Social Cognition and Sickle Cell Disease

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ABSTRACT

Background: Sickle cell disease (SCD) is monogenic disorder characterised by abnormalities in the red blood cells, specifically the haemoglobin molecule responsible for the transporting oxygen throughout the body. People with sickle cell disease have an increased risk for cognitive impairments and psychosocial problems. However, only a limited number of studies have explored the psychosocial problems associated with sickle cell disease from a neurocognitive perspective.

Aim: To investigate associations between social cognition and sickle cell disease.

Method: Eleven participants completed a neuropsychological assessment battery designed to assess premorbid ability, general cognition and social cognitive functioning.

Results: Individuals with sickle cell disease displayed weakness on social cognitive measures of theory of mind and affective empathy compared to the norm. These findings were observed in a highly educated sample who performed above average on measures of general cognition.

Discussion: Social cognitive impairments may be associated with SCD and could potentially explain the psychosocial problems experienced by this clinical population. However, given the novelty of this study, further research is necessary to draw reliable conclusions. Future studies should aim to replicate the findings in larger, more heterogenous sample and account for experiences of discrimination and internalising symptoms.

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ABBREVIATIONS

ACS *Advanced Clinical Solutions*
ASC *Autism Spectrum Condition*
ACT *Acceptance and Commitment Therapy*
ANT *Affect Naming Test*
ASD *Autism Spectrum disorder*
CBT *Cognitive Behavioural Therapy*
D-KEFS *Delis-Kaplan Executive Functioning System*
EF *Executive Function*
FDA *Food and Drug Administration*
FSIQ *Full Scale Intelligence Quotient*
HbSS *Sickle Cell Anaemia*
HbSC *Sickle Cell Disease*
HbAS *Sickle Cell Trait*
HRQL *Health Related Quality of Life*
KBNA *Kaplan Baycrest Neurocognitive Assessment*
PIQ *Performance Intelligence Quotient*
QCAE *Questionnaire of Cognitive and Affective Empathy*
RBC *Red Blood Cells*
RMET *Reading in the Minds Eyes*
SCD *Sickle Cell Disease*
SSQ *Social Stories Questionnaire*
ToM *Theory of Mind*
TOPF-UK *Test of Premorbid Functioning UK*
UK *United Kingdom*
US *United States*
WAIS-IV *Wechsler Adult Intelligence Scale – Fourth Edition*
WMS-IV *Wechsler Memory Scale – Fourth Edition*
VIQ *Verbal Intelligence Quotient*

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1. INTRODUCTION

1.1 Overview

In recent years, there has been an increasing focus on Sickle Cell Disease (SCD), an inherited blood disorder that affects haemoglobin, the protein that carries oxygen through the body. While progress has been made understanding the condition, and advances in treatment, we have a limited understanding of the cognitive, psychological and psychosocial impact on people affected. In this thesis, I will address the existing literature on cognitive function in adults with SCD, and in particular those aspects of cognitive function (social cognition) that concern the person's capacity to attribute and understand the mental states (e.g., beliefs and feelings) of other people.

This chapter will begin with overview of SCD, encompassing its pathology, symptoms, and comorbidities. Then, it will introduce the literature on cognitive function in SCD, noting that although well-studied in children, there is a very limited literature on the cognitive function of affected adults. Then it introduces the concept of *social cognition along* with its core components. Finally, it will explore the potential connections between SCD, general cognitive function, and social cognition, providing a rationale for investigating these interconnected areas.

1.2 Sickle Cell Disease

1.2.1 Definition

SCD is the most commonly inherited haemoglobinopathy. Haemoglobinopathy is a medical term used to describe a group of recessively inherited disorders that affect the red blood cells. These conditions are caused by a single gene mutation which alters the production of haemoglobin (Old, 1996). Inherited haematological conditions fall into two main categories: the thalassemias and abnormal structural variants of haemoglobin (Weatherall & Clegg, 2001).

1.2.2 Historical Background

Herrick (1910) first identified sickle cell-shaped erythrocytes in a Grenadian dental student who presented with respiratory symptoms. Based on the symptoms of the condition, the term “sickle cell anaemia” was coined by the physician Vernon Mason (Mason, 1922). However, evidence of sickle cell disease can be traced back to the 1800s, when a pharmacological documented published the absence of a spleen in an autopsy of an African slave (Adio et al., 2022). These discoveries have contributed to seminal observations related to sickle cell disease such as the identification of molecular abnormalities in sickle haemoglobin by Pauling et al. (1949). Since then, the genetic components of SCD have been researched extensively and have continued to shape our understanding of the disorder.

1.2.3 Classification

The term “sickle cell disease” specifically refers to a group of inherited blood disorders characterised by haemoglobin abnormality. There are various types of sickle cell disease, the most common being sickle cell anaemia (HbSS), which is caused by inheritance of the sickle gene from both parents. This form of sickle cell disease is the most severe and is associated with serious complications (Rees et al., 2010). Sickle cell disease (HbSC) is the next most common genotype of the disorder and is generally considered less severe. The third major type is sickle beta thalassemia, which occurs when the sickle gene is inherited with the thalassemia gene mutation. Sickle beta thalassemia is less common than the two previous types, and severity is variable (Cameron et al., 1983).

Individuals who have inherited one abnormal sickle gene and possess one normal haemoglobin gene have the sickle cell trait (HbAS). However, in rare cases, they can experience complications of the disorder such as acute pain and fatigue (Kotila, 2016). Apart from the genotypes of sickle cell disease, additional forms have been documented for example, haemoglobin-SE, haemoglobin-SD, and haemoglobin-SO which are rare.

1.2.4 Epidemiology

1.2.4.1 Global distribution

The global distribution of SCD reflects two factors: exposure to malaria and population migration. There is now strong evidence that the sickle cell gene protects heterozygous carriers (HbAS) from contracting the malaria infection. Although the mechanism of this protection is not fully understood, it has been hypothesised that the sickle cell gene offers immune-mediated mechanisms (Nagel, 2003). This contributed to the positive selection for the gene mutation, which has caused an increased prevalence of sickle cell in malaria-endemic regions including the Middle East, sub-Saharan Africa, and parts of the Indian subcontinent (Piel et al., 2013a; Rees et al., 2010). With malaria cases increasing across the world, it has been hypothesised that the sickle cell gene mutation will be sustained (Weatherall & Clegg, 2001).

Population movements due to war and African and Arab slave trades, are responsible for the widespread distribution of the sickle cell gene particularly in North America and Western Europe (Piel et al., 2013a). Detailed mapping of the sickle cell gene frequency has demonstrated that the condition can be distributed across short geographical distances (Weatherall, 2010). In recent history, the dissemination of the sickle cell gene has mainly been caused by the globalisation of people. Evidence of this was initially observed in Ireland, where people diagnosed with sickle cell disease were rare but have become quite common today (McMahon et al., 2001).

These processes have led to SCD becoming a global health problem. It is worth noting that individuals with no African ancestry can have sickle cell disease. The assumption that haematological disorders such as SCD can only impact people of colour is outdated.

1.2.4.2 Prevalence and incidence

Sickle cell disease has a high prevalence and social impact worldwide, with almost five percent of the population being carriers of the sickle cell gene (NICE, 2021). Approximately 515,000 newborns are affected by SCD worldwide,

particularly in low- and middle-income countries. A global study revealed that over the past 21 years, the number of people living with SCD has grown steadily from 5.46 million to 7.74 million (Thomson et al., 2023).

1.2.4.2.1 Africa

The prevalence of SCD remains the highest in sub-Saharan Africa. In this population, approximately 230,000 newborns per year are affected by SCD, contributing to 80 percent of the global total (Piel et al., 2013b). Obtaining precise estimates of SCD in Africa remains challenging. These challenges can be attributed to a lack of diagnostic and screening facilities (Rahimy et al., 2003).

1.2.4.2.2 United Kingdom

In the UK, the National Health Service has implemented a universal screening program for SCD, which aims to detect childhood complications related to the disease. It has been suggested that roughly 1 in 2,000 babies are born with the disorder and that approximately 14,000 people in the UK have a diagnosis of sickle cell disease (Dormandy et al., 2018). The screening tools in the UK have contributed to better detection of SCD; however, the precise number of people affected by the disorder remains unclear.

1.2.5 Pathology of SCD

1.2.5.1 Red Blood Cells

Red blood cells (RBC), also known as erythrocytes, carry oxygen throughout the body. In healthy adults approximately two million RBCs are formed per second and have a survival rate of four months (Thiagarajan et al., 2021). RBCs are soft, malleable and have a curved shape which enables them to pass easily through blood vessels. At the centre of each red blood cell is a protein molecule called haemoglobin which is made up of two smaller units of protein (alpha and beta globin) which support the transportation of oxygen (Bjorklund, 2011).

1.2.5.2 The sickled red blood cell

People with SCD have abnormal haemoglobin, stemming from a single point mutation wherein a base pair is either added, deleted or altered within the beta

globin protein molecule (Inusa et al., 2019). This mutation causes of loss of oxygen within the red blood cells, causing the cells to become distorted through a process known as polymerisation, which forms the characterised crescent 'sickled' shape (Hebbel et al., 1980). This process also causes the cells to lose elasticity, rendering the cells sticky and inflexible. These atypical RBCs struggle to pass through narrow capillaries, leading to the obstruction of blood vessels and diminished blood flow. During this process, red blood cells become deoxygenated and cling to vessel walls triggering a state of oxygen deprivation in neighbouring healthy cells – a condition known as hypoxia (Jones, 2008).

The polymerisation of red blood cells causes permanent damage to the cell membrane. This contributes to the loss of water molecules which causes the cells to become dehydrated. In SCD, this process is ongoing and leads to the production of more crescent shaped red blood cells (Lew et al., 1997). The dehydration and cycle of polymerisation causes cells to become stressed and breakdown contributing to the short lifespan of sickle cells. The early destruction of red cells is what causes symptoms such as anaemia and acute pain crises (Kavanagh et al., 2022).

1.2.6 Symptoms of SCD

SCD symptoms typically emerge in early childhood. The symptoms of the condition can vary in severity and are typically caused by poor functioning red blood cells. Patients with acute forms of the disease can experience a wide range of symptoms. However, people with sickle cell anaemia (HbSS) often experience the most challenging clinical complications.

1.2.6.1 Acute pain episodes

The most common symptom of sickle cell disease is acute episodes of pain, typically referred to as 'sickling crisis' or vaso-occlusive crisis. These episodes of pain are caused by abnormal red blood cells obstructing the capillaries and reducing blood flow. This symptom first emerges at approximately two years old. The frequency of the pain episodes can vary but often peaks between the ages of 19 to 39 years (Bainbridge et al., 1985). Pain episodes that occur during this

period of life are typically associated with increased mortality rates. Patients report experiencing pain in their lower back, legs and arms (Ifeanyi et al., 2015). However, episodes of pain can occur in any part of the body. The perceived severity of pain can range from mild to excruciating.

There is some evidence to suggest that dehydration, stress, infection, and temperature changes might trigger episodes of pain. However, episodes can also occur without any clear triggers (Rogovik et al., 2011). Painful episodes can last for approximately five to seven days (Kumar et al., 2014). Conditions like dactylitis, characterised by the inflammation of the hands and feet, are often a clinical manifestation of acute pain episodes. It usually occurs within childhood, particularly between the ages of 6 to 12 months (Gill et al., 1995).

1.2.6.2 Acute Splenic Sequestration

In SCD, the spleen is often damaged in early childhood, particularly from age 6 months to 5 years. This results in a condition is characterised by a sudden and painful enlargement of the spleen, induced by a large pooling of blood in the organ, which causes reduced levels of haemoglobin (Siado et al., 2015). Sequestration crises are treated as emergency situations, as patients may die within 1 to 2 hours if the condition is not treated (Kane et al., 2023). The acute pain related to the enlargement of the spleen typically lasts for approximately 4 hours but can persist for at least 24 hours (Khatib et al., 2009). Children who experience acute splenic sequestration have an increased risk of experiencing further episodes of this condition (Emond et al., 1985). To minimise this risk, the spleen is surgically removed after a single sequestration event.

1.2.6.3 Acute Chest Syndrome

Acute chest syndrome is a life threatening condition which occurs in children and adults living with sickle cell disease. It is the second most common symptom of SCD, accounting for nearly 25% of fatalities amongst patients (Powars et al., 1988). This symptom is characterised by discomfort in the chest, difficulty breathing, low levels of oxygen, and fevers (Friend et al., 2023). This syndrome is caused by reduced blood flow and nutrients to the lungs which is often

precipitated by infections. A significant number of patients will experience at least one episode of acute syndrome in their lifetime. Recurrent episodes of the syndrome could lead to the development of chronic lung disease (Powars et al., 1988).

1.2.6.4 Anaemia

Anaemia is a persistent feature of SCD. People with anaemia often report symptoms such as fatigue, shortness of breath, and pale skin. In sickle cell disease, acute anaemia is caused by the repeated destruction of red blood cells during a process known as haemolytic crisis. During the haemolytic crisis, red blood cells are destroyed much faster than they are created, causing low levels of haemoglobin (Smits et al., 1969).

Severe cases of anaemia can also be caused by an aplastic crisis. During an aplastic crisis the patient's bone marrow struggles to produce red bloods cells, resulting in low energy levels and tachycardia (Conrad et al., 1988). This condition is often driven by viral infections. Anaemia can also be exacerbated by acute splenic sequestration in children and infants (Kavanagh et al., 2022).

1.2.7 Clinical Complications

Sickle cell disease can be described as a multi-system disorder, due to its pathology affecting more than just red blood cells. The symptoms of sickle cell disease arise from a complex interplay among the destruction of red blood cells, inflammation, and vascular damage (Mccormick et al., 2020). These complications can vary in severity and often require close monitoring. The most common and debilitating clinical complications will be outlined in the section below:

1.2.7.1 Infections

Patients with SCD are more likely to contract harmful infections, including influenza, salmonella, meningitis and pneumonia (Serjeant, 1997). Before preventative measures, children with SCD were 30 – 60 times more likely to be affected by these infections (Halasa et al., 2007). Such infections are a common

cause of illness and death among individuals with sickle cell disease. The increased susceptibility, especially in childhood is associated with impaired splenic function. The spleen has a key role in fighting infections, and functions as filter removing old cells, damaged red blood cells, and producing antibodies (Booth et al., 2010).

1.2.7.2 Priapism

Priapism is a serious clinical manifestation of SCD. It has been defined as a painful unwanted penis erection, affecting 40 percent of males with SCD (Adeyoju et al., 2002). This condition typically emerges in childhood between the ages of 5 to 13 years and peaks between the ages of 21 to 29 years. It is mostly likely to affect patients with the HbSS genotype (Ifeanyi et al., 2015). The mechanism behind priapism is unclear. One hypothesis is that low arterial inflow into the corpora cavernosa (spongy tissue in the shaft of the penis) impedes outflow triggering the sickling of red blood cells, which causes the prolonged erection (Ahuja et al., 2021). Recurrent episodes of priapism can lead to infection and fibrosis which may eventuate in erectile dysfunction.

1.2.7.3 Renal Complications

Chronic kidney disease is a common manifestation of SCD, with almost one third of patients developing renal disease and at least 18 percent require dialysis and transplantation (Falk et al., 2010). In SCD, there is a strong tendency for the red blood cells to become sickled in the inner most part of the kidney known as the renal medulla. The abnormal red blood cells restrict blood flow to the kidney, which leads to cell death and the permanent changes to the structure of the organ. Without oxygenated blood the kidney cannot carry out its main function of filtering waste from the blood. This leaves patients suspectable to proteinuria, which is the loss of healthy proteins during urination. Renal dysfunction is apparent from an early age, especially in patients with the HbSS genotype, and progresses with age. It has been shown to reduce patients life expectancy by approximately 12 years (Drawz et al., 2016).

1.2.7.4 Ocular complications

The ocular complications observed in this patient group are caused by blocked blood vessels in the choroid and retina. The physical changes in sickle retinopathy can be classified as non-proliferative and proliferative (Scott, 2016). Non-proliferative sickle retinopathy is characterised by retinal pigmentary changes, retinal haemorrhages, and the distortion of the pupil. These symptoms have no enduring visual consequences. On the other hand, proliferative sickle retinopathy is the leading cause of vision loss due to retinal detachment and the formation of abnormal blood vessels in the retina (Lim, 2012). These complications are more likely to be observed in patients with sickle cell haemoglobin (SC). There are currently no preventative measures to avoid or reduce sickle retinopathy (Fox et al., 1990). However, routine retinal examinations are offered to patients during annual reviews.

