as distinct from problems in other cognitive domains.

3. Epilepsy and social cognition

Some of the psychological problems associated with epilepsy have their origins in the ability of people with epilepsy (PWE) to engage in meaningful and appropriate social interactions. PWE often report difficulties in social functioning (McCagh et al., 2009), yet research investigating the socio-cognitive skills of this group has been sparse. Impairments in social competence in children, adolescents and adults with epilepsy are also evident (Austin et al.,1994; Caplan et al. 2005; Herman et al., 1981; Jalava et al., 1997). Schilbach et al. (2007) argue that social competence has a considerable effect on quality of life yet the study of social cognition in epilepsy has been largely neglected. A number of studies have shown that quality of life (QoL) scores increase after surgery but often these measures do not adequately assess improvements in social functioning (Kirsch, 2006).

Epilepsy may affect social cognition in many ways that are hard to quantify. Kirsch (2006) suggests that frequent seizures may interfere with the development of interpersonal skills in children or adolescents, such that they may not always be able to participate in situations where they can develop such skills due to ictal and post ictal disruption to functioning. Medication may impact on their ability to respond effectively in interpersonal conversation to subtle social cues. The child's social networks may be reduced due to stigmatisation, lack of self esteem or because parents are more protective over the child and consequently this reduces their exposure to social environments where they may learn the intricate social

skills that are necessary to achieve social competence. Children with epilepsy have been shown to under perform on measures of social competence in comparison to children without epilepsy as indicated by their parents in a number of studies (Dorenbaum et al., 1985; McCusker et al., 2002; Williams et al., 1996).

Exactly why PWE have social difficulties is not entirely clear but is likely to be a consequence of a number of complex interrelated psychosocial factors that impact on the person with epilepsy. These include the impact of stigma, unemployment or underemployment, anxiety and depression, cognitive dysfunction, poor self esteem, social isolation and difficulties in interpersonal relationships (McCagh et al., 2009).

'Despite many years of speculation, it remains unclear to what extent psychosocial difficulties are related to the fact that patients are living with a chronic and stigmatising condition and to what extent they are related to neuropathology' (Walpole et al., 2008, p.1470).

Whether social maladjustments in PWE can be attributed to social cognitive deficits remains uncertain (Schacher et al., 2006).

3.1 Research studies

To date there have been seven studies, some of which have also looked at recognition of emotion as well as ToM in PWE, though it is not the purpose of the chapter to review research which has assessed emotion recognition in epilepsy per se. One study has investigated emotional intelligence in people with active epilepsy (who have not undergone surgery) and because of its relevance to the area it will be included in the review. The latter part of the chapter will provide a critical review of the methodology used in research to date. Throughout the chapter, the impact of epilepsy related variables in relation to socio-cognitive processing will be highlighted.

3.1.1 Temporal lobe epilepsy

3.1.1.1 Emotional intelligence and emotion recognition

Walpole et al. (2008) investigated emotional intelligence (EI) and emotion recognition in temporal lobe epilepsy (TLE). Sixteen patients with TLE were compared with 14 healthy controls (HC). People with TLE were only included in the study if they did not have any history of psychiatric illness (excluding anxiety and depression), head injury, hypoxia, personality disorder, neurological condition or autistic spectrum disorder. People with TLE who had undergone surgery for epilepsy were excluded from the study.

Participants were assessed on a range of background measures including the Wechsler Test of Adult Reading (WTAR; Wechsler, 2001), cognitive intelligence as assessed by the Full Scale IQ (FSIQ) score on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) and Quality of Life in Epilepsy 31 (QOLIFE-31; Cramer et al., 1998). Participants were also assessed on emotional intelligence (EI) using the Emotional Quotient Inventory (EQ-I; Bar On, 1997) and identification of emotional expression using Ekman and Friesen (1976) 60 photographs of facial expressions.

This study found that the TLE group were significantly impaired on total EI score but not cognitive intelligence (FSIQ). The TLE group made significantly more errors when identifying emotional expression than the control group. Significant negative correlations

were found between EI (total score) and anxiety and depression as measured by the HADS. Higher QoL scores were associated with higher EI in the TLE group, though this relationship was not significant. No significant differences in EI were established between people with LTLE (N=7) and RTLE (N=9) and EI was not significantly associated with duration of illness or number of seizures. The author concludes that the psychosocial problems in TLE may well be associated with low EI which may be a consequence of epilepsy-related disruption to the functions of the medial temporal lobe.

Walpole et al. (2008) conducted their study under the premise that impairments in a study on EI were present in people with lesions to the ventro medial prefrontal cortex (VM PFC) and to the amygdala or insular cortices, brain areas that have also been implicated in social cognition (Bar On et al., 2003). Walpole et al. (2008) argue that EI is closely related to social cognition in that it involves being able to discriminate between and monitor 'one's own feelings and those of others 'and being able to use 'this information to guide responding' (p. 1470).

