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A. Marsh^{1,2,3}, A. Hiles¹, P. Rojas², C. Doody^{1,3}, O. Keating^{2,3}, E. Brooks^{2,3}, K. Butzbach², K. Pleydell-Pearce², & I. Wright^{1,2,3}

¹Department of Neuropsychology, North Bristol NHS Trust, Bristol, UK, ²School of Experimental Psychology, ³University of Bristol, ³Department of Paediatric Neuropsychology, University Hospitals Bristol NHS FT

Introduction:

Background: Within Temporal lobe epilepsy (TLE) lateralisation of epileptogenic origination and/or sclerotic tissue to **left** temporal structures is often associated with poor **verbal memory**, whilst lateralisation to **right** temporal structures implicates **visual memory** impairments. Current assessments of **verbal memory** are **sensitive** to left pathology and **widely validated**.

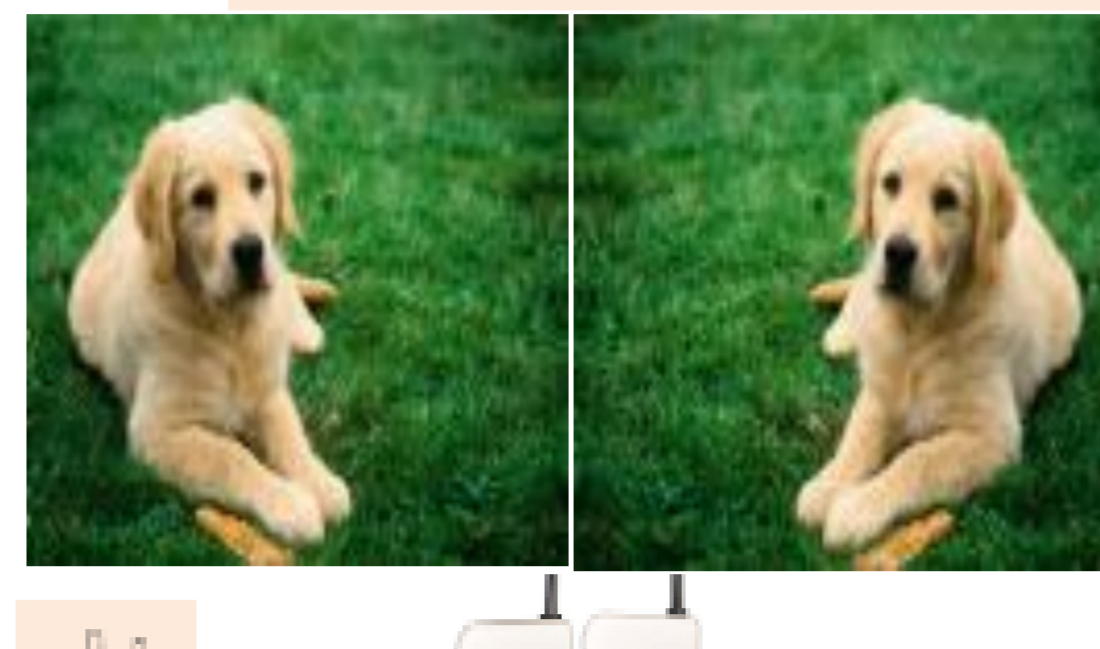
Assessments of **visual memory**, however, are **less sensitive** to right pathology and are largely reliant on subserving verbal processes (Castro et al, 2013; Frish & Helmstaedter, 2014). The most accurate measures of right TL function include stimuli which activates visual, rather than verbal, processing.

Current Investigation: Firstly, investigation aims to establish **convergent validity** of the MMT, assessing utilisation within **healthy** populations (adult and paediatric) alongside **gold standard** measures of memory. Secondly, utilisation of the MMT within **clinical** populations (TLE) will be assessed, aiming to identify sensitivity to right temporal lobe pathology. Overall percentage of correct scores is expected to significantly decline in participants with right unilateral dysfunction.

Mirror Memory Task (MMT): A novel **memory assessment** developed to better measure **visuospatial** processing by using visual stimuli. This maximises right temporal lobe recruitment, promoting the **spatial-encoding** of scenes rather than verbal (Friars et al, 2014; Han et al., 2001).

