Chapter Number

Social Cognition in Epilepsy

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6 **1. Introduction**

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7 There is a paucity of research which has investigated social cognition in epilepsy, this is 8 surprising given the abundance of evidence that exists in relation to the difficulties that 9 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.

14 The aim of this chapter is to provide a detailed critical review of research which has 15 investigated socio-cognitive functioning in people with epilepsy to date. Throughout the 16 chapter, the impact of epilepsy related variables in relation to socio-cognitive processing 17 will be considered.

18 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

21 and suggestions for future work.

22 Abbreviations

23	AED	Antiepileptic drug
24	BF	Bifrontal
25	EEG	Electroencephalogram
26	EI	Emotional intelligence
27	FHI	Frontal Head Injury
28	FL	Frontal lobe
29	FLE	Frontal lobe epilepsy
30	FSIQ	Full Scale Intelligence Quotient
31	HADS	Hospital Anxiety and Depression Scale
32	HC	Healthy Controls
33	IGE	Idiopathic generalised epilepsy
34	IQ	Intelligence Quotient
35	LT	Left temporal lobe
36	LTLE	Left temporal lobe epilepsy
37	LF	Left frontal lobe
38	LFT	Left fronto-temporal
39	LH	Left hemisphere
40	MME	Mini Mental State Examination

1	MTLE	Medial temporal lobe epilepsy
2	MRI	Magnetic resonance imaging
3	NC	Normal control group
4	QoL	Quality of Life
5	NC	Normal control group
6	OFC	Orbito-frontal cortex
7	PHT	Phenytoin
8	QoL	Quality of life
9	PFC	Prefrontal cortex
10	PWE	People with epilepsy
11	RF	Right frontal lobe
12	RFT	Right fronto-temporal
13	RH	Right hemisphere
14	RT	Right temporal lobe
15	RTLE	Right temporal lobe epilepsy
16	TASITS	The Awareness of Social Inference Task
17	ToM	Theory of mind
18	TL	Temporal lobe
19	TLE	Temporal lobe epilepsy
20	WAIS	Wechsler Adult Intelligence Scale
21	WTAR	Wechsler Test of Adult Reading
22	VM PFC	Ventromedial prefrontal cortex

23 2. Social cognition

24 Essentially social cognition is concerned with how people process social information and 25 how they use this information in social situations. Social cognitive processing involves the 26 27 perception and interpretation of social information and the ability to provide an appropriate response to it.

2.1 Theory of mind (ToM)

28 29 30 31 32 33 34 35 36 37 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 38 39 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 40 may not be immediately clear. For example, when someone makes an ironic statement, 41 drops a hint or tells a joke.

42 43 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

44 make inferences about the affective states (the emotions and preferences) of other persons 45 (Brothers & Ring, 1992; Stone, 2000).

1 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.

23456789 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 10 assessment of false belief is regarded as the 'litmus test' of ToM functioning. This method is 11 widely used and validated because it establishes whether an individual can attribute beliefs 12 to others that may differ from their own. As Astington (2001) highlights, false belief is 'an 13 unequivocal marker of mentalistic understanding' (p.685).

14 Typically false belief has been assessed at first order and second order levels of 15 intentionality. Appreciation of first order false belief usually develops by the age of four and 16 by the age of seven, children should be able to pass second order false belief tasks (Perner & 17 Wimmer, 1985; Wellman et al., 2001; Wimmer & Perner, 1983). Often such tests are 18 developed within the context of ToM stories, which are often accompanied by story boards 19 to aid the participant in following the story. First order stories involve a character having a 20 false belief about the state of the world. The tasks require the individual to understand that 21 another person may not have access to information about the world which they themselves 22 have and as a consequence that the other person's viewpoint is mistaken. Typically first 23 24 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 25 26 27 28 29 30 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., 31 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.

32 33 34 35 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 36 37 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 38 they have heard or observed.

39 More advanced tests of ToM involve being able to appreciate non-literal language or 40 figurative speech. An appreciation of the pragmatics of language is needed to understand such 41 things as sarcasm, irony, humour, metaphor and hinting and consequently paradigms using 42 these concepts have been applied to assess ToM performance. By reference to contextual 43 information, the listener must go beyond the literal meaning of the words that are used and 44 comprehend the intentions of the speaker and the meaning they are trying to convey.