Evaluation: This study would have benefited by recruiting a frontal lobe epilepsy (FLE) group to establish if EI was impaired in this sample in line with evidence in the literature which implicates the importance of the frontal lobes in social cognition (Rowe et al., 2001; Shamay-Tsoory et al., 2005a; Stone et al., 1998; Stuss et al., 2001). Walpole et al. (2008) do acknowledge the need to study EI in other types of epilepsy to determine if EI impairment is specific to TLE. This study can be criticised for not stating whether people had refractory TLE, where participants were recruited from, what AEDs they were on and how many they were taking.

Differences in RTLE and LTLE were not established in this study, though this may or may not have been impeded by the small sample size of each of the groups. It should be noted that a recent study by Gawryluk and McGlone (2007) which investigated PWE who had TL resections did not find any evidence of laterality of EI, although it needs to be emphasised that these participants did not have active epilepsy.

Quality of life (QoL) was assessed in the study and was not significantly related to EI although Walpole et al. (2008) acknowledge that the role of seizure related variables and the impact of epilepsy need to be studied in more depth in relation to EI. If a larger sample was recruited, relationships between these variables may have been more evident.

3.1.1.2 Theory of mind and emotion recognition

Shaw et al. (2007) assessed 19 PWE on ToM tasks and emotion recognition before and after anterior temporal lobectomy (excision of the amygdala occurred in all cases as did removal of anterior parts of the hippocampus) for refractory epilepsy. Those with TLE (10 RTLE and 9 LTLE) had amygdala damage as a consequence of gliosis, neuronal loss or focal lesions. Seizures had stopped or there was a marked reduction in seizures post surgery. Testing took place 1-3 months prior to surgery and 4-6 months post-surgery. Patients who underwent surgery were on the same AEDs post surgery. Nineteen healthy controls with no history of neurological or psychiatric disorders were also assessed on the same measures twice, six months apart.

Participants were assessed on a range of background measures including IQ and the Benton Facial Recognition task (Benton et al., 1983). This task entailed matching images of faces of identical people. These images were taken at different angles or levels of illumination. The Hayling and Brixton tests assessed executive functioning (Burgess & Shallice, 1996a, 1996b). The Hayling test assesses the ability to inhibit predominant responses and speed of task initiation and the Brixton test assesses set shifting and rule detection.

The two main experimental measures were recognition of facial expressions and emotions and appreciation of ToM. The Ekman and Friesen (1976) pictures of facial emotion were used and participants had to rate the intensity of one of six basic emotions (sad, happy, surprise, anger, fear, disgust) in two male and female faces who displayed all six emotions. A faux pas test by Stone et al. (1998a) and Happé's Strange Stories (Happé, 1994) assessed ToM. Happé's Strange Stories depict characters that do not literally mean what they say, participants are required to illustrate that they understand what the character really means and their true motivations. The faux pas test required participants to identify that a faux pas had taken place, why the comment was inappropriate and the affect that the faux pas may have had on the character in the story (how it would have made them feel). A control question was incorporated to assess comprehension.

Verbal and performance IQ was significantly lower in the RTLE (N = 10) and LTLE (N = 9) operative groups in relation to controls. Duration of epilepsy did not differ between these groups. Scores on the Benton Facial Recognition Test and measures of executive functioning did not differ between groups or significantly change as a consequence of surgery in either group.

Shaw et al. (2007) found that there were no significant differences in scores pre or post surgery in Happé's Strange Stories or for detection of faux pas or in either RTLE or LTLE, nor was there a significant change in scores from pre to post surgery in relation to these two groups. When RTLE and LTLE groups were combined there was no significant difference in change scores on either of the ToM measures. Change scores in executive function and ToM tasks were not correlated with each other so changes in executive function were unrelated to changes in ToM performance. Prior to surgery patients with LTLE were impaired in recognising facial expressions depicting fear but improved after surgery which the authors suggest may be accounted for by removing a hyper-excitable amygdala. . Another explanation they consider is that epileptogenic tissue in the LTLE may inhibit the emotion recognition network prior to surgery which would account for improvements post surgery, such improvements have occurred in executive processes after anterior temporal lobectomy (Hermann & Sedenberg, 1995; Martin et al., 2000).

Evaluation: Whilst differences in ToM performance pre and post surgery were not evident, the small sample size in the study will have reduced statistical power to detect changes in ToM performance. The ToM tests used in this study may not be sensitive enough to detect change in performance pre and post operatively or differences between right and left TLE in such a small sample. These tests have also not demonstrated functional activation in the amygdala in past research. Past research has shown that bilateral damage is typically found with ToM impairment in adults (Stone et al., 2003), yet participants only had unilateral damage in this study. Memory and learning effects of the tasks may have improved performance after surgery, as the same tests were administered pre and post surgery. Such effects are not controlled for and are hard to quantify, this could be overcome if different tasks were matched in terms of the amount of socio-cognitive processing involved.