1.2.7.5 Dermatological complications

Leg ulcers are a chronic and recurrent complication of sickle cell disease. They are more common among men, particularly those with sickle cell anaemia and lower levels of foetal haemoglobin (Costa & Fertrin, 2016). The condition can present in adolescence with incidence increasing with age. The ulcers usually occur around the ankle, often caused by minor trauma or an insect bite. The mechanism underpinning sickle leg ulcers is complex. They are thought to be the consequence of poorly functioning venous valves, inability to drain excess blood from the ankle causing increased pressure and inflammation thus impeding healing (Stuart & Nagel, 2004). Bacterial infections such as salmonella cause additional complications such as osteomyelitis inflammation of the bone marrow (McAnearney & McCall, 2015). Sickle cell related ulcers can cause excruciating and debilitating pain. Treatment of the ulcers can be challenging, but often includes cleansing topical ointments, antibiotics, and neuropathic pain management.

1.2.7.6 Reproductive complications

Reproductive issues are common among both women and men with sickle cell disease and include a wide range of complications. Some of these issues arise from the use of medical interventions designed to prevent or manage the symptoms of the disorder (Smith-Whitley, 2014).

1.2.7.6.1 Fertility in men

Infertility in men with sickle cell disease is caused by reduced secretion of testosterone, sperm abnormalities, and erectile dysfunction due to priapism. Approximately 24 percent of men with sickle cell disease develop issues with testosterone secretion, which causes issues including sparse facial and body hair. The underlying mechanism of this complication is the vaso-occlusion of testicular blood vessels. (Parshad et al., 1994). People with SCD experience a delay in sexual maturation which can contribute to sperm abnormalities including poor mobility and abnormal morphology (Osegbe et al., 1981). Recurrent priapism is the main cause of erectile dysfunction in men with SCD. Management of sickle related erectile dysfunction can be challenging, however penile implants has been relatively successful. Preventing repeated episodes of priapism is the most effective way of addressing erectile dysfunction as surgery can contribute to additional complications (Mantadakis et al., 2000).

1.2.7.6.2 Fertility in women

Less is known about fertility in women with sickle cell disease. However, the survival of children with sickle cell disease into their reproductive years has created a necessity for further research into their reproductive health (Pecker et al., 2021). Girls with sickle cell disease are more likely to have a late onset of their menstrual cycle. Although their bleeding patterns are relatively normal, patients can experience acute pain crises in the week before their menstrual cycle (Sharma et al., 2019). Research suggests that women with SCD have a reduced reproductive lifespan, with their ovarian reserves rapidly declining between age of 25 to 30 years. This is possibly caused by ovarian sickling and SCD treatments such as hydroxycarbamide (Chase et al., 2009; Queiroz et al., 2021). Methods such as ovarian tissue and embryo cryopreservation are often

used to preserve fertility. However, sickle cell fertility research lags in comparison to oncological fertility research, which is evidenced by the poor guidelines for women with SCD (Campbell et al., 2015).

1.2.7.6.3 Pregnancy

A major reproductive concern in women with SCD is pregnancy. Foetal complications in sickle cell disease are related to reduced blood flow which can contribute to spontaneous abortion, pre-eclampsia, and low birth weight. It can also cause maternal complications such as severe anaemia and bacterial infections (Boafor et al., 2016; Hassell, 2005). Patients are more at risk for pregnancy-related morbidity and mortality. However, advancement in antenatal and obstetric care has improved maternal outcomes in recent years.

1.2.7.7 Neurological complications

Stroke can be defined as an acute neurological event and is often a consequence of sickle cell anaemia. Before the implementation of stroke prevention measures approximately eleven percent of children with sickle cell disease had a stroke by the age of twenty years (Ohene-Frempong et al., 1998). In SCD, stroke can be precipitated by pain crises, splenic sequestration, acute chest syndrome, or as an isolated event. Common symptoms often include severe headaches, seizures and aphasia (Rees et al., 2010). It has been hypothesised that these strokes are caused by the sickling of large extracranial and intracranial blood vessels forming large blood clots which travel to the brain (Hassan & Markus, 2000).

Minor cerebral infarctions, also known as ‘silent strokes’, are common clinical manifestation of SCD. These strokes often occur early in life and are associated with neurocognitive deficits (DeBaun et al., 2012). Silent strokes may not cause significant symptoms, but they do indicate a patients risk for both acute and major strokes in the future. Less common neurological complications of sickle cell disease include Moyamoya syndrome, which is a cerebrovascular disorder caused by blocked arteries in the basal ganglia (Kassim & DeBaun, 2013).

1.2.8 Diagnosis

SCD diagnosis includes the analysis of haemoglobin. The presence of sickle haemoglobin can be detected with the solubility test. This involves the mixture of haemoglobins in a chemical solution called sodium hydrosulphite. Increased opacity of the solution is indicative of SCD (Tubman & Field, 2015). This method of testing is often used during newborn screening. However, it should not be used in isolation as it may yield false negatives in patients with severe anaemia and thalassemia trait. Newer methods such as antibody tests offer more accurate and rapid ways of diagnosing sickle cell disease (Arishi et al., 2021). Variant haemoglobin can be detected by using advanced techniques such as electrophoresis. This approach involves the separation of DNA and protein molecules based on their size. Through electrophoresis, clinicians can confirm and offer differential diagnoses (Ware et al., 2017).

1.2.9 Treatment

Treatment options for SCD have historically been limited. Researchers have argued that this is due to the lack of research funding. For example, Griesler et al., (2021) reported that despite having a lower prevalence, research funding for cystic fibrosis was 10 times greater than for SCD. However, an increased understanding of the biological underpinning of the disease has slowly led to an expansion of viable treatment options. The introduction of these treatments has significantly increased life expectancies and improved health outcomes (Ifeanyi et al., 2015).

1.2.9.1 Medication therapies

Hydroxyurea was approved by the US FDA in 1998 and aims to reduce the frequency of acute pain crises in adults with sickle cell anaemia (HbSS). Hydroxyurea is a medication which was first used for cancer treatment. In SCD, its primary function is to promote the production of foetal haemoglobin. This form of haemoglobin is rarely affected by the sickle mutation (Neumayr et al., 2019). Long-term analyses found that patients who received hydroxyurea had a significant reduction in mortality (Steinberg et al., 2003). Subsequent testing has revealed that this medication is now safe for paediatric patients. Despite the

effectiveness of hydroxyurea, studies have found that it can cause side effects such as alopecia, rash, nausea, weight gain and impact fertility all of which negatively impact adherence (McGann & Ware, 2011).

Three new medication therapies for SCD were approved in 2017: L-glutamine, crizanlizumab, and voxelotor. L-glutamine is an oral amino acid supplement intended to decrease the subspeciality of sickle red blood cells to oxidative damage, therefore reducing sickling and stickiness of the blood cells, and associated complexities (Niihara et al., 2005). Treatment with this medication has been contributed to reduced pain crises and hospitalisations (Niihara et al., 2018). Less is known about the effects of Crizanlizumab and Voxelotor, but recent trials suggest that they might have similar effects to hydroxyurea (Kavanagh et al., 2022).

1.2.9.2 Experimental therapies

Stem cell and bone marrow transplantation are the only curative treatments for SCD. These treatments aim to replace the abnormal sickle cells by promoting the production of functional haemoglobin chains (Walters, 2005). Stem cell transplantation is mainly used for children with severe complications, as older patients have a higher risk of rejecting the donated stem cells. Several studies in children have reported promising outcomes, with long-term disease-free survival rates ranging from 82% to 86% (Bhatia & Walters, 2007).

Newer treatments include gene therapy strategies. These methods have included the insertion of genes with antisickling and foetal haemoglobin properties. In 2023, the US FDA approved two gene editing therapies called Bluebird and CRISPR which work by inserting modified genes into the body through harmless viruses (Leonard & Tisdale, 2023). Initial evaluations and trials indicate that these methods can reduce pain crises and vaso-occulsive events (Kavanagh et al., 2022).

1.2.9.3 Blood transfusions

Long-term blood transfusion is commonly given to patients with sickle cell disease for the management of acute and chronic clinical manifestations. During exchange blood transfusion, the patients, abnormal cells are removed and replaced by normal red cells (Swerdlow, 2006). Transfusion has been associated with beneficial effects including correcting anaemia and decreasing the production of sickled red blood cells (Rees et al., 2010). However, repeated use of transfusions can cause complications such as iron overload in the liver and alloimmunization to RBC antigens. Other side effects of transfusion include allergic reactions and fevers, which affect fifteen percent of patients (Klings et al., 2014).

1.3 Psychological and Cognitive Features of SCD

1.3.1 Psychological Problems, Social Issues & Interventions

1.3.1.1 Mental Health

In addition to the physical complications associated with the pathology of SCD, patients have an increased risk for other comorbidities including social and mental health problems. One of the first studies exploring depression and sickle cell disease demonstrated that depression occurs more frequently than expected (Morin & Waring, 1981). Belgrave & Molock (1991) expanded on this work and found that 56 percent of the sample scored as being mildly to severely depressed on the Beck Depression Inventory (BDI). Current evidence suggests that the prevalence of depression in people with SCD is notably higher than in the general population (Adam et al., 2017).

Depression associated with SCD has been thought to be related to chronic pain and medical complications including anaemia and fatigue (Hasan et al., 2003). Depression has also been identified as a key predictor of poor pain tolerance and increased hospitalisation. For instance, Gil et al. (1993) found that patients experiencing negative thinking used healthcare services more frequently

compared to those demonstrating positive thinking patterns. Studies of young people with sickle cell disease have reported adjustment problems including low self-esteem, and poor interpersonal functioning (Benton et al., 2007). There is evidence to suggest that these difficulties can extend into adulthood (Wilson Schaeffer et al., 1999).

Research has suggested a bidirectional relationship between the physical and psychological manifestation of SCD. Toumi et al. (2018) hypothesised that the early onset of somatic symptoms, including pain and fatigue, can contribute to an increased risk for common mental health problems later in life. The increased susceptibility to mental health issues exacerbates physical health complications, including stroke. The psychological and somatic disturbances in SCD can lead to repeated hospitalisations and social difficulties, therefore impacting patients quality of life. This relentless cycle affects both the psychological and physical wellbeing of patients, thereby contributing to the reduced life expectancy often observed in sickle cell disease.

1.3.1.2 Quality of life

Disturbance of psychological functioning and physical health difficulties can have an adverse impact on quality of life. In the last ten years, studies exploring health related quality of life (HRQL) in sickle cell disease has increased. HRQL assesses the patients' wellbeing and level of functioning in context of their physical health problem. The assessment includes social, physical, emotional, school and work domains (Panepinto, 2008). Studies have demonstrated that individuals with SCD have significantly impaired HRQL in comparison to people with other chronic conditions. This is particularly noted in physical functioning domains and is linked to the impact of pain on daily functioning (Levenson et al., 2008). Disease severity is thought to be related to lower HRQL. A cross-sectional study showed that patients with the most severe genotype had the worst general and physical scores on the HRQL (Mastandréa et al., 2015).

There is also evidence to suggest that some patients cope well and are able to live fulfilling lives. A study examining resilience factors, including stress

management and hope, found that there was no significant difference between patients and unaffected siblings. However, patients still reported feelings of inadequacy which is associated with poor psychosocial functioning (Simon et al., 2009). A qualitative study examining quality of life in SCD (Thomas & Taylor, 2002) found that the condition carries a huge psychosocial burden. Participants reported difficulties forming relationship with peers, interruptions to education and work, and challenges with their religious beliefs.

1.3.1.3 Social and systemic issues

Stigma refers to the rejection of an individual based on a characteristic or behaviour that has been discredited by society (Goffman, 1986; Link & Phelan, 2001). On the other hand, health-related stigma can be defined as a form of discrimination which marginalises groups of people with particular physical health problems (M. G. Weiss et al., 2006).Given the complexity of SCD, health-related stigma may develop and be sustained for many reasons. People with SCD often report experiencing negative reaction from family, community members, and co-workers regarding their physical health status (Nelson & Hackman, 2013).The general public is not well educated about the condition contributing to harmful and negative stereotypes about people with SCD (Bulgin et al., 2018).This leads to people with SCD feeling ostracized and devalued. Studies of adults with SCD have shown that high levels of stigma are associated with poor psychological wellbeing. Patients who report high levels of stigma are more likely to report symptoms of depression, anxiety, social isolation and suicidal ideation (Ola et al., 2016). Young people who reported high levels of stigma, in both health and community settings, reported lower quality of life (Adeyemo et al., 2015).

Stigmatisation may exacerbate complex healthcare utilisation issues. For example, patients with SCD have been described as ‘drug seekers’ and ‘addicts’ because opioid analgesics are required for pain management (Blake et al., 2018). Improper treatment leads to readmission and patients are often stigmatised as ‘frequent flyers’. The literature also suggests that SCD pain complaints are often discounted by medical professionals, and this is related to discriminatory assumptions about black people’s ability to tolerate high levels of pain (Jenerette

et al., 2013). These experiences mean that patients are reluctant to seek care, and mistrust healthcare providers (Haywood et al., 2014). Individuals with SCD often adjust their care seeking behaviours and will attempt to self-medicate at home (Labore et al., 2015).

1.3.1.4 Psychological Interventions

A number of interventions have been developed with the aim of improving quality of life and health related outcomes. The three broad categories of interventions used for SCD include: cognitive behavioural techniques (CBT), behavioural techniques and social support interventions. The literature suggests that CBT interventions have the most efficacy and effectiveness for addressing psychosocial and somatic symptoms associated with SCD (Edwards et al., 2005). For example, adult studies examining the effectiveness of CBT interventions found that strategies including imagery and self-hypnosis taught across fifteen sessions improved patients sleep and need for pain medication (Thomas et al., 1984). Research suggests that self-assisted CBT can improve adherence behaviours including medication, rest and fluid intake for patients with SCD (Anie et al., 2002). However, the authors found that there were no differences in pre-versus post-pain management.

Behavioural interventions are typically aimed at altering behaviour through rewards. This approach is often targeted at families and young people with SCD. The rationale of behavioural interventions includes the recognition of dangerous symptoms such as fevers and difficulty breathing and medication adherence (Day et al., 1992). The Starbright Foundation developed computerised health education for young people who were hospitalised. This intervention enabled young people to interact with other patients on the ward, access information from staff and play games. Children who received this intervention described using less negative coping strategies and found it helpful to have access to social support during their hospital admission (Hazzard et al., 2002).

Although behavioural interventions which focus on reward have demonstrated improvements within intervention groups overtime, they appear to be less

effective in comparison to CBT interventions (Chen et al., 2004). Recent research has demonstrated that third wave interventions such as Acceptance and Commitment Therapy (ACT) might be more effective for adolescents with SCD. This intervention emphasises the importance of daily functioning and the willingness to accept difficult situations e.g., pain and fatigue (Hayes et al., 2006). A preliminary study demonstrated that young people may develop better self-esteem and experience a better quality of life after completing a brief program of ACT. These changes were also observed at a three-month follow-up (Masuda et al., 2011).

Social support can act as a buffer against adverse health outcomes and premature mortality (Berkman & Syme, 1979). Social interventions include self-help groups and family interventions. Researchers have emphasised the importance of social interventions to reflect that racialised people often rely on seeking health related information from trusted members of their community, rather than medical professionals (Holmes et al., 1992). SCD patients who attend support groups reported improvement of their pain management, and shorter pain episodes (Butler & Beltran, 1993). A study of self-facilitated support groups demonstrated that participation may reduce depressive symptoms (Nash & Kramer, 1993). There is also evidence to suggest that social support interventions can foster positive peer relationships through active discussion and exposure to good role models (Fox & Ingram, 1999).

1.3.2 Neuropsychology and SCD

1.3.2.1 Overview

People with SCD have an increased risk for neuropsychological impairment. Impairments in cognitive functioning have been observed in SCD patients with acute ischemic events and silent infarcts (Kral et al., 2001). However, neurocognitive impairment can occur in SCD patients without neurological complications (Stotesbury et al., 2019). Potential risks for neurocognitive deficits include biological factors such as impaired cerebral blood flow and reduced oxygen saturation (Ausavarungnirun et al., 2006). In addition, environmental factors including low socioeconomic status and parent education are also

associated with impaired cognitive functioning (King et al., 2014). The available literature on neurocognitive impairment associated with SCD is based mainly on paediatric samples, however studies show that these complications can increase with age and have long term consequences (Mackin et al., 2014). In adulthood, the literature suggests that main neurocognitive deficits associated with SCD include problems in processing speed, attention, visual spatial skills, working memory, verbal function and executive function (Sahu et al., 2022). These neurocognitive deficits can contribute to a poorer quality of life, and having poorer interpersonal relationships, educational and financial attainment (Sanger et al., 2016).