45 A number of paradigms have been used in studies to assess these higher order ToM 46 abilities. These include: appreciation of irony (Shamay-Tsoory et al., 2003; Shamay-Tsoory et 47 al., 2005a), sarcasm (Shamay-Tsoory et al., 2002; Shamay-Tsoory et al., 2005 a; ShamayTsoory 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.

123456789 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 eves.

10 2.3 Testing considerations

11 In order to make sure that measures reflect ToM functioning and not other cognitive skills, a 12 13 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 14 apparent deficits in ToM are not a simple consequence of general cognitive dysfunction. To 15 minimise the load on working memory, tasks utilize devices such as pictorial story boards 16 (in ToM stories) or participants are allowed to refer to the relevant text/stimuli throughout 17 testing. As well as questions which assess ToM ability, tasks usually incorporate 'reality' or 18 comprehension questions to ensure that the relevant prose has been understood and to 19 guard against the possibility that poor performance on the task simply reflects memory or 20 comprehension difficulties. In order to achieve this, tasks will typically include some 21 22 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 23 inferences about the mental states of others. All these precautions are designed to ensure 24 that the impairments that are observed reflect ToM difficulties as distinct from problems in 25 other cognitive domains.

26 3. Epilepsy and social cognition

27 Some of the psychological problems associated with epilepsy have their origins in the ability 28 of people with epilepsy (PWE) to engage in meaningful and appropriate social interactions. 29 PWE often report difficulties in social functioning (McCagh et al., 2009), yet research 30 investigating the socio-cognitive skills of this group has been sparse. Impairments in social 31 competence in children, adolescents and adults with epilepsy are also evident (Austin et 32 33 34 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 35 36 that quality of life (QoL) scores increase after surgery but often these measures do not adequately assess improvements in social functioning (Kirsch, 2006).

37 Epilepsy may affect social cognition in many ways that are hard to quantify. Kirsch (2006) 38 suggests that frequent seizures may interfere with the development of interpersonal skills in 39 children or adolescents, such that they may not always be able to participate in situations 40 where they can develop such skills due to ictal and post ictal disruption to functioning. 41 Medication may impact on their ability to respond effectively in interpersonal conversation 42 to subtle social cues. The child's social networks may be reduced due to stigmatisation, lack 43 of self esteem or because parents are more protective over the child and consequently this 44 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).

123456789 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).

- 10 'Despite many years of speculation, it remains unclear to what extent psychosocial 11 difficulties are related to the fact that patients are living with a chronic and stigmatising 12 condition and to what extent they are related to neuropathology' (Walpole et al., 2008, 13 p.1470).
- 14 Whether social maladjustments in PWE can be attributed to social cognitive deficits remains
- 15 uncertain (Schacher et al., 2006).

16 3.1 Research studies

17 To date there have been seven studies, some of which have also looked at recognition of 18 emotion as well as ToM in PWE, though it is not the purpose of the chapter to review 19 research which has assessed emotion recognition in epilepsy per se. One study has 20 investigated emotional intelligence in people with active epilepsy (who have not undergone 21 surgery) and because of its relevance to the area it will be included in the review. The latter 22 part of the chapter will provide a critical review of the methodology used in research to 23 date. Throughout the chapter, the impact of epilepsy related variables in relation to socio-24 cognitive processing will be highlighted.

25 3.1.1 Temporal lobe epilepsy

26 3.1.1.1 Emotional intelligence and emotion recognition

27 Walpole et al. (2008) investigated emotional intelligence (EI) and emotion recognition in 28 temporal lobe epilepsy (TLE). Sixteen patients with TLE were compared with 14 healthy 29 controls (HC). People with TLE were only included in the study if they did not have any 30 history of psychiatric illness (excluding anxiety and depression), head injury, hypoxia, 31 personality disorder, neurological condition or autistic spectrum disorder. People with TLE 32 who had undergone surgery for epilepsy were excluded from the study.