Schilbach et al. (2007) recruited 10 right handed females with LTLE from an epilepsy monitoring unit and an outpatient clinic. Two participants had MTS (mesial temporal sclerosis); there were no detectable structural abnormalities in the other eight. All had a history of complex partial seizures. Ten right handed healthy volunteers with no neurological or psychiatric history were also recruited. All participants included in the study had an MMSE (Mini Mental State Examination) score within the normal range and

were assessed for depression by the Beck Depression Inventory (BDI). Two of the epilepsy participants had scores of 16 or above so all further analysis took account of this.

Participants were presented with video scenarios involving virtual reality characters depicting facial expressions. The expressions were either socially relevant and the character was intending to initiate interpersonal relations with either the participant or another virtual character. Alternatively the facial expressions were arbitrary and socially irrelevant. Self involvement in the scenarios was also manipulated such that the characters either looked at the participant or looked away. Participants were required to answer two questions after presentation of each video scenario (there were 100 trials), which evaluated their perception of self involvement and required them to rate how much social interaction was present in each scenario using a four point Likert scale.

The TLE sample group all illustrated the same trend in how they rated social intent despite the different type and number of AEDs that were being taken across the sample. They rated a scenario as more socially relevant if they were more involved in the interaction, this trend was also apparent even if the facial expression was arbitrary. The authors suggest that over reacting to self involvement in social interactions may be a way that people with TLE compensate for their socio cognitive difficulties in interpreting facial expressions and the mental states (intention) of others.

Evaluation: The study can be criticised as the sample was biased towards females, that the sample was small and that only people with LTLE were tested. Another weakness is that the study did not evaluate the impact of epilepsy related variables (age at onset, seizure type or seizure frequency) on social cognition.

Schacher et al. (2006) investigated the ability to detect faux pas in 27 people with MTLE (medial temporal lobe epilepsy) of which 16 were investigated prior to surgical resection, and 11 after anterior temporal lobectomy or selective amygdalohippocamectomy (12-18 months after surgery). They also recruited 27 people who had extra mesiotemporal epilepsy (extra MTLE) but not FLE (frontal lobe epilepsy) and 12 healthy controls (HC) with no history of psychiatric or neurological disorder. PWE were recruited from an in patient epilepsy centre in Switzerland and had refractory epilepsy. MTLE and unilateral seizure onset was determined by EEG and MRI. Testing on PWE and healthy controls took place in hospital, all PWE including post surgical MTLE were being treated with AEDs.

Participants were administered with a shortened version of the faux pas test by Stone et al. (2003). Participants read the story themselves whilst having a copy of the story in front of them to reduce the working memory demands of the task. Participants were asked four questions, three questions assessed inferences about affective and cognitive mental states and one question was a control question to assess that the story had been comprehended correctly. All participants in the study had intact language comprehension as assessed by the Chapman-Cook test (Chapman, 1923) and correct answers on the faux pas comprehension question and IQ were also measured. Participants were required to understand the faux pas correctly and infer the mental state and emotions of another person.

The MTLE (pre and post op) were significantly impaired on faux pas in relation to the extra MTLE group or healthy controls, task performance between these two groups was comparable. No differences between the pre op MTLE and post op MTLE were established. In the MTLE group as a whole (R= 14 and L=13) people with right sided onset performed significantly worse than those with a left sided onset. There was an interaction between gender and side of onset such that male patients with LMTLE performed better than females

with LMTLE and males with RMTLE. Beyond the above noted epilepsy-related differences, faux pas performance was not associated with IQ, age, age at seizure onset or duration of epilepsy. IQ may have mediated faux pas performance in healthy controls as they showed a trend for higher faux pas scores when IQ was a covariate in the analysis, this mediating effect was not apparent when comparing performance in the MTLE and extra MTLE group on faux pas. Schacher et al. (2006) argue that this refutes the idea that a general cognitive deficit impairs ToM performance and supports Frith and Frith (2003) proposal that 'ToM abilities are largely autonomous of other cognitive functions' p. 2144. Impairments in faux pas can not be attributed to language or comprehension as these factors were controlled in the study. The authors suggest that the effect of AEDs is unlikely to account for the observed deficits as the extra MTLE who performed in a similar manner to healthy controls had refractory epilepsy and were receiving AED therapy.

The authors conclude that MTLE plays a role in higher-order aspects of social cognition. They emphasise the role of the amygdala in emotional and socio-cognitive functioning and highlight that this is often impaired in MTLE. MTLE may impact on socio-cognitive skills by disrupting the integration of temporolimbic and frontal systems which have been implicated in social cognitive functioning.