1.3.2.2 Full Scale IQ (FSIQ)

IQ is a measure of global intellectual functioning and draws on numerous cognitive skills working in unison (Berkelhammer et al., 2007). Studies have revealed that people with SCD have impairment in FSIQ, Verbal IQ and Performance IQ even when excluding history of neurological complications (Swift et al., 1989). For example, Steen et al. (2005) found that children without SCD related neurological injuries had a lower FSIQ when compared to healthy controls. However, studies investigating intellectual functioning have revealed that children with neurological complications demonstrate more decline in FSIQ relative to controls and SCD patients without neurological complications (Hogan et al., 2005). Furthermore, lateralisation may also affect IQ scores. Patients with SCD who had left cortical infarcts demonstrate impairment on FSIQ, VIQ and PIQ compared to test norms (Cohen et al., 1994).

1.3.2.3 Executive functions

Executive function (EF) is an umbrella term for a group of skills that enable people to control and coordinate everyday behaviour, which has been hypothesised to emerge first and is connected to skills such as cognitive flexibility (Anderson, 2002). Children with SCD may demonstrate EF deficits from an early age. For example, Downes et al. (2018) demonstrated that preschool children with SCD show have more difficulties with inhibition and cognitive flexibility in comparison to healthy controls. The literature suggests that EF impairments

observed in patients with SCD is related to cerebral injury. Children with silent infarcts are more likely to display deficits in executive function domains (Schatz et al., 2001). Further, children with SCD who had infarctions made more errors on cancellation tasks than those without infarcts (Brown et al., 2000). Similar findings have also been replicated in adult studies by (Portela et al. 2022).

1.3.2.4 Attention

Adults and young people living with SCD are reported to have difficulties with sustained attention (DeBaun et al., 2012). For example, (Hijmans et al. 2011) found that children with SCD displayed lower levels of sustained attention than controls. Similarly to executive functions impairment, difficulties with sustained attention have been associated with cerebral injury. Children with infarcts are more likely to display errors on tests of auditory vigilance than children without lesions or unaffected siblings (Craft et al., 1999). Furthermore, continuous performance tasks assessing sustained attention show high sensitivity and specificity in differentiating adolescents with neurological impairments versus those without SCD (DeBaun et al., 1998).

Research has emphasised the role of attention in regulating processing speed. Processing speed is indicative of the adept management and quick response to information which has been presented (Kail & Salthouse, 1994). There is now clear evidence to suggest that people with SCD have lower scores in domains of processing speed. For instance, Stotesbury et al. (2018) found that adults with sickle cell anaemia showed deficits in processing speed irrespective of infarctions. Instead, they found that deficits in this domain was associated with white matter injury. One research study found that when processing speed is adjusted for patients with SCD perform similarly to health controls on cognitive assessments. Therefore, suggesting that poorer cognitive functioning amongst individuals with SCD may be related to slower processing speed rather than overall cognitive impairment (Crawford & Jonassaint, 2016). However, the preliminary findings from this research study have not been replicated.

1.3.2.5 Memory

In addition to deficits in attention and executive functions, studies of people with SCD demonstrate deficits in memory (Brandling-Bennett et al., 2003). For example, children with clinical infarcts display more deficits in visual and verbal memory compared to health controls (Watkins et al., 1998). People with anterior lobe infarcts demonstrate poor performance on recall tasks in comparison to children without SCD related infarcts. However, children without SCD show similar cognitive performance on memory tasks (Craft et al., 1999). This suggests that memory is less affected in SCD patients. However, the limited number of studies examining memory function in SCD necessitate caution in drawing overall conclusions.

1.3.2.6 Language

Some researchers have proposed that language deficits in SCD are related to the degree and localisation of neurological injuries. Children with infarcts demonstrate delays in language development, and significant impairment is often associated with overt strokes (Hariman et al., 1991). Children with neurological complications may also make more mistakes while completing rapid naming tasks compared to children without abnormalities (Brown et al., 2000). It has been suggested that lesion volume may reflect the extent of language disorder (Craft et al., 1999). Children with infarcts in the left hemisphere perform more poorly on language assessments. Recent research suggests that the cumulative effect of physiological damage may contribute more to language deficits than previously suggested (Berkelhammer et al., 2007). In SCD, language deficits can occur across syntactic, semantic and phonological domains as well as vocabulary (Schatz et al., 2009).

1.4 Social Cognition

1.4.1 History and Background of Social Cognition

As with the social animals, humans have evolved intricate social skills and capacities which play an important role in navigating complex social environments. Adapting to social environments is reliant on the recruitment of

many cognitive processes including memory, executive function, language and attention (Beaudoin & Beauchamp, 2020). It also requires specific mental abilities known as social cognition, which has been defined as the ability to recognise and interpret socially relevant information, through dedicated and specific neural mechanisms (Adolphs, 2001). This domain includes skills such as face processing, moral reasoning, and joint attention (Kilford et al., 2016). Social skills allow us to form impressions of people, recognise emotions, and assess the motives of others. The literature has shown that these skills play an important role in communication, interpersonal coordination, mental health and quality of life (Beaudoin & Beauchamp, 2020).

Social psychologist and philosophers have been attempting to address topics related to social cognition for at least a century. Psychologists postulated (McDougall, 1908) that groups of people shared cognitive beliefs and motivations. At the same time, sociologist (Ross, 1908) introduced the concepts of imitation and conformity in relation to people's thinking. The introduction of cognitive psychology followed, inspired by advancements in technology and artificial intelligence. The early years of cognitive psychology produced theories which explained prosocial behaviours, including altruism and learning (Kruglanski & Stroebe, 2012). The introduction of cognitive theories inspired social psychologists to consider the ways in which cognitive processes underpinned by specific mental modules evolved for the processing of social information. Research demonstrated the relationship between complex mental processes and social behaviours including person perception (Fiske & Neuberg, 1990) and emotional appraisal (Adelmann & Zajonc, 1989).

1.4.2 Key Domains of Social Cognition

Successful social interactions requires several distinct processes, such as recognising others as living beings by analysing of complex perceptual information, including physical appearance and both verbal and nonverbal communication. Once this information has been integrated, higher level processes such as attributing emotional states (empathy) and interpreting observable behaviours such as mental states (mentalising) enable people to

adapt their behaviours to the social scenario (Arioli et al., 2018). Social cognition is a multi-dimensional concept, but this section will only outline three of its main domains: emotion recognition, mentalising and empathy. The author has focused on these domains due to their relevance to the research aims and clinical applications. Furthermore, assessments of social cognitive impairments in physical and mental health conditions of concentrate on these areas (Henry, Von Hippel, et al., 2015).

1.4.3 Emotion Recognition

1.4.3.1 Definitions & key findings

Vogeley (2017) described social perception as the ability to distinguish between inanimate objects and people (characterised by intention, physical forces and patterns of motion). This domain plays an important role in social functioning e.g. communication with people and forming new relationships. Social perception allows people to make critical appraisals and moral judgements such as the trustworthiness of other people but can also feed stereotypes and prejudices (Frith & Frith, 2011). Social perception also includes social knowledge – which is knowledge of social norms, roles and schemas related to social interactions and situations (Higgins & Bargh, 1987). Social psychological experiments have shown that individuals learn about others through automatic and low level processes including gaze following and mirroring (Frith & Frith, 2007). These skills are crucial for perceiving the goals and intentions of others and can offer clues on how to behave in social situations (Arioli et al., 2018). As well as following peoples eye movement and mirroring we can also learn about people by appraising facial expressions. Ekman (1992) suggested that all humans irrespective of race and culture can perceive the six primary emotions which include happiness, sadness, anger, fear, surprise and disgust. While facial expressions provide a wealth of emotional communication people can learn about other's emotions by gathering information from body language (Dael et al., 2012) and the voice (Scherer, 1995). Available evidence suggests that a combination of body language, tone of voice and facial expressions improves emotional decoding (Du & Martinez, 2015).

1.4.3.2 Neurological underpinnings

The perception of emotions is centred on the amygdala which plays a significant role in emotion processing and the automatic recognition of emotionally relevant facial expressions (Adolphs et al., 2002). The fusiform face area enables people to recognise invariant or neutral facial features that define identity (Kanwisher & Yovel, 2006). Other brain regions, such as the superior temporal sulcus has been associated with the perception of dynamic facial features such as eye and mouth movements (Allison et al., 2000). The unconscious perception of emotional stimuli is indicative of healthy brain functioning and has been associated with the orbito-frontal cortex (Tamietto & De Gelder, 2010). Observing facial emotions may trigger affective reactions which can influence the observer's behaviour (Van Kleef, 2009). This reaction is dependent on the generation of emotional and motivational states, which are created by the anterior insula and anterior cingulate cortex (Adolphs et al., 2002; Critchley, 2005).

1.4.4 Mental State Attribution (Theory of Mind)

1.4.4.1 Definitions & key findings

Successful interactions must also depend on the ability to understand and attribute mental and intentional states (Arioli et al., 2018). The interpretation of other people's behaviours in terms of mental states such as beliefs, desires, experiences and emotions are important for understanding and predicting their future actions. Evidence suggests that tracking the mental states of others is unconscious and occurs automatically (Frith & Frith, 2007). The ability to mentalise entails the development of "Theory of Mind" which can be described as the ability to use social inference and contextual information to understand mental states. Further, it has been shown that mentalising involves implicit and explicit processes: the former is present in young children who can ascribe false beliefs to people (Kovács et al., 2010). Explicit externalising involves higher order processes that enable people to distinguish between themselves and others, as well as the ability to mentalise the thoughts and feelings of others (Frith & Frith, 2007).

1.4.4.2 Neurological underpinnings

The literature suggests that mentalising components are moderated by specific frontal circuits. For example, the ventromedial prefrontal cortex is related to processing affective mentalising. On the other hand, the ventrolateral prefrontal and dorsolateral prefrontal cortices have been associated with the mediation of cognitive mentalising (Shamay-Tsoory & Aharon-Peretz, 2007). The mentalising pathway also includes the right temporoparietal junction (Hill et al., 2017) which is associated with the tracking of other's mental states, instances of moral judgement (Young & Saxe, 2009) and discerning false beliefs (Schneider et al., 2014). It also includes orbito-frontal cortex, amygdala and anterior cingulate cortex (Chalah & Ayache, 2017).

1.4.5 Empathy

1.4.5.1 Definitions & key findings

Smooth and adaptive social interactions also require empathy. Empathy is the ability to understand and be sensitive to the emotional states and feelings of other people (Cox et al., 2012). It is a higher order process which includes both affective components – experiencing an emotion in response to an individual's mental state and cognitive components – co-ordinating with the mental state of others (Baron-Cohen & Wheelwright, 2004). Current evidence suggests that cognitive empathy requires the processing and manipulation of situational, auditory and perceptual cues which are used to interpret another person's emotional state. Attentional processes enable people to shift back and forth between their own feelings and other persons' emotional states which enables alignment and emotional reactions such as sympathy. On the other hand, affective empathy mainly involves the assessment of other's emotion through facial expression and vocal prosody (Reniers et al., 2011). Empathy is not independent of the other domains of social cognition and is believed to require emotion recognition and metacognitive processes such as theory of mind (Heyes & Frith, 2014).

1.4.5.2 Neurobiological underpinnings

The empathy network, the third pathway involved in social cognition includes the anterior insula, prefrontal and frontal structures such as dorsal and middle parts of the anterior cingulate cortex (Fan et al., 2011). Although specific brain regions might be associated with different social cognitive domains, it is important to note that there is an overlap amongst their networks (Kennedy & Adolphs, 2012).

1.4.6 Impairment of Social Cognition

Social cognitive impairments are apparent in many clinical groups. For example, social impairments have been documented in childhood disorders such as autism spectrum disorder (Baron-Cohen, 1989) and attention-deficit hyperactivity disorder (Parke et al., 2018). Deficits in emotion recognition and mentalising have been identified as core symptoms of schizophrenia (Savla et al., 2013), and are key indicators of poor social functioning in this clinical population (Green & Plaza, 2016). Impairments in social cognition have also been recorded in people with neurological disorders (Henry, Von Hippel, et al., 2015), brain injury (Milders, 2018), dementia (Rankin, 2020) and persistent mental health problems such as bipolar disorder (Gillissie et al., 2022).

1.4.7 Clinical Assessment of Social Cognition

The clinical assessment of social cognitive functioning is important for many clinical groups, as outlined in section 1.4.3. This importance has now been recognised in the fifth edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5) which has included social cognition as a core component of neurocognitive functioning (American Psychiatric Association, 2013). The validation of social cognition has slowly contributed to the development of standardised and robust tests which aim to quantify the severity of impairment and can be used to detect subtle changes which may otherwise go undetected.

1.4.7.1 Assessment of emotion recognition

Deficits in social perception may present as deficits in recognising other people's emotions. This capacity is commonly assessed through the presentation of photographs which include a range of high intensity facial expressions. One

example of this is the standardised Ekman Faces task (Ekman & Friesen, 1976) which measures emotion labelling and discrimination. This task consists of black and white photographs of actors depicting the six universal emotions (disgust, anger, fear, happiness, sadness and surprise) and participants are required to choose the label which best describes the emotion being displayed. Cross-cultural research suggests that these emotion are widely expressed and recognised by people from different cultural backgrounds and form the building blocks of the emotion system (Ekman, 1992a). The Ekman Faces Task is highly sensitive to social cognitive difficulties in people with Alzheimer disease (Miller et al., 2012).

Emotion recognition can also be extended to voices, body posture and movement. Clinically, measures such as the Florida Affect Battery (Bowers et al., 1999) can be used to discriminate between facial expressions, vocal intonations and cross modal emotional information. Researchers have emphasised the importance of multimodal assessments as they are more reflective of real life settings and have better ecological validity. However, a limitation of these tasks is that they take longer to administrate and would not be helpful in most clinical settings due to constraints on time and resources (Henry et al., 2015).

The ability to understand others' emotions or feelings is commonly assessed by validated measures such as the Reading the Mind in the Eyes Test (RMET) (Baron-Cohen et al., 2001). This task consists of pictorial stimuli displaying complex emotional states. Participants are asked to choose different adjectives that best describe how the character in the image might be feeling. One advantage of this measure is its ability to place less demands on other cognitive functions such as working memory. It also been shown to have good reliability and validity. Yet, the visual and verbal demands of this task suggest that deficits might be related to broader visuoperceptual impairments (Henry, Von Hippel, et al., 2015).

1.4.7.2 Assessment of theory of mind

Cognitive aspects of ToM, namely the ability to reject our own beliefs about the world in order to consider the perspectives of others is often assessed by 'False Belief Tasks'. These measures were developed by Wimmer and Perner (1983) and largely focused on typically developed children but was eventually used to examine ToM deficits in people with autism spectrum condition (ASC). An example, of the false belief task includes the 'Sally-Anne' tasks in which participants view a scenario where 'Sally' puts a ball in a basket, leaves the room and 'Anne' moves it to a box. False belief processing is demonstrated by participants' ability to acknowledge that Sally still believes the ball is in the basket, despite knowing it is actually in the box (Baron-Cohen et al., 1985). The Smarties task is a content-change task (switching sweets for pencils) and assesses both the participant's and others' false belief through direct questions such as "what will your friend think is inside the tube?" (Hogrefe et al., 1986)

ToM in adults and children can also be assessed with the Strange Stories Task (Happé, 1994) in which participants are asked to demonstrate their understanding of a narrative in which the characters' behaviour can be best understood by attributing a mental state. An advantage of this measure is its ability to measure both affective and cognitive domains of mentalising. The Faux-Pas Test (Stone et al., 1998) also involves short stories, here participants are asked to identify socially inappropriate narratives and behaviours. The ability to recognise the faux pas' within the stories imposes demands on both cognitive and affective domains of mentalising as it requires the understanding that the characters feelings may have been hurt (Henry, Cowan, et al., 2015).