33 Participants were assessed on a range of background measures including the Wechsler Test 34 of Adult Reading (WTAR; Wechsler, 2001), cognitive intelligence as assessed by the Full 35 Scale IQ (FSIQ) score on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 36 1999) the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) and 37 Quality of Life in Epilepsy 31 (QOLIFE-31; Cramer et al., 1998). Participants were also 38 assessed on emotional intelligence (EI) using the Emotional Quotient Inventory (EQ-I; Bar 39 On, 1997) and identification of emotional expression using Ekman and Friesen (1976) 60 40 photographs of facial expressions.

- 41 This study found that the TLE group were significantly impaired on total EI score but not
- 42 cognitive intelligence (FSIQ). The TLE group made significantly more errors when
- 43 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

8 Walpole et al. (2008) conducted their study under the premise that impairments in a study on 9 EI were present in people with lesions to the ventro medial prefrontal cortex (VM PFC) and to 10 the amygdala or insular cortices, brain areas that have also been implicated in social cognition 11 (Bar On et al., 2003). Walpole et al. (2008) argue that EI is closely related to social cognition in 12 that it involves being able to discriminate between and monitor 'one's own feelings and those 13 of others 'and being able to use 'this information to guide responding' (p. 1470).

14 Evaluation: This study would have benefited by recruiting a frontal lobe epilepsy (FLE) 15 group to establish if EI was impaired in this sample in line with evidence in the literature 16 which implicates the importance of the frontal lobes in social cognition (Rowe et al., 2001; 17 Shamay-Tsoory et al., 2005a; Stone et al., 1998; Stuss et al., 2001). Walpole et al. (2008) do 18 acknowledge the need to study EI in other types of epilepsy to determine if EI impairment is 19 specific to TLE. This study can be criticised for not stating whether people had refractory 20 TLE, where participants were recruited from, what AEDs they were on and how many they 21 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.
- 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.

31 3.1.1.2 Theory of mind and emotion recognition

32 Shaw et al. (2007) assessed 19 PWE on ToM tasks and emotion recognition before and after 33 34 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 35 LTLE) had amygdala damage as a consequence of gliosis, neuronal loss or focal lesions. 36 Seizures had stopped or there was a marked reduction in seizures post surgery. Testing took 37 place 1-3 months prior to surgery and 4-6 months post-surgery. Patients who underwent 38 surgery were on the same AEDs post surgery. Nineteen healthy controls with no history of 39 neurological or psychiatric disorders were also assessed on the same measures twice, six 40 months apart.

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

1 The two main experimental measures were recognition of facial expressions and emotions 2 and appreciation of ToM. The Ekman and Friesen (1976) pictures of facial emotion were 3 used and participants had to rate the intensity of one of six basic emotions (sad, happy, 4 surprise, anger, fear, disgust) in two male and female faces who displayed all six emotions. 5 A faux pas test by Stone et al. (1998a) and Happé's Strange Stories (Happé, 1994) assessed 6 ToM. Happé's Strange Stories depict characters that do not literally mean what they say, 7 participants are required to illustrate that they understand what the character really means 8 and their true motivations. The faux pas test required participants to identify that a faux pas 9 had taken place, why the comment was inappropriate and the affect that the faux pas may 10 have had on the character in the story (how it would have made them feel). A control