Evaluation: This study would have benefited by recruiting a FLE group to establish if appreciation of faux pas was impaired in this sample in line with evidence in the literature which implicates the importance of the frontal lobes in social cognition (Rowe et al., 2001; Shamay-Tsoory et al., 2005a; Stone et al., 1998; Stuss et al., 2001). This would also help establish if people with MTLE has a specific deficit in appreciating faux pas.

4. The right hemisphere

4.1 ToM and emotion recognition in the right hemisphere

Fournier et al. (2008) investigated social cognition in two patients, one who underwent a right hemispherectomy (S.M.) and one who underwent a left hemispherectomy (J.H.) to treat intractable epilepsy. Both participants underwent surgery in adolescence and were assessed 30 years after surgery on emotion recognition, formation of social inferences and advanced socio- cognitive judgements. Their performance was compared to normative data collected on the measures.

J.H. (LH) no longer experienced seizures after surgery and was no longer on AED therapy, post surgical recovery was excellent. S.M. (RH) still experienced complex partial seizures after surgery, though these were considerably reduced, and he was still taking AEDs. Both participants experienced hemianopsia and hemiplegia on the contralateral side to surgery.

The two participants were assessed on a variety of background measures to examine IQ, executive functioning, language, construction skills and visual perception. FSIQ scores were comparable and differences in performance on typically RH tasks (attention and visuospatial processing) and LH tasks (verbal working memory, speeded verbal processing) were as expected. The MMSE Examination was also administered and performance was in the normal range for both participants.

The Awareness of Social Inference Task (TASITS) which assesses ToM judgements, emotion recognition and how people make social inferences in daily life was used to assess social cognition (McDonald et al., 2003). This test uses video recordings in which actors engage in scenes of everyday life. The first part of the test (Emotion Evaluation test) requires

participants to recognise common emotional expressions in 28 short video vignettes. Happy, sad, disgust, anger, fear, surprise or neutral expressions are demonstrated on four separate occasions that are randomly administered. Participants have to choose one of the seven emotions and match them to each of the vignettes.

The second and third part of the TASITS involves identifying whether conversations between individuals are sincere; such that conversations can be understood in terms of their literal meaning or that they are counterfactual, where there are discrepancies in the literal content of the conversation and its context. The counterfactual vignettes involve the participant having to infer the underlying meaning of the conversational exchange. In the second part of the test (Social Inference – Minimal) the participant must detect sincere or sarcastic exchanges in 15 vignettes. To detect sarcasm involves appreciating prosody, body language and facial expressions and participants are asked four questions after each vignette. These questions assess participant's ability to detect what the protagonist was thinking, doing, saying and feeling. Two of the questions probe what the protagonist was intending and feeling, these assess both first and second order levels of ToM.

In the third part of the test (Social – Inference Minimal) 16 short vignettes are administered with similar content to part two of the test, the only difference is that participants are provided with extra information regarding the conversational exchange before and after the video. Participants are expected to comprehend the true nature of the exchange whilst integrating the additional information provided to them so that they can determine the protagonist's intention.

The probe questions asked after the video assess appreciation of deception (lies) and sarcasm. Both participants were also administered the Reading the Mind in the Eyes test (Baron-Cohen et al. 2001).

The participant who underwent RH (S.M.) surgery was impaired in recognising negative emotional expressions and surprise, in appreciation of sarcasm, lies, detecting others intentions and their emotions. The participant who underwent (J.H.) LH surgery was competent in interpersonal situations and was mildly impaired when recognising emotional disgust or anger but performed well on parts two and three of the TASITS.

Fournier et al. (2008) argue that their findings emphasise the importance of the RH in reasoning and social cognition:

'taken together, the results suggest a strong role of the right hemisphere in social cognition and processing of information related to the understanding of basic emotional expressions, attributions of the beliefs and intensions of others, as well as the meaning of specific types of conversational inferences' (p. 468).

Evaluation: This study was unique in that it is the first of its kind to establish the long term effects of right and left hemispherectomy on social cognition with reference to ToM. An additional strength of the study is that it utilised an ecologically valid measure of ToM and emotion recognition by using the TASITS. The main criticism is that ToM was not evaluated prior to surgery so the observed impairments cannot be conclusively related to the surgery itself. S.M. who underwent RH surgery was still experiencing seizures and being treated by AEDs at the time of testing which may have accounted for some of the impairments observed.

As MMSE performance was normal and examines general neurocognitive functions the authors argue that the observed socio-cognitive impairments were not specific to any modality (visual, motor or auditory). Attention deficits and general cognitive impairment could account for the impairment in appreciating sarcasm and the intentions of the protagonist observed in S.M. (RH). Fourier et al. (2008) argue that this is unlikely as both the

sincere and sarcastic vignettes did not differ greatly in terms of attentional demands. Also J.H. (LH) demonstrated deficits on verbal working memory but showed no difficulty in correctly identifying the true nature of social exchange in the vignettes, her performance on the comprehension questions were comparable to that of healthy controls.