1.4.7.3 Assessment of empathy

Potential insights into empathic disturbances can be derived from self-reported measures of affective empathy. Several questionnaires have been developed including the Hogan Empathy Scale (Hogan, 1969) and the Balance emotional empathy Scale (Mehrabian, 2000). Other commonly used measures include the Empathy Quotient (EQ) (Baron-Cohen et al., 2003) which assesses an individual's ability to understand and predict someone else's affective and

cognitive empathy. However, others have argued that this measure mainly assesses general social skills rather than empathy (Lawrence et al., 2004). The Interpersonal Reactivity Index is commonly used to assess both cognitive and affective empathy, across subscales including perspective-taking and understanding other people's beliefs. It has been shown to have strong validity and test-retest reliability (Davis, 1983)

1.4.7.4 Problems in the assessment of social cognition

Despite the rapid expansion of social cognition research there are still a number of issues with its assessment. For example, performance on tasks such as Mind in the Eyes Test (MET) is moderately associated with educational attainment and the ability to comprehend complex vocabulary and western vocabulary such as "aghast" (Baker et al., 2014). Additionally, the complexity of this measure can contribute to minimal ceiling effects (Baker et al., 2014). Many of the mentalising measures were also developed for the assessment of ASC which raises questions about their generalisability. One study, Yager & Ehmann (2006) argued that social information processing tasks might be confounded by other cognitive processes including working memory and abstract reasoning. The authors also suggested that poor performance on some measures might reflect the influence of executive functioning and not deficits in social functioning. Moreover, there is a large body of research which shows that there are cultural differences in cognition. Dodell-Feder et al. (2020) argued that measures of social cognition do not have representative normative samples, the potential implications of this will be explored in the critical review.

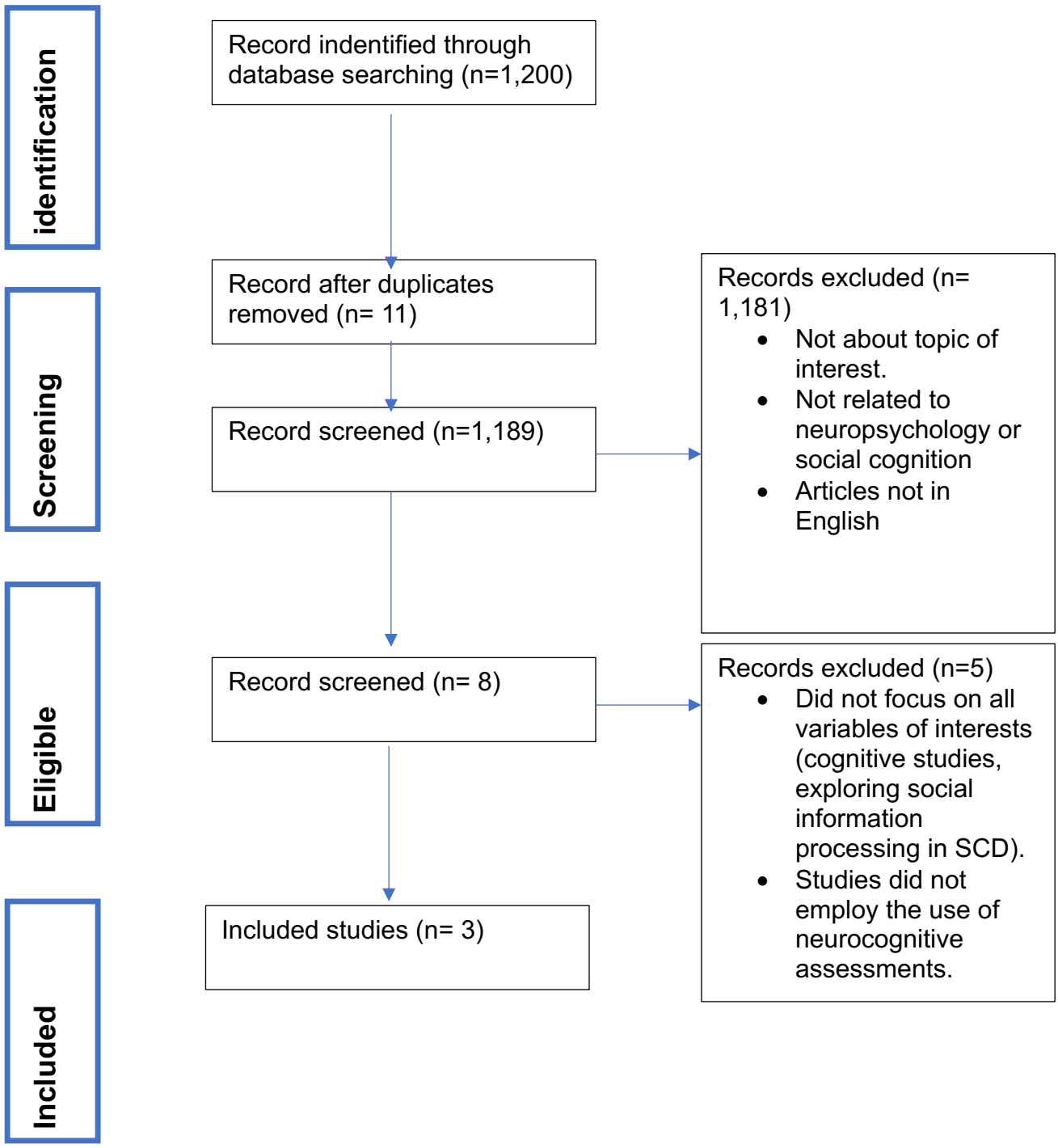
1.4.8 Social Cognition and Sickle Cell Disease

1.4.8.1 Literature review

Key search terms "social cognition", "cognitive functioning", "sickle cell disease", "social information processing" and "neuropsychology" were entered into literature databases PubMed, PsychInfo and Science Direct. The following search engines, accessed through the UEL library, were selected for their comprehensive coverage of neuropsychology and psychology literature. Search terms were combined with Boolean operators such as "AND", "OR" and "IF" to

maximise search results. The outcome of this literature search has been detailed below (see section 1.4.8.2). Faced with limited research in the field, the author expanded the search to include unpublished materials (e.g. doctoral theses) which was sourced from Google Scholar. Papers which were not included in English were excluded. Papers focusing on the variables on interest (sickle cell disease, cognition and social cognition) were included. The initial database searched yielded 1,189 items. After screening titles and abstracts against exclusion and inclusion criteria and removing duplicates, only three papers remained. Due to the limited number of papers retrieved, a narrative review was used to identify and summarise research broadly exploring social cognition and SCD.

Figure 1. *Search strategy*



1.4.8.2 Summary of findings

People with sickle cell disease are at increased risk for emotional, behavioural and social difficulties. Children with SCD have been shown to have difficulties with specific social skills and peer relationships (Rodrigue et al., 1996). Studies examining social relationships found that females with SCD have fewer friendships and are less likely to be accepted by their peers (Noll et al. 2007). Research has suggested social skill deficits in SCD can be attributed to low social competence (Noll et al. 1995). Social adjustments in SCD have mainly been examined in childhood but appear to expand into adulthood and have an adverse impact on people's overall quality of life (Thomas & Taylor, 2002).

In the past ten years, researchers have attempted to develop a better understanding of the mechanisms underlying poor social functioning in SCD. For example, research has suggested that the social skill deficits observed in people with SCD might be associated with socioeconomic status and broader environmental factors including reduced access to peers due to absence from school. People with SCD have an increased risk for cognitive deficits which have been associated with emotional difficulties and poor social functioning (Schoemaker et al. 2013). Research exploring social functioning and cognition in relation to SCD remains sparse. However, the literature search revealed three studies that have attempted to bridge this gap in the literature:

1) In a preliminary study, Hensler et al. (2014) explored the relationship between executive functions and social skills in young people with sickle cell disease. The results revealed that EF deficits correlated with poorer overall social skills and specific skills including responsibility and self-control. However, there were a number of limitations of this study including the small sample size and the exclusion of a control group, therefore findings of this study should be interpreted tentatively.
2) Boni et al. (2001) examined social information processing, social skills such as emotion recognition and cognitive function in children with sickle cell disease. The authors hypothesised that difficulties with processing social information might be related to cerebral injuries. Findings revealed that children with more severe genotypes of SCD, who had sustained cerebral

injuries, demonstrated more errors on facial and vocal recognition compared to those with less severe genotypes and healthy controls. The study supported previous research which has suggested that neurological insults may be associated with poor social information processing. However, the children included in the sample had known history of difficulties in school therefore confounding the results.

3) Zwicker et al. (2024) explored social adjustment in children with sickle cell disease in context of executive function and non-disease factors including family function. The findings revealed that 16 percent of the sample experienced social difficulties. Factors including family functioning and years living in Canada was a significant predictor of social adjustment. Equally, deficits in executive functioning was also found to be associated with poor social skills. The authors found that there were sex differences in social adjustment with male participants performing better on measures of social skills. In contrast to previous research studies, disease severity did not predict social functioning.

1.5 Research Rationale

Research has indentified social cognition impairments in various clinical populations and has indicated potential associations between deficits in executive functioning and social cognition. The literature outlined in chapter one highlights an increased risk of cognitive impairment and impaired social functioning in people with SCD. Frith & Frith (2007) suggest that impaired social cognition can contribute to challenges in forming and maintaining close relationships, an experience frequently reported in SCD. Yet, the core domains of social cognition in this clinical population have not been thoroughly explored. Understanding social cognition in SCD is important for providing support and reducing isolation. The clinical implications may extend to the development of tailored therapeutic interventions and programs specifically designed to improve social functioning in individuals with SCD, ultimately contributing to an enhanced quality of life.

1.6 Aims and Research Questions

Few studies have examined the cognition of adults with SCD. This study seeks to fill the existing gap in the literature by addressing the limited understanding of the neuropsychological impairments associated with SCD. There is also a notable absence of published research exploring social cognition in SCD, despite evidence suggesting problems in social skills within this population. This study will address these gaps within existing literature on SCD, particularly the cognitive and social dimensions of the condition.

To do so this study will address the following questions:

- Are deficits in social cognition evident in the SCD population?

2. EPISTEMOLOGY AND METHOD

2.1 Epistemology

Epistemology, which can be defined as the theory of knowledge, concerns itself with how knowledge is created, validated and justified (Raelin, 2017). According to Carter and Little (2007), a researcher's epistemological stance can influence methodology and methods such as study design and analysis. An example of an epistemological paradigm is positivism, a framework which has strong ties to behaviourism and quantitative approaches in psychology. Positivism operates on the assumption that reality is measurable, objective, and can be generalised across all contexts. However, this paradigm has been criticised for its naïve realism, which assumes that the world can be purely understood through empirical observation without considering the complexities of context and interpretation (Guba & Lincoln, 1994).

In response to these criticisms, alternative paradigms emerged to address the ontological and epistemological limitations of positivism. Critical realism, based on the work of Bhaskar (1975), suggests that an objective reality exists independent of human perception, yet this reality is not always directly observable. Instead, critical realism acknowledges that underlying mechanisms and structures exist and can be investigated through empirical research, but our understanding of them is inherently influenced by context and is therefore fallible. It occupies a middle ground between positivism, which emphasises objective measurement, and relativism, which argues that reality is entirely constructed by social and cultural contexts. Critical realism allows for the investigation of the real world while recognising that our knowledge is shaped by human perceptions, biases and social influences (Sturgiss & Clark, 2019).

In the context of the current study, a critical realist perspective is particularly important. By adopting this stance, the author acknowledges that while neuropsychological constructs like attention, memory, and executive functions

can be measured using validated tools, these measurements are not entirely objective or context-free. Instead, critical realism justifies the measurement of these cognitive constructs by emphasising that they are shaped by various social, cultural and historical influences. This epistemological stance is important in neurocognitive research, especially in context of sickle cell disease, where cognitive functioning may be affected not only by biological factors but also an individual's lived experiences, such as coping with chronic illness, access to healthcare, socioeconomic status and educational opportunities. By embracing critical realism, the research is better positioned to produce findings that are not only scientifically rigorous but sensitive to the lived experience of participants, thus offering a more nuanced understanding of cognitive function in the SCD population. Furthermore, this perspective ensures that the research remains aware of its own limitations and avoids the pitfalls of assuming that cognition can be measured purely objectively, thus making the findings more meaningful and relevant to real-world applications.

2.2 Method

2.2.1 Design

The research study uses a combined cross-sectional, and between-subjects design to explore cognitive function in a sample of people living with sickle cell disease.

A cross sectional correlational design was used to address a relationships between cognition, sickle cell disease and other areas of interests such as disease severity. A strength of this approach is its ability to examine multiple outcomes and areas of interests at one single time point. However, a disadvantage of this design is its inability to determine a causal relationship between the variables being examined (Lau & Kuziemsky, 2016).

2.2.2 Sample size

The sample size was largely based on previous studies exploring the cognitive impairment observed in the sickle cell population. These studies included a sample size below 30 participants (Cotter et al., 2018). In addition, a preliminary power analysis was performed to determine an appropriate sample size. This procedure revealed a sample of 21 would be needed when d=0.5 (medium effect size) and power (1-β) = 0.8 for differences to show significant at the 0.05 level. Cohen's d=0.5 effect size is commonly used in power analyses for psychological research (Kang, 2021). Using a medium effect size allowed the author to design a study that was neither underpowered (which could lead to false negatives) nor overly ambitious (requiring a large sample size). This approach ensured the study was both feasible and sensitive enough to detect meaningful effects.

2.2.3 Ethics

2.2.3.1 Ethical approval

As participants were recruited from an NHS site, ethical permission was sought from the IRAS NHS research committee who granted approval in July 2023 (Appendix A). The research and development department at Guy's and St Thomas' granted local access in January 2024 (Appendix B).

2.2.3.2 Informed consent

All participants were given and encouraged to read the participant information sheet which detailed the research aims, procedure, confidentiality and requirements of participants (Appendix C). Participants were also provided with an opportunity to ask any questions before signing the consent form (Appendix D). After participation, participants were asked if they would like to receive a summary of their cognitive assessment.

2.2.3.3 Confidentiality

All participants were given a unique participant code which was stored separately from identifiable information such as name, age and ethnicity. Identifiable information which was collected via consent forms was stored securely in a locked cabinet within the UEL psychology department until they were scanned and shredded. Only anonymised information was entered into electronic databases and was used for data analysis. To maintain confidentiality, identifiable information was destroyed within six weeks of data collection and was only retained for this duration, in case participants asked to withdraw from the study.

2.2.3.4 Protection from harm

People living with sickle cell disease can experience high levels of cognitive and physical fatigue for a range of reasons, for example, variations in temperature or perceived stress (Ahmadi et al., 2018). Participants were required to remain focused for the entire session of testing. To minimise the chance of participants experiencing fatigue they were offered frequent rest and movement breaks. Level of comfort was regularly monitored. Additionally, participants were given the right to withdraw at any stage of testing without any consequences.

2.2.4 Recruitment

Participants were recruited from the Haematology department in a hospital based in London, United Kingdom by volunteer sampling. This department offers specialist treatment and care for people with sickle cell disease. As a part of this care package, patients are offered annual reviews to monitor changes to their

physical health. Staff facilitating the clinic would ask attending patients to speak to the researcher about the aims of the study.

If patients expressed an interest, the researcher met with them in a private room to discuss the study in more detail. Patients were then offered the opportunity to be assessed on the same day. Otherwise, patients were invited to contact the researcher to arrange an alternative appointment to complete the assessment.

Potential participants were also sought from the weekly sickle cell support group facilitated by the service. Patients were provided with a brief overview of the study aims and rationale. People who demonstrated an interest were encouraged to leave their contact information and were invited to take part by email.

2.2.4.1 Inclusion and exclusion criteria

To be included in the study, participants had to be over 18 years, have a formal diagnosis of sickle cell disease and registered with the Haematology department in their local hospital. All participants were required to have English as their primary language to ensure comprehension of the information sheet, consent form and the assessment. Participants were excluded if they were recently transfused (as Hood et al. 2019, found that executive abilities can improve immediately after transfusion), experiencing acute symptoms of SCD including pain and fatigue (Ahmadi et al., 2018), or had completed a cognitive assessment within the last 6 months to minimise practice effects and preserve the validity of the results.

Participants with a history of mental health problems were not excluded, as individuals with sickle cell disease (SCD) often experience elevated rates of common mental health issues, such as low mood and anxiety (Adam et al., 2017). Including these participants was essential to accurately reflect the broader population affected by SCD and to avoid negatively impacting the sample size. Mental health history of all participants was discussed before the assessment and the potential impact of this was considered during data analysis.

2.2.5 Procedure

A brief pre-assessment interview was conducted. During this interview demographic information was collected, including date of birth, nationality, years of education, employment history, mental health history and mood at the time of the assessment.

Participants then completed a full battery of neuropsychological assessments. All measures were administered according to the test manual to ensure good reliability. Testing took approximately 60 to 90 minutes. Frequent breaks were offered throughout to minimise fatigue and discomfort. Participants were thanked for taking part in the study, offered a verbal debrief and reminded about their right to withdraw. In total, each participants assessment appointment (including breaks) took approximately 120 minutes.

2.2.6 Materials

The neuropsychological assessment contained standardised measures of premorbid functioning, general cognition and social cognition (see Table 1). The measures included have demonstrated strong psychometric properties, as summarised below. Additionally, section 1.3.2, “Neuropsychology and SCD”, reviews aspects of cognition potentially impacted by sickle cell disease, providing a rationale for the selection of the assessed domains.