- 11 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.
- 17 Shaw et al. (2007) found that there were no significant differences in scores pre or post 18 surgery in Happe's Strange Stories or for detection of faux pas or in either RTLE or LTLE, 19 nor was there a significant change in scores from pre to post surgery in relation to these two 20 groups. When RTLE and LTLE groups were combined there was no significant difference in 21 change scores on either of the ToM measures. Change scores in executive function and ToM 22 tasks were not correlated with each other so changes in executive function were unrelated to 23 changes in ToM performance. Prior to surgery patients with LTLE were impaired in 24 recognising facial expressions depicting fear but improved after surgery which the authors 25 suggest may be accounted for by removing a hyper-excitable amygdala. . Another 26 explanation they consider is that epileptogenic tissue in the LTLE may inhibit the emotion 27 recognition network prior to surgery which would account for improvements post surgery, 28 such improvements have occurred in executive processes after anterior temporal lobectomy 29 (Hermann & Sedenberg, 1995; Martin et al., 2000).
- 30 **Evaluation:** Whilst differences in ToM performance pre and post surgery were not evident, 31 the small sample size in the study will have reduced statistical power to detect changes in 32 ToM performance. The ToM tests used in this study may not be sensitive enough to detect 33 change in performance pre and post operatively or differences between right and left TLE in 34 such a small sample. These tests have also not demonstrated functional activation in the 35 amygdala in past research. Past research has shown that bilateral damage is typically found 36 with ToM impairment in adults (Stone et al., 2003), yet participants only had unilateral 37 damage in this study. Memory and learning effects of the tasks may have improved 38 performance after surgery, as the same tests were administered pre and post surgery. Such 39 effects are not controlled for and are hard to quantify, this could be overcome if different 40 tasks were matched in terms of the amount of socio-cognitive processing involved.
- 41 Schilbach et al. (2007) recruited 10 right handed females with LTLE from an epilepsy 42 monitoring unit and an outpatient clinic. Two participants had MTS (mesial temporal 43 sclerosis); there were no detectable structural abnormalities in the other eight. All had a 44 history of complex partial seizures. Ten right handed healthy volunteers with no 45 neurological or psychiatric history were also recruited. All participants included in the 46 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.

123456789 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 10 of self involvement and required them to rate how much social interaction was present in 11 each scenario using a four point Likert scale.

12 The TLE sample group all illustrated the same trend in how they rated social intent despite 13 the different type and number of AEDs that were being taken across the sample. They rated 14 a scenario as more socially relevant if they were more involved in the interaction, this trend 15 was also apparent even if the facial expression was arbitrary. The authors suggest that over 16 reacting to self involvement in social interactions may be a way that people with TLE 17 compensate for their socio cognitive difficulties in interpreting facial expressions and the 18 mental states (intention) of others.

19 **Evaluation:** The study can be criticised as the sample was biased towards females, that the 20 sample was small and that only people with LTLE were tested. Another weakness is that the 21 study did not evaluate the impact of epilepsy related variables (age at onset, seizure type or 22 seizure frequency) on social cognition.

 $\overline{23}$ Schacher et al. (2006) investigated the ability to detect faux pas in 27 people with MTLE 24 (medial temporal lobe epilepsy) of which 16 were investigated prior to surgical resection, 25 and 11 after anterior temporal lobectomy or selective amygdalohippocamectomy (12-18 26 months after surgery). They also recruited 27 people who had extra mesiotemporal epilepsy 27 (extra MTLE) but not FLE (frontal lobe epilepsy) and 12 healthy controls (HC) with no 28 history of psychiatric or neurological disorder. PWE were recruited from an in patient 29 epilepsy centre in Switzerland and had refractory epilepsy. MTLE and unilateral seizure 30 onset was determined by EEG and MRI. Testing on PWE and healthy controls took place in 31 hospital, all PWE including post surgical MTLE were being treated with AEDs.

32 Participants were administered with a shortened version of the faux pas test by Stone et al. 33 (2003). Participants read the story themselves whilst having a copy of the story in front of them 34 to reduce the working memory demands of the task. Participants were asked four questions, 35 three questions assessed inferences about affective and cognitive mental states and one 36 question was a control question to assess that the story had been comprehended correctly. All 37 participants in the study had intact language comprehension as assessed by the Chapman-38 Cook test (Chapman, 1923) and correct answers on the faux pas comprehension question and

39 IQ were also measured. Participants were required to understand the faux pas correctly and 40 infer the mental state and emotions of another person.

41 The MTLE (pre and post op) were significantly impaired on faux pas in relation to the extra 42 MTLE group or healthy controls, task performance between these two groups was

43 comparable. No differences between the pre op MTLE and post op MTLE were established.