As this research adopted a case study approach this study did not evaluate the impact of epilepsy related variables (AED therapy, duration of epilepsy, seizure type or seizure frequency) on social cognition. Consequently the findings cannot be generalised to the wider epilepsy population.

5. Frontal lobe epilepsy

5.1ToM and emotion recognition

Farrant et al. (2005) investigated facial emotion recognition and ToM in 14 people with FLE (8 LFLE, 5 RFLE and 1 Bilateral) and 14 healthy controls. The FLE group were recruited from a specialist epilepsy unit and were being assessed for surgery. Groups did not differ significantly on age, gender ratio, years of education, premorbid IQ or long term memory. Executive functioning was assessed using the Trail Making Task (Reitan & Wolfson, 1993) to assess sequencing (part A) and mental flexibility (part B). The FLE group were significantly slower on the sequencing aspect of this task. The Hayling and Brixton tests (Burgess & Shallice, 1996a, 1996b) were administered and the FLE were significantly slower on the section 1 of the Hayling Test though there were no group differences on response inhibition, though FLE did make more mistakes on the task. The FLE were significantly impaired in relation to controls on a verbal fluency task.

ToM was measured using Happé's Strange Stories (Happé et al., 2001; Happé et al., 1999). The ToM stories all involved human interaction where double bluff, mistakes, white lies or persuasion were evident (with two examples or each of these), participants were asked a question which required them to make an inference about the mental states of people in the story. Faux pas was assessed using a version of the task by Stone et al. (1998a). Participants were assessed on their ability to make inferences about affective and cognitive mental states and their comprehension of the stories (as a control measure).

Humour was assessed via a cartoon task which required the participant to infer the mental state of a character in six cartoons (ToM) or to acknowledge a physical anomaly or a violation of a social norm (non ToM) in six cartoons. The memory load of the ToM stories, faux pas and humour tasks was reduced as participants had a copy of the story/cartoon in front of them whilst being asked questions. The Reading the Mind in the Eyes Task by Baron-Cohen et al. (2001) was administered where participants had to match correct emotions to the photographs displayed. Recognition of facial emotion was assessed using Ekman and Friesen (1976) pictures of facial emotion depicting the following emotions; sad, happy, surprise, anger, fear, disgust. Twelve pictures were displayed, one male and female picture for each emotion and participants were required to match the correct verbal labels to the emotions displayed.

FLE did not show deficits on the story task or appreciation of faux pas though they did illustrate a trend towards impairment. FLE were impaired in both the mental state and physical state cartoons, on emotion recognition and perception of eye gaze expression. ToM was intact but appreciation of humour and emotional expression was not. Mild impairments were observed except in the appreciation of emotion expression where impairment was substantial. These impairments were in relation to recognising sadness, anger and fear.

Verbal second order ToM was intact in the FLE group (as examined in the story task). Age of onset was not correlated with any of the socio-cognitive measures. Executive functions were not correlated with socio-cognitive tasks in the FLE group but verbal fluency was correlated with the eyes task and the non ToM cartoons in the control group.

Evaluation: It is unlikely that the observed deficits in social cognition can be attributed to memory or IQ or deficits in executive functioning in the FLE group. As has been supported in studies of cognitive dysfunction in FLE the sample in this study exhibited specific as opposed to general deficits in social cognition. This may be because some tests are more sensitive to detecting impairment than others, though it should be noted that a large sample may have detected more impairments across the tasks. Specific areas in the FL may support different aspects of social cognition, consequently deficits in performance may reflect those areas of damage in the brain in the FLE group. This is the main criticism of the study as it did not report any analysis based on whether people had RFLE or LFLE, due to the small sample size of the groups. The exact site of seizure foci could only be established in 9 of the 14 FLE group (6 with medial and 3 with dorsolateral abnormalities), there were no patients with orbitofrontal involvement. Consequently whether different regions of damage within the FL are associated with specific impairments in the social cognition could not be fully explored. The study did not recruit people with MTLE to compare performance on tests of social cognition in relation to FLE.

This study does not provide the reader with any background information about seizure frequency, seizure type, duration of epilepsy or AED treatment in the FLE group, all of which could impact on functioning. Analysis has not been considered in light of these epilepsy related variables.

5.2 ToM and pragmatic language

Corcoran et al. (cited in Corcoran, 2000) conducted a small scale study (unpublished) in the Chalfont Centre for Epilepsy in 1999. They compared the performance of epilepsy patients on their appreciation of veiled intention in a Hinting Task (Corcoran et al., 1995), a ToM measure. Five patients with right frontal or right fronto-temporal foci, 3 with left frontal and left fronto-temporal foci, 3 with bilateral frontal foci and 23 normal controls were tested. Despite the small sample size differences were found between the groups on performance of the Hinting Task. The right fronto-temporal group appeared to perform worse than normal controls on the Hinting Task independent of group differences in IQ.