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Table1. *Neuropsychological Test Battery*

Table 1: Neuropsychological Test Battery		
Domain	***Task/Component***	**Test**
Optimal Ability		TOPF-UK
Attention	Verbal stores & Working Memory	WAIS Digit Span Forward
		WAIS Digit Span Backward
		WAIS Digit Sequencing
	Selective	WAIS Digit Symbol Coding
	Sustained	KBNA Auditory Signal Detection
Verbal & Visual Reasoning	Verbal	WAIS Similarities
	Visual	WAIS Matrix Reasoning
Executive Functions	Word generation	DKEFS Letter Fluency
		DKEFS Category Fluency
		DKEFS Switch Total
		DKEFS Switch Accuracy
	Verbal inhibition	DKEFS Colour Naming
		DKEFS Word Reading
		DKEFS Interference
Learning & Memory	Verbal	WMS Story: Immediate
		WMS Story: Delayed
	Visual	WMS Visual Reproduction: Immediate
		WMS Visual Reproduction: Delayed
Social Cognition	Emotion Recognition	ACS Affect Naming Test
	Theory of Mind	Social Stories Questionnaire
	Empathy	QCAE Cognitive Empathy
		QCAE Affective Empathy

2.2.6.1 Assessment of optimal ability

Word reading ability strongly correlates with intelligence and is often resistant to neurological damage, therefore providing a good estimate for premorbid intelligence (Willshire et al., 1991). The TOPF is commonly used to assess premorbid function, and participants were asked to read a series of phonetically irregular words, which increased in difficulty. Participants received a score for each word they pronounced correctly. This assessment tool has been shown to have good validity and reliability indicated by a high Cronbach alpha coefficient range of 0.80 to 0.90 (Wechsler, 2009a).

Given the paucity of research within this population, little is known about the tests ability to provide a reliable and accurate estimate of pre-morbid functioning for people with sickle cell disease. Therefore, appropriate care was taken during analysis and offering feedback.

2.2.6.2 Assessment of attention

Attention and working memory were assessed by using the WAIS IV Digit Span forward, backwards and sequencing subtests (Wechsler, 2008). These tests generally show strong reliability, with a Cronbach alpha ranging between 0.70 and 0.90 and good validity (Lezak et al., 2012).

In the digit span forward task, participants were asked to listen to and then repeat back a string of numbers. The digit span backwards followed a similar format as forward; however, participants were asked to repeat the string of numbers in the reserve order. The length of the strings became longer as the task progressed requiring participants to access their short term memory stores.

The sequencing task also followed the same format as forward and backwards however for this task participants were required to repeat the string back in terms of numerical order. This task assesses an individual's ability to retrieve and manipulate verbal information in the short term stores. Participants earned a point for each correct response across three subtests.

The KBNA Auditory Signal Detection (Leach et al. 2000) task was included to measure sustained attention. This tool has high to moderate reliability and good validity, making it a useful tool for measuring attentional capacities in both general and clinical populations (Kaufman & Kaufman, 2004). Participants were required to listen to a recording of letters of the alphabet and tap the table when they heard the letter “A”. The duration of the recording required participants to remain focused over the task trial.

The WAIS-IV (Wechsler, 2008) Symbol Search subtest measures how well an individual can quickly and efficiently process visual information. The symbol search has high reliability, with a coefficient ranging 0.80 to 0.90 and good validity (Wechsler, 2008). This measure is particularly useful in assessing neurocognitive impairment in context of physical health conditions (L. G. Weiss et al., 2013).

Participants were instructed to identify and fill in the missing symbols which corresponded with a target of numbers in 90 seconds. Participants were awarded a point for the number of symbols which identified, incorrect responses were deducted from the final score.

2.2.6.3 Assessment of verbal and visual reasoning

Visual reasoning was assessed by using the WAIS IV Matrix Reasoning subtest which consists of four nonverbal reasoning tasks including pattern completion, serial reasoning, classification and analogy (Wechsler, 2008). This tool has a reliability coefficient above 0.90, indicating high reliability, and also has strong validity (Wechsler, 2008).

Participants were presented with a design, from which a section is missing and asked to select the missing piece from five response options. A score was awarded for correct responses. This test measures an individual’s perceptual organization and abstraction skills.

Verbal comprehension was assessed by the WAIS IV Similarities subtest, which measures concept formation, abstract thinking and verbal reasoning skills. This

measure has strong reliability, with a reliability coefficient of 0.90 and good validity (Wechsler, 2008). Participants were asked to explain how the two objects or concepts are alike. Correct responses were awarded two marks, for incomplete answers participants were awarded a score of one.

2.2.6.4 Assessment of executive function

Delis-Kaplan Executive Function Systems (Delis et al., 2001) tasks were chosen to assess executive function. The reliability of these tasks are moderate to strong with coefficient ranging from 0.60 to 0.80 and has good validity (Homack et al., 2005). The verbal fluency subtest involved participants orally generating words starting with the 'F', 'A' and 'S' within a minute, with the exception of nouns such as names and places. The total number words generated was recorded, excluding mistakes such as repeated words and nouns.

The D-KEFS colour word interference task (CWIT) consisted of three parts: colour naming, word reading and inhibition. During the colour naming trial, participants were shown a page of red, green and blue squares and then asked to verbally identify the colours as quickly as possible without making mistakes. During the word reading trial, participants were asked to verbally pronounce the words "red", "green" and "blue" which were printed in black ink. To assess inhibition participants were asked to accurately name the words "red", "green" and "blue", which were printed incongruently in red, green, or blue ink.

2.2.6.5 Assessment of learning and memory

Verbal learning and memory was assessed by the Wechsler Memory Scale (WMS) logical memory test (Wechsler, 2009b). This task has demonstrated strong reliability, with coefficients ranging from 0.70 to 0.90 and strong validity (Lezak et al., 2012). Participants were verbally presented with stories and asked to recall the details immediately and 20 minute delay. Correct responses were awarded a point.

The WMS visual reproduction tests was included to assess visual learning and memory. Participants were shown pages with different geometric designs for ten

seconds, before it was removed from view. They were then asked to draw the design immediately and after 20 minutes. A score was given for each part of the design that drawn correctly.

2.2.6.6 Assessment of social cognition

The Affect Naming Test (ANT) (Pearson, 2009) was chosen to assess emotion recognition through facial expressions. Participants were presented with pictures of actors who displayed the following emotions: anger, fear, disgust, sadness, happiness and neutral. They were then asked identity the emotion of each actor from a list of emotion words. Correct responses were awarded a point. Previous studies have confirmed the reliability, validity and cultural sensitivity of this task (Kandalaft et al., 2012).

Theory of Mind was assessed by using the Social Stories Questionnaire (SSQ). This task has been shown to have strong reliability, with Cronbach's alpha coefficients ranging from 0.75 to 0.85, and has good validity (Lawson et al., 2004). Participants were required to read ten short stories involving a character saying something which might be upsetting to another character featured in the story. Participants were then required to judge whether the story contained potentially upsetting utterances and asked to select the sentence the utterance occurred in. Each story contained ten blatant and ten subtle solecisms. This task measures the ability to understand the perspectives of people in different social contexts. A score was awarded for correctly identified statements.

The Questionnaire of Cognitive and Affective Empathy (QCAE) was developed by Reniers et al. (2011) and aims to provide a clear distinction between cognitive and affective empathy. This self-report measure asks participants to indicate how much they agreed with each statement by using a scale ranging from strongly agree to strongly disagree. The subscale items were summed to produce a total score for affective and cognitive empathy. It has been shown to have good reliability with Cronbach's alpha coefficients generally ranging from 0.70 and 0.90 and good validity (Reniers et al., 2011).

2.2.7 Participant characteristics

Eleven participants were recruited between January and April 2024.
Initially, twenty-two individuals had shown interest during the recruitment period. However, six did not attend the assessment; one was excluded due to physical health symptoms, and another could not travel to the assessment site. Additionally, three did not respond to the appointment booking email. The recorded attrition rate of 52% exceeds the anticipated level for this study. Nonetheless, the complex physical and social factors within this population may account for the high attrition rate.

Of the eleven participants recruited, eight identified as females and three as males. The sample included participants aged 22 to 64 years (M = 34.9, SD = 14.33), reflecting a demographic representative of the general population in the UK. However, most participants were younger adults in their mid-twenties to early thirties. Nine participants university degrees, one had received education at a vocational level, while another held a postgraduate diploma. The sample was therefore well-educated relative to the norm.

On a measure of reading irregular words (which is considered resistant to cognitive decline) the participants age-scaled scores ranged from 10 to 14, with a mean of 11.91 (SD = 0.37). Based on the expected parameters for the general population (mean scaled score is 10, SD = 3) the current overall had better than expected levels of estimated optimal ability.). A one-sample Wilcoxon Signed Rank test confirmed that the sample's optimal ability was reliably higher than the population norm (*Mdn* = 12), z = 2.83, p= .005.

In regard to ethnicity, the majority of the sample identified as 'Black British' (*n* = 7) one indentified as 'Black Caribbean' and three as 'Black African'. All participants spoke English as their primary language. Other languages spoken included Arabic (*n* =1), Italian = (*n* = 1), Spanish = (*n* = 1) and African dialect Yoruba (*n* = 1).

In terms of physical health, ten participants had a diagnosis of the most severe form of sickle cell disease (HbSS), and one had the milder form (HbSC). One participant reported a childhood history of stroke. Regarding mental health, one participant reported history of mental health difficulties including low mood, while one had recently experienced bereavement.

2.2.8 Data Analysis

IBM SPSS Statistics (Version 29) software (IBM SPSS, 2024) was used for data collation and analysis. The assessments were scored according to test manuals, with raw scores from subtests being converted into age-matched scaled scores. Nonparametric tests were then used to analyse the data due to the small sample size and likely non-normal distribution.

The planned analysis procedure included generating and examining descriptive statistics. One-sample tests Wilcoxon Rank-Sum tests as then conducted to examine whether participant scores were comparable to age-scaled norms for the population, within a defined set of parameters (M = 10, SD = 3) (Wilcox, 2003). Additional bootstrapping procedures was incorporated to address the limitations posed by the small sample size. This was achieved by using SPSS for exact tests. The significance level of p-value was set at $P<0.05$. In many research fields, setting the significance level at $p < 0.05$ is standard practice, as it balances the risks of Type I errors (incorrectly concluding that an effect exists) and Type II errors (failing to detect a real effect) (Benjamin et al., 2017). While using a stricter threshold, such as $p < 0.01$, can reduce Type I errors, it increases the likelihood of Type II errors (Nickerson, 2000). Therefore, the author chose $p < 0.05$ as a compromise, allowing for reasonable sensitivity to detect effects without being overly conservative.

3. RESULTS

3.1 Exploratory Data Analysis

Histograms and scatterplots were generated and reviewed to check for potential outliers, coding errors and missing data which were all corrected. Skewness and kurtosis scores (skewness>1, kurtosis>3) were assessed to check for potential violations of the parametric assumptions (symmetry and continuous scores).

3.2 Descriptive Data Analysis

As shown in table 2, descriptive statistics were generated for the measures of general cognition and social cognition.

3.3 Analysis of General Cognition

The average scores for tests assessing general cognition were consistent with the normative data score for most subtests (refer to table 2). Scores close to the population mean were observed across WAIS-IS matrix reasoning, WAIS-IV digit span total, WMS delayed recall (logical memory and visual reproduction), D-KEFS word generation (letter fluency, category, switching accuracy and switching output) and D-KEFS processing speed (colour-word interference). Conversely, slightly lower than expected scores were observed on WAIS-IV digit span forward and digit span backward, WAIS-IV coding, WMS logical memory immediate recall and D-KEFS tasks (colour naming and word reading).

Table 2. *Descriptive Statistics for Cognitive Tests and Subtests*

Test and Subtest	Mean	SD	Min	Max	IQR	Skew	Kurtosis
WAIS Similarities	12.55	2.58	9	17	4	.362	-.878
WAIS Matrix Reasoning	10.55	2.12	8	14	4	.349	-1.269
WAIS Digit Span Forward	9.18	3.55	5	18	3	1.596	3.460
WAIS Digit Span Backward	9.27	2.10	6	13	2	.824	.613
WAIS Digit Span Sequence	11.45	3.98	6	19	7	.158	-.083
WAIS Digit Spans Overall	10.09	3.86	5	19	6	1.179	1.886
WAIS Coding	9.27	2.69	5	14	5	.288	-.610
KBNA Signal Detection*	21.26	1.03	19	22	1	-1.584	1.744
WMS LM Immediate Recall	9.82	3.28	3	14	5	-.593	.521
WMS LM Delayed Recall	10.64	3.96	2	15	6	-.972	.834
WMS VR Immediate	12.18	2.14	8	14	3	-.965	-.074
WMS VR Delayed	10.64	1.80	8	14	2	.167	-.088
DKEFS Letter Fluency	11.09	3.33	6	19	3	1.214	2.838
DKEFS Category Fluency	10.00	3.52	5	16	7	.134	-.842
DKEFS Switching Accuracy	12.09	4.11	1	17	1	-2.213	6.008
DKEFS Switching Output	12.82	2.86	8	19	3	.632	1.636
DKEFS Colour Naming	8.18	1.89	5	12	2	.336	.907
DKEFS Word Reading	9.09	1.97	6	11	3	-.535	-1.245
DKEFS Stroop Interference	10.55	1.64	8	13	3	.237	-.809
QCAE Cognitive Empathy	10.09	3.56	5	15	7	.298	-1.480
QCAE Affective Empathy	8.55	1.70	6	11	3	.131	-1.137
ACS Affect Naming	10.18	3.46	5	15	6	.026	-1.223
Social Stories Questionnaire	5.27	2.69	2	9	5	-.014	-1.439

* Raw score

Abbreviations:

WAIS = Wechsler Adult Intelligence Scale, KBNA = Kaufman Auditory Signal Detection, WMS= Wechsler Memory Scale, DKEFS = Delis-Kaplan Executive Function System, QCAE = Questionnaire of Cognitive and Affective Empathy, ACS = Affect Control Scale.

Table 3.
One sample Wilcoxon Signed-Rank Test of General Cognition and Social Cognition compared with normative data (exact tests)

Test and Subtests	W	Z	R (Z/√N)	Exact Sig. (2-tailed)
WAIS Similarities ↑	43.00	**-2.442**	**-.736**	.016
WAIS Matrix Reasoning	40.50	-.679	-.205	.545
WAIS Digit Span Forward	12.50	-1.188	-.358	.270
WAIS Digit Span Backward	17.00	-1.081	-.326	.336
WAIS Digit Span Sequence	44.50	-1.026	-.309	.328
WAIS Digit Spans Overall	25.00	-.257	-.077	.820
WAIS Coding	23.00	-.896	-.270	.388
KBNA Signal Detection*	*0.00*	***-1.841***	***-.555***	*.125*
WMS LM Immediate Recall	18.50	-.070	-.021	.944
WMS LM Delayed Recall	35.50	-.819	-.247	.413
WMS VR Immediate ↑	60.00	**-2.438**	**-.735**	.015
WMS VR Delayed	20.00	-1.052	-.317	.293
DKEFS Letter Fluency	25.50	-1.058	-.319	.290
DKEFS Category Fluency	22.00	-.059	-.018	.953
DKEFS Switching Accuracy ↑	*54.00*	***-1.901***	***-.573***	*.057*
DKEFS Switching Output ↑	52.00	**-2.534**	**-.764**	.011
DKEFS Colour Naming ↓	5.00	**-2.325**	**-.701**	.020
DKEFS Word Reading	10.00	-1.501	-.453	.133
DKEFS Stroop Interference	25.50	-1.066	-.321	.286
QCAE Cognitive Empathy	30.00	-.256	-.077	.798
QCAE Affective Empathy ↓	6.00	**-2.226**	**-.671**	.026
ACS Affect Naming	35.50	-.223	-.067	.823
Social Stories Questionnaire ↓	0.00	**-2.944**	**-.888**	.003

* Raw score
↑ Performance above normative data
↓ Performance below normative data

Table 3. gives the outcomes of one-sample Wilcoxon tests (signed rank) for all scores, compared to the expected. As per the convention, p-values (Exact Sig. 2-tailed) are reported here. However, these should be considered with caution, given the large number of separate tests undertaken, without an adjustment to the alpha to avoid Type 1 errors. Interpretation of the data here and below instead reflects the obtained effect sizes (Z, and R).

