Introduction
Autism Spectrum Disorder (ASD) is a complex neuro-developmental disorder that is primarily defined by impairments in reciprocal social and communicative abilities.

ASD is also characterised by a multifaceted cognitive phenotype that includes a particular pattern of memory strengths and weaknesses (Boucher et al., 2012; Boucher et al., 2011).

Because it is well known how the typical brain mediates learning and memory processes (e.g., Eichenbaum, 2004; Mayes et al., 2007), the study of this domain provides a window into the brain basis of ASD.

Moreover the study of memory offers important pointers to the possible developmental origins of ASD since learning and memory processes mature early in life (e.g. Bauer, 2004).

Here we outline some of the approaches we have taken in the ARG to understand the brain basis of ASD through the study of memory.

Looking at the Brain Directly
Medial Temporal and Frontal brain areas play a critical role in the formation and retrieval of memories. We have examined the integrity of this memory system directly through fMRI and EEG methods.

Memory Formation: ASD individuals have difficulties encoding semantic relations amongst words in a manner that promotes subsequent memory. This difficulty is related to atypically low posterior hippocampal involvement during encoding.

Memory Retrieval: When memory is tested for individual items instead of relations, performance is preserved in ASD. Nevertheless, retrieval ERPs show atypical engagement of early (300-500ms) semantic processes and later (500-1500ms) recollective processes that mediate the 'reliving' of the past.

Insights through animal learning tasks
The animal learning literature offers many implicit learning tasks that are ideally suited for the study of memory in lower functioning and younger individuals with Autism.

Computer based versions of the Morris Water-maze (Morris, 1981) can be used to differentiate between allocentric and egocentric spatial navigation abilities. Allocentric processing allows us to use meaning of landmarks to navigate, which relies on the hippocampus (e.g. Botbol et al., 2004) whereas egocentric processing allows us to use our body as a reference point for navigation and is regulated by the caudate nucleus of the basal ganglia (e.g. Botbol et al., 2004). We expect that ASD individuals will have difficulties in allocentric but not egocentric water-maze tasks.

Processing the configuration of visual stimuli is mediated by the hippocampus (Sutherland & Rudy, 1989) and can be examined by structural learning tasks (Sanderson et al., 2008), where participants learn to identify which of two stimulus configurations leads to a reward. Similar to individuals with hippocampal damage we expect ASD participants to experience difficulties on structural learning but not other configural processing tasks.

The Use of Eye-Tracking
Eye-tracking technology can be implemented to study memory in infants as young as a few weeks old and we are developing paradigms that will allow us to do so in ASD in the near future.

Novelty preference: Hippocampal damage leads participants to perceive a familiar stimulus as newer if the background on which it is presented changes, which suggests impaired flexibility in forming item-background associations (Pascali et al., 2008). Eye-tracking studies reveal a similar pattern in ASD.

What is the clinical significance?
Structural language impairment (LI) occurs in around 50% of people with ‘low-functioning’ ASD (LFA) who have co-morbid intellectual disability. Memory is well known to be important for language development, and we have hypothesised (Boucher & Hayes, 2006) that impaired familiarity processes associated with medial temporal lobe pathology contributes to LI in LFA. Available evidence provides preliminary support for this hypothesis (Boucher et al., 2008b; Boucher et al., 2012) and an ongoing large-scale study using our ‘shape-recognition action recall’ task is testing further predictions stemming from this hypothesis.

Relationships between scores on these tests and tests of lexical semantic knowledge, mindreading, central coherence, nonverbal intelligence, and socio-economic status are being assessed. An application for funding to assess brain correlates of declarative memory impairments in high- and low-functioning ASD is under review.