Evaluation: This study had a very small sample size and consequently hinting ability was not evaluated in relation to any epilepsy related variables.

6. Methodological difficulties of past research

In critically evaluating their study Farrant et al. (2005) suggest that a larger sample is needed to enable seizure foci in FLE and social cognition to be fully explored. People with FLE need to be compared with other focal epilepsies particularly MTLE to establish if there are specific socio cognitive deficits observed in FLE. Executive impairments have been illustrated in both FLE and TLE, so it is important to determine the nature of socio-cognitive dysfunction in epilepsy. Farrant et al. (2005) also highlight that a larger sample would enable comparison of performance between right and left FLE.

Most of the studies are cross sectional in that they either investigate social cognition post surgery or pre surgery. Consequently these studies cannot differentiate between social

cognitive deficits as a consequence of surgery or the pre-existing epilepsy syndrome (Kirsch, 2006).

One main criticism with all the studies cited in this review is that no single study has compared people with TLE and FLE, so none of the studies can conclusively determine whether socio-cognitive deficits are characteristic of TLE and/or FLE. Studies that have attempted to investigate the impact of side of seizure onset can all be criticised for having small sample sizes and consequently findings cannot be generalised or the power to detect an effect is greatly reduced. None of the studies reviewed recruited a group of patients with idiopathic generalised epilepsy (IGE) who could act as a clinical control group to help to establish the impact of focal epilepsy on these skills. The added advantage of using an IGE group is that they have active epilepsy, take AEDs and will also be affected by epilepsy related variables such as seizure frequency, seizure type, age of onset and duration. None of the studies that have investigated social cognition in FLE recruited a frontal head injured group without epilepsy in order to determine the impact of FLE on socio-cognitive functioning. The studies reviewed have also not evaluated socio-cognitive performance in relation to social functioning in PWE.

There is a general lack of research investigating social cognition in epilepsy as highlighted in the literature (Schacher et al., 2006; Kirsch, 2006). Research that has been conducted has not utilised designs that can adequately explore socio-cognitive functioning in focal epilepsy. The impact that socio-cognitive skills have in relation to everyday social functioning in PWE needs to be investigated (Walpole et al., 2008; Schacher et al., 2006; Farrant et al., 2005). Such research could provide valuable insight into the socio-cognitive deficits associated with epilepsy and may ultimately improve social functioning in PWE.

7. Current research

In light of the methodological problems highlighted in previous studies, the author and colleagues (McCagh et al., unpublished) designed a study to explore socio-cognitive functioning in people with seizure foci in the RF, LF, RT, LT lobes. To overcome previous sample size difficulties the minimum number of people within each group was 11. As well as a healthy control group, this study recruited an IGE and FHI (frontal head injured) group to establish the impact that focal epilepsy and in particular FLE have on these skills, as Farrant et al. (2005) argue, social cognition has not been fully explored in FLE. Information was also collected on relevant epilepsy related variables (age at onset, AEDs, seizure frequency and duration of epilepsy) in relation to the sample. The study also aimed to establish the impact that socio-cognitive functioning may have on the every day life of PWE by assessing social cognitive performance in relation to perceived impact of epilepsy using the Impact of Epilepsy Scale (Jacoby et al., 1993).

Appreciation of false belief and deception in ToM stories and understanding veiled intentions in the Hinting Task were assessed across all clinical groups. All epilepsy groups were administered the Impact of Epilepsy Scale to compare task performance in relation to the perceived impact of epilepsy, this could then help top establish how socio-cognitive skills are related to social functioning in real life.

To date this is the largest lesion study to investigate ToM and the largest study within the field of epilepsy to investigate social cognition. The findings of this research are currently being written up for publication. A major outcome from the study is that the RF epilepsy group consistently under performed on ToM tasks. They illustrated deficits across two

different ToM paradigms, appreciation of first and second order false belief and deception and appreciation of non-literal language in the Hinting Task in relation to the other experimental groups. These findings indicate that impaired ToM may be a particular feature of right frontal lobe pathology. The extent of the RF mentalising deficit is evident in their performance on one of the most basic assessment measures of ToM, first order ToM (Stone, 2000).

This deficit in first order ToM cannot be attributed to the impact of immediate story recall or level of education, nor is it a consequence of group differences in IQ, number of AEDs, age of onset or duration of epilepsy. The RF group also appear to have difficulty in making inferences based on non-literal language. They were significantly worse on this task than all of the other experimental groups, though further analyses revealed that this deficit was mediated by immediate story recall. The LT were impaired on second order ToM tasks and appreciation of hints though both of these deficits were mediated by immediate story recall. NC performed significantly better on the Hinting Task than all of the patient groups.