The Wilcoxon Sign Rank tests yielded no difference from typical scores for the majority of tasks, suggesting that the samples performance was consistent with age-scaled normative data. Scores for WAIS-IV, WMS visual reproduction immediate and D-KEFS verbal were above the population mean. Only, scores on DKEFS colour naming *Mdn* = 8, z = -2.34, p= .020 was significantly lower than expected. There were larger effect sizes (r>.5) for KBNA Signal Detection and DKEFS Switching Accuracy, though neither were statistically reliable.

3.4 Analysis of Social Cognition

Descriptive statistics and Wilcoxon Signed Rank tests were conducted to ascertain if participants' performance on social cognition subtests aligned with normative data (*M* = 10, *SD* = 3).

On initial inspection of descriptive statistics, the mean scores showed that participants showed weaknesses on two measures of social cognition. Participants scored close to the normative data on measures of empathy and affect naming. However, scores on affective empathy and on the Social Stories Questionnaires (SSQ) fell well below the population mean. Wilcoxon Signed Rank tests confirmed that participants scored below the population mean on QCAE affective empathy (*Mdn* = 9), z = -2.23, p= .026 and on the Social Stories Questionnaire (*Mdn* = 8), z = -2.94, p= .003. Participants performance on QCAE cognitive empathy and Affect naming were consistent with normative data.

3.5 Comparison with Optimal Ability

The sample had higher than expected optimal ability, scores on tests of current cognitive and social cognitive functions were compared to the sample TOPF score (M=11.91, SD = 1.22) using the Wilcoxon one-sample test.

4. DISCUSSION

This preliminary study investigated social cognition among adults with sickle cell disease (SCD). SCD is a complex physical health condition characterised by symptoms including pain and anaemia. Individuals with SCD are at risk for neurocognitive, and social-emotional problems (Hijmans et al., 2011) which can affect their overall quality of life. It is well documented that people with SCD may experience difficulties with social skills and forming relationships (Thomas & Taylor, 2002). Studies assessing social relationships found that people SCD were less likely to have reciprocal friendships (Rodrigue et al., 1996). Social problems in people with SCD have mainly been investigated in context of environmental and psychosocial contexts but with limited exploration into relationships with neurocognition. Hensler et al. (2014) postulated a relationship between social skills and deficits in execution. However, it is not clear what contributes to poor social functioning in SCD. The study aimed to bridge the gaps in the existing literature by examining the relationship between sickle cell disease and domains of social cognition such as theory of mind, empathy and emotion recognition. As well as, determining whether difficulties in social cognitive difficulties are associated with general cognitive functioning.

4.1 Summary of Results

The current study revealed that a sample of individuals diagnosed with sickle cell disease obtained average or above-average scores on measures of general cognition. However, the sample showed weaknesses on two measures of social cognition, theory of mind and affective empathy (relative to age-matched population norms).

4.1.1 General cognitive function

Analysis of the samples general cognitive function indicated moderate weakness on the DKEF switching trial, suggesting potential deficits in verbal executive function skills, finding documented in other neurocognitive studies with both adult

(Portela et al., 2022) and paediatric samples (Downes et al., 2018). On the contrary, the sample performed above average in other tasks assessing executive function skills, such as word generation. This discrepancy may imply specific executive function challenges; however, the high educational level of the sample could also influence performance on word generation. An alternative explanation could be that performance on this task might have been exaggerated by outliers suggesting that interpretation should be approached with caution.

The sample demonstrated strengths in performance on measures of verbal comprehension and visual memory, relative to the population normative data. These results are inconsistent with previous research regarding performance on measures visual memory (Brandling-Bennett et al., 2003; Watkins et al., 1998) and verbal abilities (Schatz et al., 2009). However, the sample in these studies mainly included participants with neurological complications, whereas in the current study, only one individual had a history of stroke. It appears that visual memory and verbal abilities in SCD are less likely to be impaired in the absence of neurological complications.

Previous research suggests that domains of cognitive functioning such as processing speed (Stotesbury et al., 2018) and sustained attention (Hijmans et al., 2011; Hsu & Debaun, 2001) are less likely to be impaired in SCD. Failure to detect deficits in these cognitive domains may be attributed to the higher scores of optimal (pre-morbid) ability observed in the sample. Despite this the sample displayed weakness in performance on a simple test of selective attention (colour naming), suggesting specific attentional deficits.

4.1.2 Social Cognition

The main focus of the study was to examine whether individuals with SCD displayed impairments in social cognition, given the limited exploration of both the neurological and psychosocial problems in this clinical population. The current sample demonstrated weaknesses of self-reported affective empathy and ToM when compared to population normative data. This is despite the sample scoring

close to the population norms on measures of cognitive empathy and affect naming.

4.1.2.1 Emotion recognition

The ACS Affecting Naming Task (ANT) (Pearson, 2009) assessed the ability to recognise and identify emotions from images of facial expressions, making it a task partly independent of verbal ability. The sample scores were close to the population norm, suggesting that emotion recognition was unaffected in this group. These findings were in context of the sample performing above the population normative data on measures of visuospatial abilities, a skill which can affect performance on the affect naming task. The sample performance deviated from the findings of Boni et al. (2001) who found that individuals with HbSS were more likely to display errors in facial recognition. It is noteworthy, that this study was of a paediatric sample with known neurological complications and may not be generalisable to other groups such as the sample of this research study. Further research into the adult population is necessary to better compare performance on emotion recognition tasks and to draw more reliable conclusions.

4.1.2.2 Theory of Mind

Theory of mind was evaluated using the Social Stories Questionnaire (SSQ), which involves participants identifying verbal utterances from one character that might upset another character in a story vignette. Success on this task relies on participants ability to understand the perspective of the character in the story. It also relies on other cognitive processes including working memory, language and verbal reasoning. The findings revealed that the current sample performed significantly below age-matched norms. Although the SSQ requires adequate reading and comprehension skills, considering that the sample's score for optimal functioning surpassed the population, the observed weaknesses in ToM were arguably not associated with deficits in reading ability or other language functions in the sample.

Furthermore, the sample demonstrated strengths on verbal executive functioning tasks of word generation, but also demonstrated weaknesses on the colour

naming task, which would have implications for processing written information. Deficits in executive function have been linked to poor social skills in sickle cell disease (Hensler et al., 2014; Zwicker et al., 2024). The findings of this study may provide a basis for further exploration of these cognitive aspects. The significance of scores on the SSQ relative to the sample general cognitive function and optimal functioning strongly suggests specific challenges in theory of mind (rather than verbal functions or executive functioning).

4.1.2.3 Empathy

The Questionnaire of Cognitive and Affective Empathy (QCAE) is a self-report tool designed to address the cognitive and affective aspects of empathy (Reniers et al., 2011). Exploration of these constructs revealed that the sample self-reported weaknesses in affective empathy. Whilst scores on cognitive empathy fell close to the population norm. Aspects of empathy has yet to be considered in context of the psychosocial problems in sickle cell disease.

4.2 Summary and Interpretation of Findings

In summary, the analyses showed that individuals with sickle cell disease demonstrated cognitive weaknesses compared to the norm in theory of mind and affective empathy. These findings were observed in a sample that was highly educated and above the population mean for optimal functioning and general cognitive function. This study provided results that align with existing literature but has also advanced it, particularly in the field of SCD neurocognitive research involving adult samples. The examination of social cognition provides preliminary evidence for weaknesses that may be associated with the psychosocial challenges associated with sickle cell disease. However, these findings call for further exploration. Implications and recommendations are outlined below for both clinical and broader contextual issues, with emphasis on the importance of integrating routine neuropsychological assessments for individuals SCD.

4.3 Critical Review

This section offer a critical evaluation of the preliminary investigation into social cognition among individuals diagnosed with sickle cell disease. Beginning with an analysis of the study's methodology, particularly factors such as sample size, participants' demographics and experimental design. Furthermore, the validity, reliability and effectiveness of the tools used to measure cognition in this context will be considered. Considering the novelty of this study, and the complex interplay between sickle cell disease and social factors, contextualising the findings within existing literature is important. Finally, the author will acknowledge the potential implications of the study's findings for clinical practice and future research.

4.3.1 Strengths

This study was the first to explore social cognition in people diagnosed with SCD, despite research suggesting that people within this clinical population can experience psychosocial problems which has been associated with a reduced quality of life. Additionally, it contributes to a broader understanding of cognition among the adult SCD population, thereby advancing this field of research. General and social cognition was assessed using a selection of validated and reliable neuropsychological measures. Comprehensive data analysis were conducted, incorporating bootstrapping procedures to address the limitations posed by the small sample size.

4.3.2 Limitations

4.3.2.1 Sample

Efforts were made to achieve a sample size comparable to that of similar neurocognitive studies (Boni et al., 2001; Hensler et al., 2014). However, challenges related to local authorisation and service closures placed limitations on recruitment efforts. While small sizes are suitable for exploratory research, they have limited power, thus increasing the risk of type-one errors and potentially compromising the study's validity (Hackshaw, 1991). Therefore, it is important to approach the interpretation of the current findings with caution.

A larger sample size could have facilitated the inclusion of more male participants, enabling the exploration of potential sex differences. The current study lacked control-group comparisons for age, identity and socioeconomic status, preventing it from drawing conclusions about the social cognitive functioning of adults with SCD in comparison to healthy peers. Nonetheless, similar neurocognitive studies (Hensler et al., 2014) without control groups have indentified poor social functioning skills within this population.

The characteristics of the sample could impact the generalisability of the study's findings. The majority of participants had HbSS, the most severe form of sickle cell disease, which is often associated with more physical and psychosocial problems (Rees et al., 2010). During the assessment participants reported no recent acute symptoms or physical co-morbidities, except for one individual who had a history of neurological issues. However, it is known that a significant proportion of the SCD population experience stroke during childhood, which is in contrast with the sample. Therefore, suggesting that the current sample has biased milder disease manifestations as only physically well participants were included in the study. A more heterogenous sample would be more reflective of the clinical population, enabling more nuanced analyses of disease severity and social cognitive functioning.

While the age range of the sample was representative of the general population, a significant proportion (at least 80 percent) possessed university-level education, with mean optimal scores surpassing the average population norms. Sociodemographic factors like age and education have demonstrated influences on neuropsychological test outcomes (Scheffels et al., 2023), potentially providing the sample with an added advantage and obfuscating cognitive weaknesses. Moreover, participants were exclusively self-selected, possibly skewing towards individuals inclined towards research participation or an interest in psychology – a common occurrence in psychological studies. The sample characteristics inclines towards higher-functioning participants, potentially overlooking individuals within the population who may face more psychosocial challenges. Future studies must aim for a more representative sample to explore

the relationship between variables like education level, socioeconomic status and, SCD adults capacity for undertaking neuropsychological assessments.

4.3.2.2 Study Design

The present study employed a cross-sectional design, which involves data collection at a single time point. One notable advantage of cross-sectional studies is their efficiency, making them suitable for pilot studies that can guide future research endeavours (Teti, 2005). However, this design has methodological limitations. For instance, it does not establish causal relationships, thus, it cannot determine whether sickle cell disease directly causes social cognitive problems, or if so, how. This limitation stems from the failure to account for potential confounding variables, such as discrimination and internalising symptoms.

Research has shown that experiences of social discrimination, such as health disparities, are associated with impaired empathy (Fourie et al., 2019) and changes to the neural pathways responsible for understanding and sharing emotional states (Pechtel & Pizzagalli, 2011). The findings of the present study, although preliminary, revealed that affective empathy was below the population mean, while cognitive empathy was close to the mean. Considering evidence that individuals with SCD often face health disparities (Panepinto, 2008) and encounter everyday discriminations (Blake et al., 2018), one could argue that these experiences might be an explanation for the samples performance on measures of empathy. This consideration is particularly relevant given that cross-sectional designs, are unable to account for confounding variables such as experience of discrimination.

Internalised symptoms refers to the manifestations of low mood and anxiety e.g., withdrawal and isolation (Achenbach & Edelbrock, 1981). People with sickle cell disease are at an increased risk for internalising symptoms, with increased pain episodes and other disease complications being key contributing factors (Benton et al., 2007; Reader et al., 2020).There is now evidence to suggest a complex interplay between internalised symptoms and impaired theory of mind (Tone & Tully, 2014). The findings of study highlighted deficits of theory of mind within the

sample. However, experiences of mental health difficulties were not accounted for and could serve as an alternative explanation for the observed impairments in ToM. It is plausible that managing the burdens of this chronic physical health problem might impact patients' capacity to fully empathise and comprehend others' experiences, which are important aspects of successful social interactions.

As this study is novel and preliminary, future research should consider the inclusion of measures of discrimination, stigma and internalising symptoms. This will help to determine if these factors influence the way people empathise, recognise emotions and mentalise. Nevertheless, this study has taken important steps towards developing a better understanding of the potential social problems associated with SCD and makes it a contribution to the currently limited literature.

4.3.2.3 Test Materials

Efforts were made to use the standardised test administration protocol during the assessment. The main critique of assessing cognitive functioning is its poor ecological validity. Neuropsychological assessments are often administered under controlled environments with minimal noise and distractions (Chaytor & Schmitter-Edgecombe, 2003). However, this controlled environment may not accurately reflect everyday cognitive demands. These issues highlight the need for assessments that better capture the complexities of daily cognitive demands, ensuring a more accurate representation of individuals' cognitive abilities and functioning. Moreover, neurocognitive tools are also suspectable to confounding variables such as, fatigue and pain which is particularly relevant to this clinical population.

An overarching concern regarding neuropsychological assessments is their applicability to racialised communities and cross-cultural validity. While the study included measures based on adequate normative samples, it is well documented that these norms are not representative of racialised communities, especially those from Black backgrounds (Woods & Norman, 2022).

Historically rooted in intelligence testing, these norms have been influenced by eugenicist ideologies asserting the inferiority of certain communities compared to white populations. This disparity is evidenced in research demonstrating lower scores among Black participants compared to their White counterparts across all cognitive domains, irrespective of their educational and socioeconomic backgrounds (Werry et al., 2019). Efforts to address these disparities have led to the development of norms specific to ethnic and cultural grounds (Gasquoine, 2009). However, the use of race-specific norms pose several challenges. For example, they do not mitigate the issues of test bias or ensure cultural equivalence in neuropsychological tests (Manly, 2008). The impact of cultural and racial insensitivity in relation to the neurocognitive tasks included will be detailed below.

4.3.2.3.1 Affect Naming Task (ANT)

The Affect Naming Task (ANT) has demonstrated high internal reliability and minimal correlation with measures of language and memory, suggesting that performance on ANT is relatively independent of other cognitive abilities (Suchy & Holdnack, 2013). It has also been found to effectively distinguish between unimpaired individuals and clinical populations (Suchy & Holdnack, 2013). Despite these strengths, there are several limitations to consider.

A significant concern regarding this measure specifically relates to the sample, all of whom indentified as “Black”. The Affect Naming Task (ANT) operates under the assumption that emotional expressions are universally recognisable across cultures (Ekman, 1992b). Contrary to this perspective, researchers have highlighted that emotional expressions and their recognition are learned and thus culturally influenced (Bonassi et al., 2021). This is particularly relevant for the sample, given that three participants were not born in the UK, which is common within this clinical population. Subsequent research has emphasised the idea of cultural familiarity and same-race advantages, where people are asked to recognise faces, they have previously encountered and are less prone to misinterpreting facial expressions of people from similar racialised and cultural backgrounds (Wong et al., 2020). The ANT stimulus only includes images of two

Black actors, thus representing minimal diversity in both race and ethnicity which could have implications for measuring emotion recognition in racially homogenous samples. Despite these concerns, the sample's performance on this task was consistent with the normative data. Nonetheless, future research should consider incorporating tasks featuring actors from Black backgrounds when assessing emotion recognition within this clinical population.

4.3.2.3.2 Social Stories Questionnaire (SSQ)

The Social Stories Questionnaire (SSQ) relies on participants' ability to infer the perspectives of characters within hypothetical stories, with success indicating Theory of Mind proficiency. However, the SSQ can be criticised for its use of outdated social language and Eurocentricity, particularly white middle class British contexts. It is possible that the Eurocentric bias of this task may have failed to fully capture cultural differences in mentalisation, which might partially explain the participants' poor performance. For instance, one participant noted, *"I think this task is missing details, which could be related to my culture, I recently moved here, and some nuisances might be lost on me".* Therefore, performance on this task may reflect participants' familiarity with social norms in Western contexts rather than their ability to demonstrate mentalisation. With evidence also suggesting that performance on measures of Theory of Mind being associated with social status and cultural factors (Dodell-Feder, Ressler, et al., 2020), there is a need to revise or replace the SSQ and similar instruments to incorporate culturally and contextually relevant content.