44 In the MTLE group as a whole (R= 14 and L=13) people with right sided onset performed

45 significantly worse than those with a left sided onset. There was an interaction between

46 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
- 1 2 3 4 5 6 7 8 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
- 9 pas can not be attributed to language or comprehension as these factors were controlled in 10 the study. The authors suggest that the effect of AEDs is unlikely to account for the 11 observed deficits as the extra MTLE who performed in a similar manner to healthy controls
- 12 had refractory epilepsy and were receiving AED therapy.
- 13 The authors conclude that MTLE plays a role in higher-order aspects of social cognition. 14 They emphasise the role of the amygdala in emotional and socio-cognitive functioning and 15 highlight that this is often impaired in MTLE. MTLE may impact on socio-cognitive skills by
- 16 disrupting the integration of temporolimbic and frontal systems which have been
- 17 implicated in social cognitive functioning.
- 18 Evaluation: This study would have benefited by recruiting a FLE group to establish if
- 19 appreciation of faux pas was impaired in this sample in line with evidence in the literature
- 20 which implicates the importance of the frontal lobes in social cognition (Rowe et al., 2001;
- 21 Shamay-Tsoory et al., 2005a; Stone et al., 1998; Stuss et al., 2001). This would also help
- 22 establish if people with MTLE has a specific deficit in appreciating faux pas.

23 4. The right hemisphere

24 4.1 ToM and emotion recognition in the right hemisphere

- 25 Fournier et al. (2008) investigated social cognition in two patients, one who underwent a 26 right hemispherectomy (S.M.) and one who underwent a left hemispherectomy (J.H.) to 27 treat intractable epilepsy. Both participants underwent surgery in adolescence and were 28 assessed 30 years after surgery on emotion recognition, formation of social inferences and 29 advanced socio- cognitive judgements. Their performance was compared to normative data 30 collected on the measures.
- 31 32 33 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 34 participants experienced hemianopsia and hemiplegia on the contralateral side to surgery.
- 35 The two participants were assessed on a variety of background measures to examine IQ,
- 36 executive functioning, language, construction skills and visual perception. FSIQ scores were 37 comparable and differences in performance on typically RH tasks (attention and
- 38 visuospatial processing) and LH tasks (verbal working memory, speeded verbal processing)
- 39 were as expected. The MMSE Examination was also administered and performance was in
- 40 the normal range for both participants.
- 41 The Awareness of Social Inference Task (TASITS) which assesses ToM judgements, emotion
- 42 recognition and how people make social inferences in daily life was used to assess social
- 43 cognition (McDonald et al., 2003). This test uses video recordings in which actors engage in
- 44 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.

123456789 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 10 second part of the test (Social Inference - Minimal) the participant must detect sincere or 11 sarcastic exchanges in 15 vignettes. To detect sarcasm involves appreciating prosody, body 12 language and facial expressions and participants are asked four questions after each 13 vignette. These questions assess participant's ability to detect what the protagonist was 14 thinking, doing, saying and feeling. Two of the questions probe what the protagonist was 15 intending and feeling, these assess both first and second order levels of ToM.

16 In the third part of the test (Social – Inference Minimal) 16 short vignettes are administered 17 with similar content to part two of the test, the only difference is that participants are 18 provided with extra information regarding the conversational exchange before and after the 19 video. Participants are expected to comprehend the true nature of the exchange whilst 20 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).
- 21 22 23 24 25 26 27 28 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:
- 29 30 31 32 33 34 '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).
- 35 36 37 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 38 additional strength of the study is that it utilised an ecologically valid measure of ToM and 39 emotion recognition by using the TASITS. The main criticism is that ToM was not evaluated 40 prior to surgery so the observed impairments cannot be conclusively related to the surgery 41 itself. S.M. who underwent RH surgery was still experiencing seizures and being treated by 42 AEDs at the time of testing which may have accounted for some of the impairments observed.
- 43 As MMSE performance was normal and examines general neurocognitive functions the
- 44 authors argue that the observed socio-cognitive impairments were not specific to any
- 45 modality (visual, motor or auditory). Attention deficits and general cognitive impairment
- 46 could account for the impairment in appreciating sarcasm and the intentions of the
- 47 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.

1 2 3 4 5 6 7 8 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.