****WATCH****

****CHOOSE****



	P	R	P	R	P	R	P	R	P	R	P	R
1	1	21	21	41	41	61	61	81	81	101	101	101
2	2	22	22	42	42	62	62	82	82	102	102	102
3	3	23	23	43	43	63	63	83	83	103	103	103
4	4	24	24	44	44	64	64	84	84	104	104	104
5	5	25	25	45	45	65	65	85	85	105	105	105
6	6	26	26	46	46	66	66	86	86	106	106	106
7	7	27	27	47	47	67	67	87	87	107	107	107
8	8	28	28	48	48	68	68	88	88	108	108	108
9	9	29	9	49	12	69	15	89	18	109	21	21
10	30	10	50	13	70	16	90	19	110	22	22	22
11	31	11	51	14	71	17	91	20	111	23	23	23
12	32	12	52	29	72	32	92	35	112	38	38	38
13	33	13	53	30	73	33	93	36	113	39	39	39
14	34	14	54	31	74	34	94	37	114	40	40	40
15	35	15	55	32	75	35	95	38	115	41	41	41
16	36	16	56	33	76	36	96	39	116	42	42	42
17	37	17	57	34	77	37	97	40	117	43	43	43
18	38	18	58	35	78	38	98	41	118	44	44	44
19	39	19	59	36	79	39	99	42	119	45	45	45
20	40	20	60	37	80	40	100	43	120	46	46	46

Easy

Difficult

Task difficulty

As shown above, the presentation of stimuli (P) and recognition trials (R) was structured such that later trials were subject to greater interference. Therefore the difficulty of discriminating true images from mirror images was systematically increased throughout the procedure.

Method:

Eleven patients with epilepsy participated in this study, 5 paediatric patients (mean age = 13.2 years) and 6 adult patients (mean age = 41.4 years). All participants completed the MMT, which included **graduated task difficulty**. In addition, paediatric participants completed subtests from the WISC and established memory measures such as the CMS.

During **encoding (WATCH)** trials, participants were instructed to attend to the novel visual stimuli and in particular to its spatial layout (*see image above*).

The **mirror image** of the scene (B) is presented alongside A for participants to discriminate between during a recognition phase of the study

Stimuli were presented in **blocks** of 20 consecutive images. Subsequent **recognition blocks** were presented comprising 8 images from the immediately preceding block and images from earlier blocks.

Analysis: Behavioural data was analysed to determine **encoding success (hits) or failure (misses)** during early blocks (predominantly **easy**) versus later blocks (predominantly **difficult**).