Similar to many other neuropsychological measures, SSQ can be critiqued for its ecological validity. Arguably, the use of stories may not accurately capture social interactions in the real world, or how individuals from diverse backgrounds might relate to others, contributing to challenges in accurately completing the task. This is evidenced by a participants comment: *"I found myself over-thinking some of the stories, I think in real life I might have responded differently".*

4.3.2.3.3 KBNA

The Kaplan auditory signal detection test was included as a measure of sustained attention as this was indentified as an area of potential weakness in SCD (Hijmans et al., 2011; Hsu & Debaun, 2001). One major concern is that this measure may not be suitable for individuals with SCD unless they have significant issues with sustained attention. The KBNA might not identify subtle deficits, which is why most participants performed well. Future studies should consider incorporating measures that assess sustained and the speed of accuracy when identifying targets such as, Sustained Attention to Response Task (SART) which employs a more difficult and more sensitive NoGo paradigm (Robertson et al., 1997).

4.4 Critical Reflection

In full transparency, the author identifies as Black Caribbean and has family members affected by haematological conditions. The authors clinical and personal experiences have both underscored the importance of conducting research that sheds light on the complexities of haematological conditions, particularly those that disproportionately affect Black communities, such as sickle cell disease (SCD). Despite impacting millions worldwide, conditions like SCD less attention in research compared to other chronic physical health conditions such as cancer and cystic fibrosis (Griesler et al., 2021). This neglect can be attributed to injustices such as systemic racism (Power-Hays & McGann, 2020).

Some might argue that these experiences could influence the study's approach and methodology. The author recognises that biases are an inherent aspect of research, and efforts were made to minimise them by recruiting participants through volunteer sampling and seeking guidance from supervisors throughout the process. Furthermore, the author's critical realist positioning has enabled the objective measurement of constructs, whilst recognising their fallibility and their susceptibility to broader social and scientific constructs. The researcher recognises that cognitive functioning is not fixed and internalised, but rather fluid and context dependent. These narratives may influence how we understand the

social problems experience by people with SCD. Therefore, the author will consider the study's findings below and propose future recommendations for both research and clinical practice.

4.5 Implications

Successful social interactions involve multiple processes, beginning with the recognition of others through the analysis of perceptual cues including facial expressions and nonverbal communication. Once this information is processed higher level functions such as empathy and mentalising enable people to adapt their behaviours to the social context (Arioli et al., 2018). Impairments in social cognition can lead to challenges in establishing and sustaining peer relationships, a concern often reported among individuals with sickle cell disease (Noll et al., 1995, 2007). Despite this, few studies have explored the relationship between cognitive functions and the psychosocial problems associated with SCD. This study offers preliminary evidence which suggests that individuals diagnosed with SCD show weaknesses in social cognition, particularly in mentalising and empathy. The author emphasises the tentative nature in which conclusions should be drawn from these findings, given the preliminary nature of the study. Nevertheless, these findings may have implications for clinical and broader society.

4.5.1 Clinical Practice

In clinical practice, psychologists and other professionals providing support to patients should screen for psychosocial issues, paying attention to key indicators such as difficulties maintaining relationships, and social cognitive weaknesses such as Theory of Mind, which could signal potential social impairment. Recognising these impairments could influence how multidisciplinary teams offer care, particularly since social cognitive impairment may impact patients' interactions with healthcare professionals.

Furthermore, cognitive assessments should be considered for patients presenting with interpersonal problems such as social withdrawal and difficulties sustaining

peer relationships. As a standard practice, psychology services should consider incorporating social cognitive measures such as SSQ (or an adapted version) into pre-existing neuropsychological batteries, as they are relatively straightforward to administer. Patients with sickle cell disease may present with comorbid physical health conditions associated with impairments in social cognitive functioning, further emphasising the need for comprehensive assessments. By doing so, clinicians can gain a better understanding of the emotional and social issues experienced by patients. Incorporating these findings into patients' care plans might enable doctors, nurses and other staff members to make necessary adjustments to better meet the needs of patients, thereby promoting a more holistic approach to care.

4.5.2 Wider Implications

While the study's findings don't suggest causation, they do carry significant implications for society. As previously highlighted, research on sickle cell disease is grossly underfunded, despite its widespread impact on millions of individuals worldwide. This study highlights the need for better funding for research, specially focusing on the neurocognitive and psychosocial aspects of SCD. Findings from such research can raise can public awareness about the complexities of the condition beyond the physical symptoms. This increased awareness may also lead to a greater understanding and empathy towards individuals with SCD, reducing stigma and promoting inclusivity in society. Furthermore, increased awareness may pave the ways for the development of policies aimed at accommodating the needs of people with SCD in educational and workplace settings.

4.6 Future directions

In recent years, there has been increasing attention on sickle cell disease, with more research addressing the associated neuropsychological implications. Yet, only a few studies had investigated the relationship between cognitive functioning and psychosocial issues in SCD, most of which focused on adolescent samples and rarely in adults. The study aims to address this gap by suggesting

preliminary associations between sickle cell disease and social cognition, offering new insights into the psychosocial challenges faced by this community. Nevertheless, the study has limitations and indicates the importance of addressing them in future research. The following section will outline recommendations for future research, as well as suggestions for clinical and broader societal practices.

4.6.1 Research recommendations

Were the researcher to conduct the study again, there are several methodological issues that could be addressed. For example, future studies should recruit a larger sample. This would increase the reliability of findings but also facilitate a more comprehensive fractionation and analysis of factors such as socioeconomic status, education level, disease severity and sex differences. Recruitment from a single site will have limited the size and generalisability of the study. To address this limitation in future studies, recruitment efforts should be expanded to include multiple institutions, including charities, and recruitment through social media platforms. This broader approach would help to reach individuals who may have been inadvertently excluded from the sample, such as those less likely to attend annual review clinics or adhere to medical treatments.

In terms of test materials, there are significant concerns generally regarding the suitability of neuropsychological measures for individuals from Black backgrounds, largely due to their inherent underpinning assumptions and Eurocentrism. It is crucial that measures included in studies are adapted and representative of the sample to ensure accurate assessment of neurocognitive functioning. The current study has highlighted issues with the Affective Naming Test, noting that the stimuli used was not adequately representative of the sample. This discrepancy could potentially impact the measurement of emotion recognition and consequently the validity of the study's findings. Moving forwards, researchers should consider developing specific tools tailored for exclusively Black samples or incorporating racially diverse affect naming task such as the Racially Diverse Affective Expression test (RADIATE). This stimulus was developed by (Conley et al., 2018) and consists of 1,721 facial expressions of racialised adult models. Preliminary research suggests that this measure has

good reliability and validity. The SSQ may also be critiqued for its cultural insensitivity and reliance on outdate social lexicons. Similar to the Affect Naming Task, this assessment should be adapted to better meet the needs of the clinical population, for example the inclusion of culturally specific narratives, idioms or colloquialisms.

The Affect Naming Test used in the current study did not incorporate the evaluation of prosody, which has been shown to play a crucial role in accurate emotion recognition (Scherer, 1995). Future studies consider the inclusion of the prosody condition of the Affect Naming Test or alternative measures such as The Awareness of Social Inference Test (TASIT) (McDonald et al., 2003).

Future research endeavours focusing on this clinical population should carefully examine the relationship between experiences of discrimination and social cognition. It has been well documented that individuals with sickle cell disease experience systemic injustices in their daily lives, including hospital settings, which has been associated with psychosocial challenges and reduced quality of life. Future research will need to demonstrate whether reported instances of both everyday discrimination and health related stigma interact with the social cognitive function of this population.

Finally, future research should employ a longitudinal approach to observe changes over time in social cognitive functioning among individuals with sickle cell disease. For example, researchers could recruit paediatric participants from NHS institutions, where they could initially conduct baseline assessments of social cognitive functioning. Thereafter, annual assessments could be conducted until adulthood. Given that sickle cell disease is a lifelong condition requiring long-term monitoring, leveraging NHS institutions for recruitment and follow-up assessments offers a practical and sustainable framework for conducting longitudinal research in this population. With advancements in treatments, individuals with SCD are now living well into older adulthood, which serves as an additional rationale for developing a better understanding of general and social cognitive functioning in this population.

4.6.2 Clinical recommendations

Based on the clinical implications previously outlined, the following recommendations might be useful for clinicians supporting individuals with sickle cell disease. For example, increased funding for psychologists in haematology departments could enhance patients' access to neuropsychological assessments, leading to early detection of psychosocial problems, particularly in the context of social cognitive deficits. This is crucial, given that impairments in social cognition have been associated with homelessness, which is a growing concern among this patient group (Ato, 2023).

5. CONCLUSION

Overall, this study offers preliminary insights into the psychosocial challenges faced by individuals with sickle cell disease (SCD), particularly from a neurocognitive perspective. As one of the first studies to investigate social cognition domains in individuals with SCD, the findings suggest potential weaknesses in theory of mind and self-reported affective empathy within a well-educated sample. However, given the small sample size and other limitations, these results should be interpreted cautiously. While the findings may have implications for clinical practice—such as increased access to neuropsychological assessments—further research with larger, more diverse samples and additional variables like socioeconomic background and education is needed to validate and expand upon these findings.

6. BIBLIOGRAPHY

Achenbach, T. M., & Edelbrock, C. S. (1981). Behavioral Problems and Competencies Reported by Parents of Normal and Disturbed Children Aged Four Through Sixteen. Monographs of the Society for Research in Child Development, 46(1), 1. https://doi.org/10.2307/1165983

Adam, S. S., Flahiff, C. M., Kamble, S., Telen, M. J., Reed, S. D., & De Castro, L. M. (2017). Depression, quality of life, and medical resource utilization in sickle cell disease. Blood Advances, 1(23), 1983–1992. https://doi.org/10.1182/bloodadvances.2017006940

Adelmann, P. K., & Zajonc, R. B. (1989). Facial Efference and the Experience of Emotion. Annual Review of Psychology, 40(1), 249–280. https://doi.org/10.1146/annurev.ps.40.020189.001341

Adeyemo, T. A., Ojewunmi, O. O., Diaku-Akinwumi, I. N., Ayinde, O. C., & Akanmu, A. S. (2015). Health related quality of life and perception of stigmatisation in adolescents living with sickle cell disease in Nigeria: A cross sectional study. Pediatric Blood & Cancer, 62(7), 1245–1251. https://doi.org/10.1002/PBC.25503

Adeyoju, A. B., Olujohungbe, A. B. K., Morris, J., Yardumian, A., Bareford, D., Akenova, A., Akinyanju, O., Cinkotai, K., & O'Reilly, P. H. (2002). Priapism in sickle-cell disease; incidence, risk factors and complications – an international multicentre study. BJU International, 90(9), 898–902. https://doi.org/10.1046/J.1464-410X.2002.03022.X

Adio, W. S., Christopher, F. C., Adesola, R. O., & Mary, F. I. (2022). Current trends in the treatment of sickle cell anemia. World News of Natural Sciences, 43, 60–75.

Adolphs, R. (2001). The neurobiology of social cognition. Current Opinion in Neurobiology, 11(2), 231–239. https://doi.org/https://doi.org/10.1016/S0959-4388(00)00202-6

Adolphs, R., Baron-Cohen, S., & Tranel, D. (2002). Impaired Recognition of Social Emotions following Amygdala Damage. Journal of Cognitive Neuroscience, 14(8), 1264–1274. https://doi.org/10.1162/089892902760807258

Ahmadi, M., Poormansouri, S., Beiranvand, S., & Sedighie, L. (2018). Predictors and Correlates of Fatigue in Sickle Cell Disease Patients. In International Journal of Hematology-Oncology and Stem Cell Research Original Article IJHOSCR (Vol. 12, Issue 1).

Ahuja, G., Ibecheozor, C., Okorie, N. C., Jain, A. J., Coleman, P. W., Metwalli, A. R., & Tonkin, J. B. (2021). Priapism and Sickle Cell Disease: Special Considerations in Etiology, Management, and Prevention. Urology, 156, e40–e47. https://doi.org/10.1016/j.urology.2021.06.010

Allison, T., Puce, A., McCarthy, G., Allison, T., Puce, A., & McCarthy, G. (2000). Social perception from visual cues: role of the STS region. Trends in Cognitive Sciences, 4(7), 267–278. https://doi.org/10.1016/S1364-6613(00)01501-1

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-5TM, 5th ed. In Diagnostic and statistical manual of mental disorders: DSM-5TM, 5th ed. American Psychiatric Publishing, Inc. https://doi.org/10.1176/appi.books.9780890425596

Anderson, P. (2002). Assessment and Development of Executive Function (EF) During Childhood. Child Neuropsychology, 8(2), 71–82. https://doi.org/10.1076/chin.8.2.71.8724

Anie, K. A., Green, J., Tata, P., Fotopoulos, C. E., Oni, L., & Davies, S. C. (2002). Self-help manual-assisted cognitive behavioural therapy for sickle cell disease. Behavioural and Cognitive Psychotherapy, 30(4), 451–458. https://doi.org/10.1017/S135246580200406X

Arioli, M., Crespi, C., & Canessa, N. (2018). Social Cognition through the Lens of Cognitive and Clinical Neuroscience. BioMed Research International, 2018. https://doi.org/10.1155/2018/4283427

Arishi, W. A., Alhadrami, H. A., & Zourob, M. (2021). Techniques for the Detection of Sickle Cell Disease: A Review. Micromachines, 12(5). https://doi.org/10.3390/mi12050519

Ato, O. (2023, February 6). Homelessness and Sickle Cell Disease: The Intersection of Two Major Health Crises | by Orevaoghene Ato | Medium. https://medium.com/@orevaato/homelessness-and-sickle-cell-disease-the-intersection-of-two-major-health-crises-e1bcee47a288

Ausavarungnirun, P., Sabio, H., Kim, J., & Tegeler, C. H. (2006). Dynamic Vascular Analysis Shows a Hyperemic Flow Pattern in Sickle Cell Disease. Journal of Neuroimaging, 16(4), 311–317. https://doi.org/10.1111/J.1552-6569.2006.00053.X

Bainbridge, R., Higgs, D. R., Maude, G. H., & Serjeant, G. R. (1985). Clinical presentation of homozygous sickle cell disease. The Journal of Pediatrics, 106(6), 881–885. https://doi.org/https://doi.org/10.1016/S0022-3476(85)80230-4

Baker, C. A., Peterson, E., Pulos, S., & Kirkland, R. A. (2014). Eyes and IQ: A meta-analysis of the relationship between intelligence and “Reading the Mind in the Eyes.” Intelligence, 44, 78–92. https://doi.org/https://doi.org/10.1016/j.intell.2014.03.001

Baron-Cohen, S. (1989). The Autistic Child’s Theory of Mind: a Case of Specific Developmental Delay. Journal of Child Psychology and Psychiatry, 30(2), 285–297. https://doi.org/https://doi.org/10.1111/j.1469-7610.1989.tb00241.x

Baron-Cohen, S., Hill, J., Plumb, I., Raste, Y., & Wheelwright, S. (2001). The “Reading the Mind in the Eyes” Test Revised Version: A Study with Normal Adults, and Adults with Asperger Syndrome or High-functioning Autism. The Journal of Child Psychology and Psychiatry and Allied Disciplines, 42(2), 241–251. https://doi.org/DOI: 10.1017/S0021963001006643

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a “theory of mind” ? Cognition, 21(1), 37–46. https://doi.org/10.1016/0010-0277(85)90022-8

Baron-Cohen, S., Richler, J., Bisarya, D., Gurunathan, N., & Wheelwright, S. (2003). The systemizing quotient: an investigation of adults with Asperger syndrome or highfunctioning autism, and normal sex differences. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 358(1430), 361–374. https://doi.org/10.1098/RSTB.2002.1206

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. Journal of Autism and Developmental Disorders, 34(2), 163–175. https://doi.org/10.1023/B:JADD.0000022607.19833.00

Beaudoin, C., & Beauchamp, M. H. (2020). Social cognition. Handbook of Clinical Neurology, 173, 255–264. https://doi.org/10.1016/B978-0-444-64150-2.00022-8

Belgrave, F. Z., & Molock, S. D. (1991). The role of depression in hospital admissions and emergency treatment of patients with sickle cell disease.