9 5. Frontal lobe epilepsy

10 5.1ToM and emotion recognition

11 Farrant et al. (2005) investigated facial emotion recognition and ToM in 14 people with FLE 12 (8 LFLE, 5 RFLE and 1 Bilateral) and 14 healthy controls. The FLE group were recruited 13 from a specialist epilepsy unit and were being assessed for surgery. Groups did not differ 14 significantly on age, gender ratio, years of education, premorbid IQ or long term memory. 15 Executive functioning was assessed using the Trail Making Task (Reitan & Wolfson, 1993) to 16 assess sequencing (part A) and mental flexibility (part B). The FLE group were significantly 17 slower on the sequencing aspect of this task. The Hayling and Brixton tests (Burgess & 18 Shallice, 1996a, 1996b) were administered and the FLE were significantly slower on the 19 section 1 of the Hayling Test though there were no group differences on response inhibition, 20 though FLE did make more mistakes on the task. The FLE were significantly impaired in 21 relation to controls on a verbal fluency task.

22 ToM was measured using Happé's Strange Stories (Happé et al., 2001; Happé et al., 1999). 23 The ToM stories all involved human interaction where double bluff, mistakes, white lies or 24 25 26 27 28 29 30 31 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, 32 faux pas and humour tasks was reduced as participants had a copy of the story/cartoon in 33 front of them whilst being asked questions. The Reading the Mind in the Eyes Task by 34 Baron-Cohen et al. (2001) was administered where participants had to match correct 35 36 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, 37 happy, surprise, anger, fear, disgust. Twelve pictures were displayed, one male and female 38 picture for each emotion and participants were required to match the correct verbal labels to 39 the emotions displayed.

40 FLE did not show deficits on the story task or appreciation of faux pas though they did 41 illustrate a trend towards impairment. FLE were impaired in both the mental state and 42 physical state cartoons, on emotion recognition and perception of eye gaze expression. ToM 43 was intact but appreciation of humour and emotional expression was not. Mild impairments

44 were observed except in the appreciation of emotion expression where impairment was

45 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.

123456789 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 10 may have detected more impairments across the tasks. Specific areas in the FL may support 11 different aspects of social cognition, consequently deficits in performance may reflect those 12 13 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 14 sample size of the groups. The exact site of seizure foci could only be established in 9 of the 15 14 FLE group (6 with medial and 3 with dorsolateral abnormalities), there were no patients 16 with orbitofrontal involvement. Consequently whether different regions of damage within 17 the FL are associated with specific impairments in the social cognition could not be fully 18 explored. The study did not recruit people with MTLE to compare performance on tests of 19 social cognition in relation to FLE.

20 This study does not provide the reader with any background information about seizure 21 frequency, seizure type, duration of epilepsy or AED treatment in the FLE group, all of 22 which could impact on functioning. Analysis has not been considered in light of these 23 epilepsy related variables.

24 5.2 ToM and pragmatic language

25 26 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 27 28 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 29 left fronto-temporal foci, 3 with bilateral frontal foci and 23 normal controls were tested. 30 Despite the small sample size differences were found between the groups on performance of 31 the Hinting Task. The right fronto-temporal group appeared to perform worse than normal 32 controls on the Hinting Task independent of group differences in IQ.

33 **Evaluation:** This study had a very small sample size and consequently hinting ability was 34 not evaluated in relation to any epilepsy related variables.

35 6. Methodological difficulties of past research

36 In critically evaluating their study Farrant et al. (2005) suggest that a larger sample is needed 37 to enable seizure foci in FLE and social cognition to be fully explored. People with FLE need 38 to be compared with other focal epilepsies particularly MTLE to establish if there are 39 specific socio cognitive deficits observed in FLE. Executive impairments have been 40 illustrated in both FLE and TLE, so it is important to determine the nature of socio-cognitive 41 dysfunction in epilepsy. Farrant et al. (2005) also highlight that a larger sample would 42 enable comparison of performance between right and left FLE.

43 Most of the studies are cross sectional in that they either investigate social cognition post 44 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).