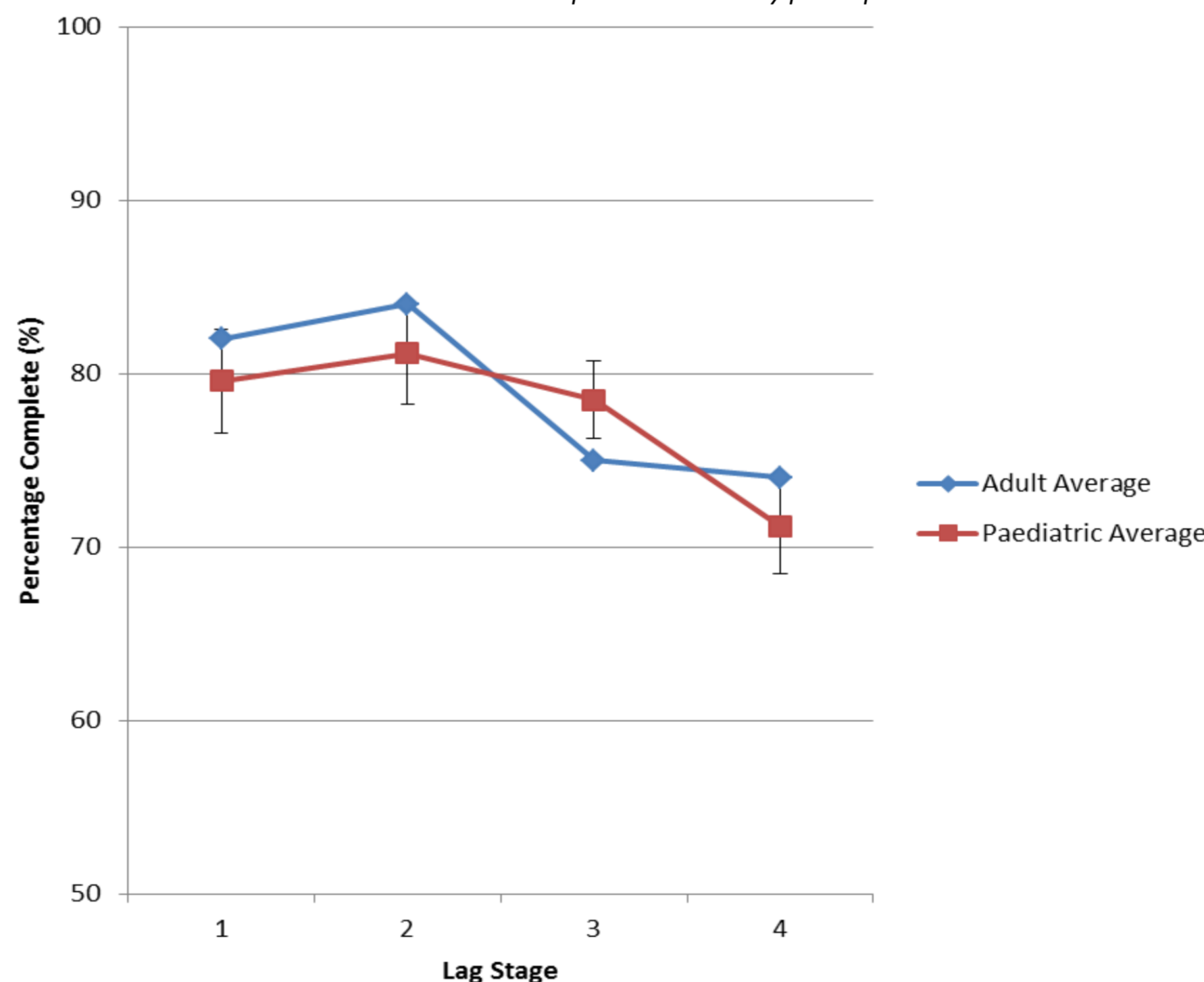
Current Research and Results

Table 1. Clinical participant demographic characteristics

Patient	Gender	Age	Lateralisation	Pathology	CMS (Dots subtest)	WISC (PRI)
1	M	34.02	-	Nocturnal complex partial seizures, temporal lobe semiology	-	-
2	F	13.06	L	Left anteromedial temporal lobe resection; left hippocampal sclerosis	37 ^{9/16}	45 ^{10/16}
3	F	23.01	R	Temporal lobe tumour	-	-
4	M	15.01	R	Mass in medial temporal region	-	-
5	M	15.07	R	Right temporal lobectomy, continuing epileptic seizures, perilesional sinus thrombosis	9 ^{16/16}	61 ^{16/16}
6	F	9.04	L	Left fusiform gyrus lesion, intractable seizure disorder	63 ^{16/16}	-
7	F	56.04	Bilateral	Temporal lobe epilepsy	-	-
8	F	61.06	L	Temporal lobe semiology; left hippocampal sclerosis	-	-
9	M	51.01	R	Aura of panic and bilateral tonic seizures	-	-
10	M	29.01	R	Right temporal DNET	-	<0.1 ^{16/16}
11	M	12.01	L	Epilepsy with 1 seizure type	9 ^{16/16}	-