The results did not show a significant difference between the epilepsy groups on the Impact of Epilepsy score. Only a subgroup of participants were included in this analysis as this questionnaire was administered part way through recruitment. Therefore this sub sample may not have been representative of the entire target population, though there is no specific evidence to suggest this was the case. The RF group did rate the impact of epilepsy higher than any of the other groups but given the small cell sizes, there may not have been sufficient power to detect significant differences between the groups and so it is necessary to exercise caution in interpreting these findings. PWE do not appear to have insight into their social functioning difficulties, which may well reflect underlying pathology. Interestingly there was a significant negative correlation between impact of epilepsy score and level of education suggesting that the more educated the individual was the more likely they were to realise the social restraints of their condition.

The exact site of lesion within the frontal and temporal lobes is not analysed in relation to task performance. Whilst seizure foci and lateralisation are clearly established, there was no more detailed information available for the PWE included in this study to further localise the exact anatomical site of the seizure focus. Thus the information obtained for this study was not detailed enough to make generalisations about how important specific anatomical locations were within the frontal and temporal lobes in the processing of the tasks used.

8. Directions for future research

Small sample sizes have reduced the statistical power of findings in many of the studies discussed in the literature review (Farrant et al., 2005; Schilbach et al., 2007; Shaw et al., 2007; Walpole et al., 2008), clearly there is a need for studies with larger sample sizes that will enable comparisons across anatomical lesion sites in the frontal and temporal lobes. None of the epilepsy studies that were reviewed recruited a suitable control group or assessed both right and left frontal and temporal groups. The authors current research, recruited an IGE group, who were also taking AEDs to reduce the possibility that the impact of medication might confound the results. Future study designs need to consider these issues. Lesion studies have to date mostly focused on assessing ToM in either patients with frontal or temporal lobe damage but as this study (McCagh et al., unpublished) and brain imaging studies have shown (Brunet et al., 2000; Fletcher et al.,1995; Gallagher et al., 2000; Goel et al., 1995; Saxe & Kanwisher, 2003; Vogeley et al., 2001), both lobes would appear to

be implicated in the processing of ToM. Therefore future research should incorporate patients with unilateral lesions to both the frontal and temporal lobes.

Often it has been too difficult to compare the findings of studies which employ different ToM paradigms. Harrington et al. (2005) reviewed 30 studies testing ToM in schizophrenia and concluded that ToM deficits are apparent but that comparison of results was difficult due to the fact that a variety of ToM measures were used to test the same construct e.g. irony and picture board stories, deception, false belief, hinting etc. As Baron-Cohen et al. (1995) suggest, ToM may be underpinned by a network of many neural structures which could represent different aspects of ToM abilities and differing task demands. Consequently this may account for the disparity in research findings. Therefore future research should endeavour to administer ToM test batteries that assess ToM using techniques that are validated and incorporate measures of general inferential ability, executive function and memory. This will help to establish if ToM abilities are domain general or domain specific skills. Immediate story recall mediated some of the ToM deficits observed in the authors research and so should be accounted for when assessing ToM in future studies. To enable more fruitful comparison between research findings, future research needs to use similar ToM tasks across different populations or to carefully monitor variations in task demand with corresponding active brain regions.

Studies should further explore the effects of brain damage at different stages of development to ToM (Happé et al., 1999). This would differentiate the importance of specific structures in the development of ToM and in online ToM abilities in adulthood. Whilst some studies have attempted to do this (Shaw et al., 2004) there is lack of research in this area.

Inconsistent findings across studies using adult samples may in part be due to the difficulty in finding appropriate measures to assess ToM in adult populations. Tests need to be hard enough to 'generate errors yet simple enough that errors are not merely due to more general processing demands' (Apperley et al., 2004, p.1774.). Future work could endeavour to develop more sophisticated measures. Studies should utilise more ecological valid measures of testing which reflect the complex subtle social cues that are apparent in human social interaction (Lough et al., 2006). To date most research which has investigated socio-cognitive functioning specifically in relation to ToM has used vignettes depicting social interactions or photographs illustrating different emotional expressions. Traditional measures are easy to administer but may not necessarily tap into the complex perceptual processes that occur when we interpret social interactions. Future work should use ecologically valid measures of dynamic social interaction as it occurs in everyday life. It has been asserted that the TASITS is a much more ecologically valid measure of emotion recognition and social inference than traditional measures. This test might be incorporated into future research as it may be particularly sensitive in detecting impairments in social functioning. It has been used in one epilepsy study to date (Schilbach et al., 2007) and has been shown to be a valid measure of social cognition in people with head injury in past research (McDonald et al., 2003).