1 2 3 4 5 6 7 8 9 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 10 establish the impact of focal epilepsy on these skills. The added advantage of using an IGE 11 group is that they have active epilepsy, take AEDs and will also be affected by epilepsy 12 13 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 14 group without epilepsy in order to determine the impact of FLE on socio-cognitive 15 functioning. The studies reviewed have also not evaluated socio-cognitive performance in 16 relation to social functioning in PWE.

- 17 There is a general lack of research investigating social cognition in epilepsy as highlighted in 18 the literature (Schacher et al., 2006; Kirsch, 2006). Research that has been conducted has not
- 19 utilised designs that can adequately explore socio-cognitive functioning in focal epilepsy.
- 20 The impact that socio-cognitive skills have in relation to everyday social functioning in PWE
- 21 needs to be investigated (Walpole et al., 2008; Schacher et al., 2006; Farrant et al., 2005). Such
- 22 research could provide valuable insight into the socio-cognitive deficits associated with 23 epilepsy and may ultimately improve social functioning in PWE.

24 7. Current research

25 In light of the methodological problems highlighted in previous studies, the author and 26 colleagues (McCagh et al., unpublished) designed a study to explore socio-cognitive 27 functioning in people with seizure foci in the RF, LF, RT, LT lobes. To overcome previous 28 29 30 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 31 32 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 33 frequency and duration of epilepsy) in relation to the sample. The study also aimed to 34 establish the impact that socio-cognitive functioning may have on the every day life of PWE 35 by assessing social cognitive performance in relation to perceived impact of epilepsy using 36 the Impact of Epilepsy Scale (Jacoby et al., 1993).

- 37 Appreciation of false belief and deception in ToM stories and understanding veiled 38 intentions in the Hinting Task were assessed across all clinical groups. All epilepsy groups 39 were administered the Impact of Epilepsy Scale to compare task performance in relation to 40 the perceived impact of epilepsy, this could then help top establish how socio-cognitive 41 skills are related to social functioning in real life.
- 42 To date this is the largest lesion study to investigate ToM and the largest study within the 43 field of epilepsy to investigate social cognition. The findings of this research are currently 44 being written up for publication. A major outcome from the study is that the RF epilepsy
- 45 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

7 This deficit in first order ToM cannot be attributed to the impact of immediate story recall or 8 level of education, nor is it a consequence of group differences in IQ, number of AEDs, age 9 of onset or duration of epilepsy. The RF group also appear to have difficulty in making 10 inferences based on non-literal language. They were significantly worse on this task than all 11 of the other experimental groups, though further analyses revealed that this deficit was 12 mediated by immediate story recall. The LT were impaired on second order ToM tasks and 13 appreciation of hints though both of these deficits were mediated by immediate story recall. 14 NC performed significantly better on the Hinting Task than all of the patient groups.

15 The results did not show a significant difference between the epilepsy groups on the Impact 16 of Epilepsy score. Only a subgroup of participants were included in this analysis as this 17 questionnaire was administered part way through recruitment. Therefore this sub sample 18 may not have been representative of the entire target population, though there is no specific 19 evidence to suggest this was the case. The RF group did rate the impact of epilepsy higher 20 than any of the other groups but given the small cell sizes, there may not have been 21 sufficient power to detect significant differences between the groups and so it is necessary to 22 exercise caution in interpreting these findings. PWE do not appear to have insight into their 23 social functioning difficulties, which may well reflect underlying pathology. Interestingly 24 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.

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

34 Small sample sizes have reduced the statistical power of findings in many of the studies 35 discussed in the literature review (Farrant et al., 2005; Schilbach et al., 2007; Shaw et al., 36 2007; Walpole et al., 2008), clearly there is a need for studies with larger sample sizes that 37 will enable comparisons across anatomical lesion sites in the frontal and temporal lobes. 38 None of the epilepsy studies that were reviewed recruited a suitable control group or 39 assessed both right and left frontal and temporal groups. The authors current research, 40 recruited an IGE group, who were also taking AEDs to reduce the possibility that the impact 41 of medication might confound the results. Future study designs need to consider these 42 issues. Lesion studies have to date mostly focused on assessing ToM in either patients with 43 frontal or temporal lobe damage but as this study (McCagh et al., unpublished) and brain 44 imaging studies have shown (Brunet et al., 2000; Fletcher et al., 1995; Gallagher et al., 2000; 45 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.