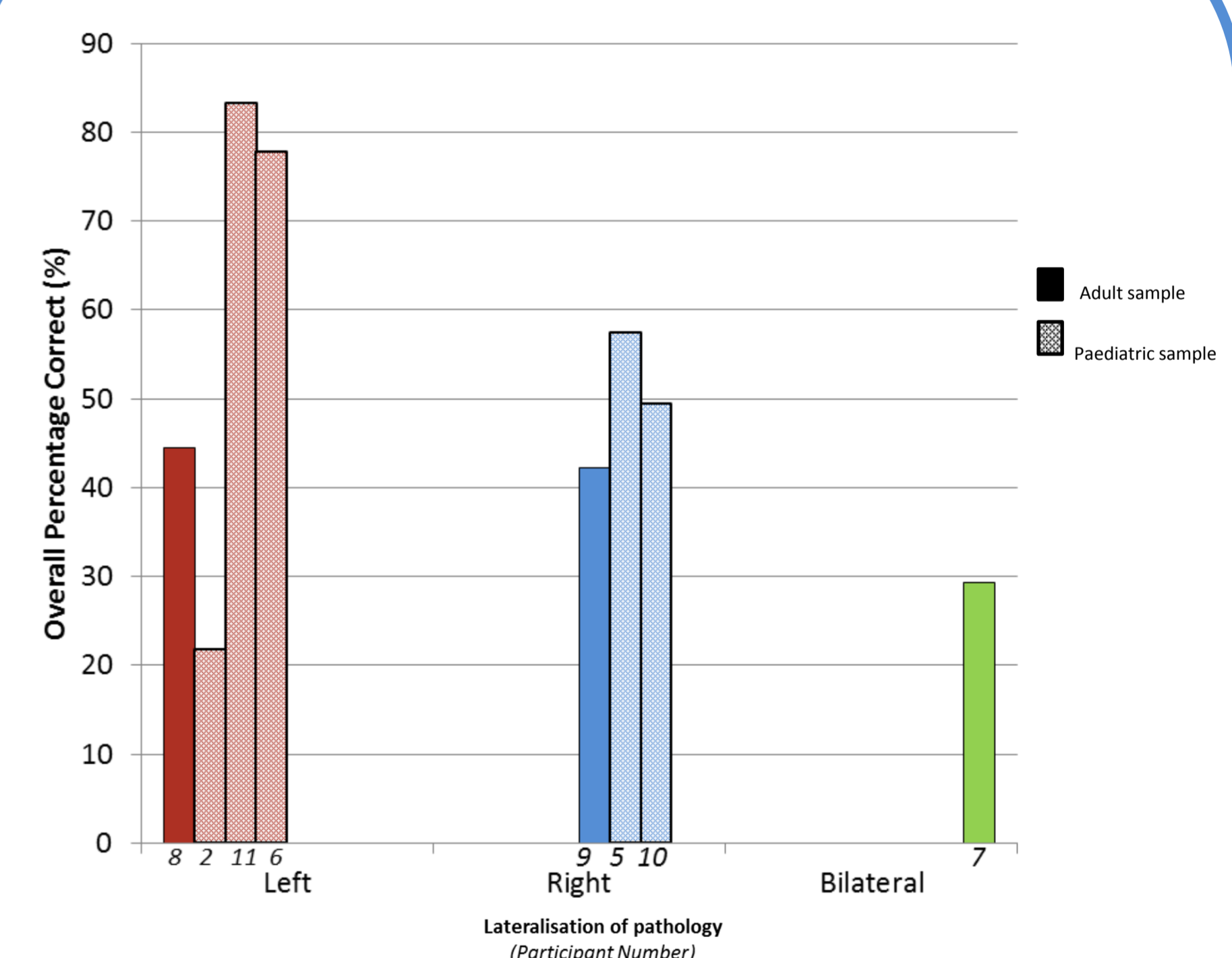
Patient demographic characteristics, pathology, and performance on Gold standard memory test (CMS) and WISC Perceptual Reasoning Index).

Figure 2: The percentage correct (%) of mean scores, across all four lag stages, for both adult and paediatric healthy participants



Behavioural results of healthy adult participants are shown alongside child participants on each stage of lag difficulty on the MMT (Daisley-Devoy et al., 2014; Ryan et al., 2015). Percentage of correct mean scores decrease with task difficulty across both samples, with no significant age-effects found.

Figure 3: Adult and paediatric performance on the MMT, grouped by epileptogenic pathology



MMT Clinical Application (TLE):

- Overall percentage correct, for each participant, is presented and analysed with regard to lateralisation of pathology.
- Participants with **right** unilateral pathology endorse **higher** rates of **incorrect responses** than those with left pathology. This suggests that the MMT may elicit **visuo-spatial encoding** of scenes, rather than verbal, indicating its potential to be a **sensitive** measure in detecting discrete right temporal lobe dysfunction.
- Noted are **possible age effects** within the clinical population, with **paediatric** participants performing better than adults; indicative of potential **neuro-plasticity** and **adaptation**.
- Additionally, a **larger discrimination** of performance between 'left' and 'right' pathology in children may outline an **increased** sensitivity/accuracy of the MMT within the paediatric population.
- Such preliminary results support our hypothesis and enable further investigation into the clinical application of the MMT and its concurrent validity.

Conclusions:

- Behavioural results show good levels of **recognition accuracy** following visual scene encoding.
- Preliminary analysis with patient data suggests that the Mirror Memory Task could be used to **detect visuospatial memory impairment**. In patients with epilepsy, this study demonstrates the sensitivity of the MMT to temporal lobe dysfunction and specifically to visuospatial memory deficits associated with right temporal lobe pathology.
- The conclusions drawn suggest that the Mirror Task is a promising predictor of visuospatial memory ability, which has **high convergent validity** and two levels of difficulty. It further suggests that this paradigm is suitable for **determination** of right hippocampal recruitment for visual memory.

Further Research:

Extension of this investigation will incorporate **fMRI** data with behavioural performance on the task to determine the merit of the MMT in maximising BOLD asymmetry to the right by placing a preferential load on spatial memory.