One of the main problems in investigating social cognition in epilepsy is that it is difficult to differentiate between the impact of development, the epileptic foci, AED therapy and surgery on the social abilities of PWE (Kirsch 2006). A number of studies have shown that quality of life scores increase after surgery but often these measures do not adequately assess improvements in social functioning (Kirsch, 2006). As Schilbach et al. (2007) argue, social competence has a considerable effect on quality of life yet the study of social cognition

in epilepsy has been largely neglected. Future research needs to continue to explore the impact that socio-cognitive dysfunction has on social functioning and quality of life in FLE and TLE. This could be achieved by administering a wide range of measures that utilise different paradigms in social cognition. Future work should include objective ratings of social functioning to see if real life behaviour is related to socio cognitive task performance. Quality of life measures that fully explore the impact of epilepsy on social functioning that are not self report measures but objective measures completed by significant others need to be employed. This may help resolve the difficulty of insight that appears to be apparent in FLE.

Future research which assesses social cognition before and after surgery is needed (Fournier et al., 2008). Surgery may help reduce seizures activity and reduce the amount of AEDs taken which in turn may improve social cognitive performance. Shaw et al. (2007) found improvements in social cognition (facial expression recognition) in people with left TLE after surgery. There is need for longitudinal research which establishes the impact of surgery on social cognition to establish whether epilepsy surgery is beneficial in improving such skills.

Further research should focus on trying to rehabilitate PWE after surgery where they may find themselves in new social situations that they have not previously experienced and may have difficulty adjusting (Bladin, 1992; Wilson, Bladin & Saling, 2004). PWE may have new found independence which can impact on interpersonal relationships, causing friction and resentment. This may be particularly problematic if parental over protectiveness was a feature before surgery.

9. Conclusion

ToM deficits may also provide some explanation for the complex psychosocial difficulties apparent in PWE. Such difficulties include the experience of stigma, unemployment or underemployment, anxiety and depression, poor self esteem, social isolation and difficulties in interpersonal relationships (Austin & de Boer, 1997; Collings, 1990; De Souza & Salgado, 2006; Fisher et al, 2000; Grabowska-Grzyb et al., 2006; Jacoby et al., 1996; McCagh et al., 2009; McCagh 2010; Mensah et al., 2007; Morrell, 2002; Suurmeijer et al., 2001.).

Current quality of life measures rely on patients to self report improvements in functioning after surgery which may be problematic as this will rest on how well the patient has insight into their social difficulties. This could pose a particular problem for patients with RH lesions where sense of self may be impaired. (Kirsch, 2006) Discrepancies between self report and objective measures of social functioning reports by significant others and or carers of social functioning in PWE on quality of life measures have been evident Hays et al. (1995). This evidence and the findings of the authors study imply that self report measures are not reliable so clinicians need to consider alternative ways of measuring social functioning in PWE.

Presurgical neuropsychological evaluation plays a major role in determining potential outcomes and treatment intervention after surgery. Recent research have demonstrated that PWE have difficulties with socio cognitive functioning (Corcoran et al., 2000; Farrant et al., 2005; Fournier et al., 2008; Schacher et al., 2006; Schillbach et al., 2007; Walpole et al., 2008). It is becoming clear that neuropsychological assessment during clinical audit needs to consider assessing socio cognitive functioning in PWE and that such an assessment should be part of the pre and post surgical evaluation of potential surgical candidates. It is

recommended that an instrument such as the TASITS which is more ecologically valid and likely to be more sensitive to socio cognitive impairment in real life, should be incorporated with more traditional measures to accurately establish the impairments of social perception in PWE. Such assessments should be complemented by an effective measure of the actual social difficulties that PWE experience in everyday life. A number of authors criticise current measures of social functioning used on PWE, currently these measures do not fully explore the impact that surgery has on interpersonal relationships or social competence (Kirsch, 2006; Schilbach et al., 2007). Therefore development of more appropriate measures is needed.

The authors' current research lateralises socio-cognitive dysfunction to the right frontal lobe and left temporal lobe, further study in this area may be able to support the lateralisation of these skills. If this is the case then socio-cognitive assessment may provide clinicians with a useful and inexpensive tool for lateralising the site of seizure foci in patients, particularly where anterior foci are suspected. This may be particularly valuable as there are few neuropsychological tests which can lateralise damage in the prefrontal cortex. The effects of lateralisation or localisation have not been found in studies which assess cognitive functioning in FLE (Helmstaedter et al., 1996; Upton & Thompson, 1996). Tests of social cognition may provide the clinician with an objective measure of deficits in social competence particularly as patients with FLE may lack insight into their impairments.

Patients who are at risk of reduced social competence can be identified and may possibly benefit from treatment intervention. Future investigations should assess the efficacy of such interventions in epilepsy.

Social cognition is an important but neglected area of study in the field of epilepsy. The study of ToM in epilepsy will lead to a greater understanding of the social cognitive deficits of the epileptic condition. This may in turn lead to more effective psychological interventions to enable the smoother functioning of people with epilepsy in society.

10. References

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