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 \end{array}$ 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 11 endeavour to administer ToM test batteries that assess ToM using techniques that are 12 13 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 14 skills. Immediate story recall mediated some of the ToM deficits observed in the authors 15 research and so should be accounted for when assessing ToM in future studies. To enable 16 more fruitful comparison between research findings, future research needs to use similar 17 ToM tasks across different populations or to carefully monitor variations in task demand 18 with corresponding active brain regions.

19 Studies should further explore the effects of brain damage at different stages of 20 development to ToM (Happé et al., 1999). This would differentiate the importance of specific 21 structures in the development of ToM and in online ToM abilities in adulthood. Whilst some 22 studies have attempted to do this (Shaw et al., 2004) there is lack of research in this area.

- 23 Inconsistent findings across studies using adult samples may in part be due to the difficulty 24 in finding appropriate measures to assess ToM in adult populations. Tests need to be hard 25 enough to 'generate errors yet simple enough that errors are not merely due to more general 26 27 28 29 30 31 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 sociocognitive functioning specifically in relation to ToM has used vignettes depicting social interactions or photographs illustrating different emotional expressions. Traditional 32 33 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 34 ecologically valid measures of dynamic social interaction as it occurs in everyday life. It has 35 been asserted that the TASITS is a much more ecologically valid measure of emotion 36 recognition and social inference than traditional measures. This test might be incorporated 37 into future research as it may be particularly sensitive in detecting impairments in social 38 functioning. It has been used in one epilepsy study to date (Schilbach et al., 2007) and has 39 been shown to be a valid measure of social cognition in people with head injury in past 40 research (McDonald et al., 2003).
- 41 One of the main problems in investigating social cognition in epilepsy is that it is difficult to 42 43 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 44 quality of life scores increase after surgery but often these measures do not adequately 45 assess improvements in social functioning (Kirsch, 2006). As Schilbach et al. (2007) argue, 46 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
- 20 found independence which can impact on interpersonal relationships, causing friction and
- 21 resentment. This may be particularly problematic if parental over protectiveness was a
- 22 feature before surgery.

23 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

- Current quality of life measures rely on patients to self report improvements in functioning 31 32 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 33 lesions where sense of self may be impaired. (Kirsch, 2006) Discrepancies between self 34 report and objective measures of social functioning reports by significant others and or 35 carers of social functioning in PWE on quality of life measures have been evident Hays et al. 36 (1995). This evidence and the findings of the authors study imply that self report measures 37 are not reliable so clinicians need to consider alternative ways of measuring social 38 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.,
- 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
- 42 2005; Fournier et al., 2008; Schacher et al., 2006; Schillbach et al., 2007; Walpole et al., 2008). It
 43 is becoming clear that neuropsychological assessment during clinical audit needs to
- 44 consider assessing socio cognitive functioning in PWE and that such an assessment should
- 45 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
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 \end{array}$ 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 11 and left temporal lobe, further study in this area may be able to support the lateralisation of
- 12 13 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
- 14 where anterior foci are suspected. This may be particularly valuable as there are few
- 15 neuropsychological tests which can lateralise damage in the prefrontal cortex. The effects of
- 16 lateralisation or localisation have not been found in studies which assess cognitive 17 functioning in FLE (Helmstaedter et al., 1996; Upton & Thompson, 1996). Tests of social
- 18 cognition may provide the clinician with an objective measure of deficits in social
- 19 competence particularly as patients with FLE may lack insight into their impairments.
- 20 Patients who are at risk of reduced social competence can be identified and may possibly 21 benefit from treatment intervention. Future investigations should assess the efficacy of such 22 interventions in epilepsy.
- 23 Social cognition is an important but neglected area of study in the field of epilepsy. The 24 study of ToM in epilepsy will lead to a greater understanding of the social cognitive deficits 25 of the epileptic condition. This may in turn lead to more effective psychological 26 interventions to enable the smoother functioning of people with epilepsy in society.

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