Journal of the National Medical Association, 83(9), 777. /pmc/articles/PMC2627102/?report=abstract
Benjamin, D. J., Berger, J. O., Johannesson, M., Nosek, B. A., Wagenmakers, E. J., Berk, R., Bollen, K. A., Brembs, B., Brown, L., Camerer, C., Cesarini, D., Chambers, C. D., Clyde, M., Cook, T. D., De Boeck, P., Dienes, Z., Dreber, A., Easwaran, K., Efferson, C., … Johnson, V. E. (2017). Redefine statistical significance. Nature Human Behaviour 2017 2:1, 2(1), 6–10. https://doi.org/10.1038/s41562-017-0189-z
Benton, T. D., Ifeagwu, J. A., & Smith-Whitley, K. (2007). Anxiety and depression in children and adolescents with sickle cell disease. Current Psychiatry Reports, 9(2), 114–121. https://doi.org/https://doi.org/10.1007/s11920-007-0080-0
Berkelhammer, L. D., Williamson, A. L., Sanford, S. D., Dirksen, C. L., Sharp, W. G., Margulies, A. S., & Prengler, R. A. (2007). Neurocognitive Sequelae of Pediatric Sickle Cell Disease: A Review of the Literature. Child Neuropsychology, 13(2), 120–131. https://doi.org/10.1080/09297040600800956
Berkman, L. F., & Syme, S. L. (1979). Social Networks, Host Resistance, and Mortality: A Nine-Year Follow-up Study of Alameda County Residents. American Journal of Epidemiology, 109(2), 186–204. https://doi.org/10.1093/OXFORDJOURNALS.AJE.A112674
Bhaskar, R. (1975). A Realist Theory of Science. Harvester.
Bhatia, M., & Walters, M. C. (2007). Hematopoietic cell transplantation for thalassemia and sickle cell disease: past, present and future. Bone Marrow Transplantation 2008 41:2, 41(2), 109–117. https://doi.org/10.1038/sj.bmt.1705943
Bjorklund, Ruth. (2011). Sickle cell anemia. Marshall Cavendish Benchmark.
Blake, A., Asnani, V., Leger, R. R., Harris, J., Odesina, V., Hemmings, D. L., Morris, D. A., Knight-Madden, J., Wagner, L., & Asnani, M. R. (2018). Stigma and illness uncertainty: adding to the burden of sickle cell disease. Hematology, 23(2), 122–130. https://doi.org/10.1080/10245332.2017.1359898
Boafor, T. K., Olayemi, E., Galadanci, N., Hayfron-Benjamin, C., Dei-Adomakoh, Y., Segbefia, C., Kassim, A. A., Aliyu, M. H., Galadanci, H., Tuuli, M. G., Rodeghier, M., Debaun, M. R., & Oppong, S. A. (2016). Pregnancy outcomes in women with sickle-cell disease in low and high income countries: a systematic review and meta-analysis. BJOG: An International Journal of Obstetrics & Gynaecology, 123(5), 691–698. https://doi.org/10.1111/1471-0528.13786
Bonassi, A., Ghilardi, T., Gabrieli, G., Truzzi, A., Doi, H., Borelli, J. L., Lepri, B., Shinohara, K., & Esposito, G. (2021). The Recognition of Cross-Cultural Emotional Faces Is Affected by Intensity and Ethnicity in a Japanese Sample. Behavioral Sciences, 11(5). https://doi.org/10.3390/BS11050059
Boni, L. C., Brown, R. T., Davis, P. C., Hsu, L., & Hopkins, K. (2001). Social Information Processing and Magnetic Resonance Imaging in Children With Sickle Cell Disease. Journal of Pediatric Psychology, 26(5), 309–319. https://doi.org/10.1093/jpepsy/26.5.309
Booth, C., Inusa, B., & Obaro, S. K. (2010). Infection in sickle cell disease: A review. International Journal of Infectious Diseases, 14(1), e2–e12. https://doi.org/10.1016/J.IJID.2009.03.010
Bowers, D., Blonder, L., & Heilman, K. (1999). Florida Affect Battery. Center for Neuropsychological Studies.
Brandling-Bennett, E. M., White, D. A., Armstrong, M. M., Christ, S. E., & DeBaun, M. (2003). Patterns of Verbal Long-Term and Working Memory Performance

Reveal Deficits in Strategic Processing in Children With Frontal Infarcts Related to Sickle Cell Disease. Developmental Neuropsychology, 24(1), 423–434. https://doi.org/10.1207/S15326942DN2401_01
Brown, R. T., Davis, P. C., Lambert, R., Hsu, L., Hopkins, K., & Eckman, J. (2000). Neurocognitive Functioning and Magnetic Resonance Imaging in Children With Sickle Cell Disease. Journal of Pediatric Psychology, 25(7), 503–513. https://doi.org/10.1093/JPEPSY/25.7.503
Bulgin, D., Tanabe, P., & Jenerette, C. (2018). Stigma of Sickle Cell Disease: A Systematic Review. Issues in Mental Health Nursing, 39(8), 675–686. https://doi.org/10.1080/01612840.2018.1443530
Butler, D. J., & Beltran, L. R. (1993). Functions of an Adult Sickle Cell Group: Education, Task Orientation, and Support. Health & Social Work, 18(1), 49–56. https://doi.org/10.1093/HSW/18.1.49
Cameron, B. F., Christian, E., Lobel, J. S., & Gaston, M. H. (1983). Evaluation of clinical severity in sickle cell disease. Journal of the National Medical Association, 75(5), 483–487. http://europepmc.org/abstract/MED/6864827
Campbell, J. E., Assanasen, C., Robinson, R. D., & Knudtson, J. F. (2015). Fertility Preservation Counseling for Pediatric and Adolescent Cancer Patients. Journal of Adolescent and Young Adult Oncology, 5(1), 58–63. https://doi.org/10.1089/jayao.2015.0040
Carter, S. M., & Little, M. (2007). Justifying Knowledge, Justifying Method, Taking Action: Epistemologies, Methodologies, and Methods in Qualitative Research. Qualitative Health Research, 17(10). https://doi.org/10.1177/1049732307306927
Chalah, M. A., & Ayache, S. S. (2017). Deficits in Social Cognition: An Unveiled Signature of Multiple Sclerosis. Journal of the International Neuropsychological Society, 23, 266–286. https://doi.org/10.1017/S1355617716001156
Chase, A. R., Howard, J., & Oteng-Ntim, E. (2009). Ovarian sickling as a proposed mechanism for premature ovarian failure necessitating ovum donation. Menopause International, 15(2), 70–71. https://doi.org/10.1258/mi.2009.009015
Chaytor, N., & Schmitter-Edgecombe, M. (2003). The ecological validity of neuropsychological tests: A review of the literature on everyday cognitive skills. Neuropsychology Review, 13(4), 181–197. https://doi.org/10.1023/B:NERV.0000009483.91468.FB/METRICS
Chen, E., Cole, S. W., & Kato, P. M. (2004). A Review of Empirically Supported Psychosocial Interventions for Pain and Adherence Outcomes in Sickle Cell Disease. Journal of Pediatric Psychology, 29(3), 197–209. https://doi.org/10.1093/jpepsy/jsh021
Cohen, M. J., Branch, W. B., McKie, V. C., & Adams, R. J. (1994). Neuropsychological Impairment in Children With Sickle Cell Anemia and Cerebrovascular Accidents. Clinical Pediatrics, 33(9), 517–524. https://doi.org/10.1177/000992289403300902
Conley, M. I., Dellarco, D. V., Rubien-Thomas, E., Cohen, A. O., Cervera, A., Tottenham, N., & Casey, B. J. (2018). The racially diverse affective expression (RADIATE) face stimulus set. Psychiatry Research, 270, 1059–1067. https://doi.org/10.1016/J.PSYCHRES.2018.04.066
Conrad, M. E., Studdard, H., & Anderson, L. J. (1988). Aplastic crisis in sickle cell disorders: bone marrow necrosis and human parvovirus infection. The American Journal of the Medical Sciences, 295(3), 212–215. https://doi.org/10.1097/00000441-198803000-00009

Costa, F. F., & Fertrin, K. Y. (2016). Clinical Manifestations and Treatment of Adult Sickle Cell Disease. In F. F. Costa & N. Conran (Eds.), Sickle Cell Anemia: From Basic Science to Clinical Practice (pp. 285–318). Springer International Publishing. https://doi.org/10.1007/978-3-319-06713-1_12

Cotter, J., Granger, K., Backx, R., Hobbs, M., Looi, C. Y., & Barnett, J. H. (2018). Social cognitive dysfunction as a clinical marker: A systematic review of meta-analyses across 30 clinical conditions. Neuroscience & Biobehavioral Reviews, 84, 92–99. https://doi.org/10.1016/J.NEUBIOREV.2017.11.014

Cox, C. L., Uddin, L. Q., Di Martino, A., Castellanos, F. X., Milham, M. P., & Kelly, C. (2012). The balance between feeling and knowing: affective and cognitive empathy are reflected in the brain's intrinsic functional dynamics. Social Cognitive and Affective Neuroscience, 7(6), 727–737. https://doi.org/10.1093/scan/nsr051

Craft, J. S. S., Koby, M., Siegel, M. J., Resar, L., Lee, R. R., Chu, J.-Y., Launius, G., Dadash-Zadehm, M., & Le DeBaun, M. R. (1999). Neuropsychologic Deficits in Children with Sickle Cell Disease and Cerebral Infarction: Role of Lesion Site and Volume. Child Neuropsychology, 5(2), 92–103. https://doi.org/10.1076/chin.5.2.92.3170

Crawford, R. D., & Jonassaint, C. R. (2016). Adults with sickle cell disease may perform cognitive tests as well as controls when processing speed is taken into account: a preliminary case–control study. Journal of Advanced Nursing, 72(6), 1409–1416. https://doi.org/10.1111/JAN.12755

Critchley, H. D. (2005). Neural mechanisms of autonomic, affective, and cognitive integration. Journal of Comparative Neurology, 493(1), 154–166. https://doi.org/https://doi.org/10.1002/cne.20749

Dael, N., Mortillaro, M., & Scherer, K. R. (2012). Emotion expression in body action and posture. Emotion, 12(5), 1085–1101. https://doi.org/10.1037/a0025737

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. Journal of Personality and Social Psychology, 44(1), 113–126. https://doi.org/10.1037/0022-3514.44.1.113

Day, S., Brunson, G., & Wang, W. (1992). A successful education program for parents of infants with newly diagnosed sickle cell disease. Journal of Pediatric Nursing, 7(1), 52–57. https://europepmc.org/article/med/1548563

DeBaun, M. R., Armstrong, F. D., McKinstry, R. C., Ware, R. E., Vichinsky, E., & Kirkham, F. J. (2012). Silent cerebral infarcts: a review on a prevalent and progressive cause of neurologic injury in sickle cell anemia. Blood, 119(20), 4587–4596. https://doi.org/10.1182/blood-2011-02-272682

DeBaun, M. R., Schatz, J., Siegel, M. J., Koby, M., Craft, S., Resar, L., Chu, J. Y., Launius, G., Dadash-Zadeh, M., Lee, R. B., & Noetzel, M. (1998). Cognitive screening examinations for silent cerebral infarcts in sickle cell disease. Neurology, 50(6), 1678–1682. https://doi.org/10.1212/WNL.50.6.1678

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). Delis-Kaplan Executive Function System. https://doi.org/https://doi.org/10.1037/t15082-000

Dodell-Feder, D., Germine, L. T., & Ressler, K. J. (2020). Social cognition or social class and culture? On the interpretation of differences in social cognitive performance. Psychological Medicine, 50(1), 133–145. https://doi.org/DOI: 10.1017/S003329171800404X

Dodell-Feder, D., Ressler, K. J., & Germine, L. T. (2020). Social cognition or social class and culture? On the interpretation of differences in social cognitive

performance. Psychological Medicine, 50(1), 133–145. https://doi.org/10.1017/S003329171800404X
Dormandy, E., James, J., Inusa, B., & Rees, D. (2018). How many people have sickle cell disease in the UK? Journal of Public Health, 40(3), e291–e295. https://doi.org/10.1093/pubmed/fdx172
Downes, M., Kirkham, F. J., Telfer, P. T., & De Haan, M. (2018). Assessment of Executive Functions in Preschool Children with Sickle Cell Anemia. Journal of the International Neuropsychological Society, 24(9), 949–954. https://doi.org/10.1017/S1355617718000255
Drawz, P., Ayyappan, S., Nouraie, M., Saraf, S., Gordeuk, V., Hostetter, T., Gladwin, M. T., & Little, J. (2016). Kidney Disease among Patients with Sickle Cell Disease, Hemoglobin SS and SC. Clinical Journal of the American Society of Nephrology, 11(2), 207–215. https://doi.org/10.2215/CJN.03940415
Du, S., & Martinez, A. M. (2015). Compound facial expressions of emotion: from basic research to clinical applications. Dialogues in Clinical Neuroscience, 17(4), 443–455. https://doi.org/10.31887/DCNS.2015.17.4/sdu
Edwards, C. L., Scales, M. T., Loughlin, C., Bennett, G. G., Harris-Peterson, S., De Castro, L. M., Whitworth, E., Abrams, M., Feliu, M., Johnson, S., Wood, M., Harrison, O., & Killough, A. (2005). A brief review of the pathophysiology, associated pain, and psychosocial issues in sickle cell disease. International Journal of Behavioral Medicine 2005 12:3, 12(3), 171–179. https://doi.org/10.1207/S15327558IJBM1203_6
Ekman, P. (1992a). An argument for basic emotions. Cognition & Emotion, 6(3–4), 169–200. https://doi.org/10.1080/02699939208411068
Ekman, P. (1992b). Are there basic emotions? Psychological Review, 99(3), 550–553. https://doi.org/10.1037/0033-295X.99.3.550
Ekman, P., & Friesen, W. V. (1976). Pictures of Facial Affect. Consulting psychologists Press. https://books.google.co.uk/books?id=gbfMSgAACAAJ
Emond, A. M., Collis, R., Darvill, D., Higgs, D. R., Maude, G. H., & Serjeant, G. R. (1985). Acute splenic sequestration in homozygous sickle cell disease: Natural history and management. The Journal of Pediatrics, 107(2), 201–206. https://doi.org/10.1016/S0022-3476(85)80125-6
Falk, R. J., Scheinman, J., Phillips, G., Orringer, E., Johnson, A., & Jennette, J. C. (2010). Prevalence and Pathologic Features of Sickle Cell Nephropathy and Response to Inhibition of Angiotensin-Converting Enzyme. Http://Dx.Doi.Org/10.1056/NEJM199204023261402, 326(14), 910–915. https://doi.org/10.1056/NEJM199204023261402
Fan, Y., Duncan, N. W., de Greck, M., & Northoff, G. (2011). Is there a core neural network in empathy? An fMRI based quantitative meta-analysis. Neuroscience & Biobehavioral Reviews, 35(3), 903–911. https://doi.org/https://doi.org/10.1016/j.neubiorev.2010.10.009
Fiske, S. T., & Neuberg, S. L. (1990). A Continuum of Impression Formation, from Category-Based to Individuating Processes: Influences of Information and Motivation on Attention and Interpretation. In M. P. Zanna (Ed.), Advances in Experimental Social Psychology (Vol. 23, pp. 1–74). Academic Press. https://doi.org/https://doi.org/10.1016/S0065-2601(08)60317-2
Fourie, M. M., Stein, D. J., Solms, M., Gobodo-Madikizela, P., & Decety, J. (2019). Effects of early adversity and social discrimination on empathy for complex mental states: An fMRI investigation. Scientific Reports 2019 9:1, 9(1), 1–14. https://doi.org/10.1038/s41598-019-49298-4

Fox, P. D., Dunn, D. T., Morris, J. S., & Serjeant, G. R. (1990). Risk factors for proliferative sickle retinopathy. The British Journal of Ophthalmology, 74(3), 172–176. https://doi.org/10.1136/bjo.74.3.172

Fox, P., & Ingram, D. (1999). Theory and Practice of Self-Induced Pain Management: Approaches Learned from Effective Copers. Http://Dx.Doi.Org/10.1177/0095798499025003009, 25(3), 427–452. https://doi.org/10.1177/0095798499025003009

Friend, A., Settelmeyer, T. P., & Girzadas, D. (2023). Acute Chest Syndrome. StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK441872/

Frith, C. D., & Frith, U. (2007). Review Social Cognition in Humans. Current Biology, 17, 724–732. https://doi.org/10.1016/j.cub.2007.05.068

Frith, C. D., & Frith, U. (2011). Mechanisms of Social Cognition. Annual Review of Psychology, 63(1), 287–313. https://doi.org/10.1146/annurev-psych-120710-100449

Gasquoine, P. G. (2009). Race-norming of neuropsychological tests. Neuropsychology Review, 19(2), 250–262. https://doi.org/10.1007/S11065-009-9090-5/TABLES/3

Gil, K. M., Thompson, R. J., Keith, B. R., Tota-faucette, M., Noll, S., & Kinney, T. R. (1993). Sickle Cell Disease Pain in Children and Adolescents: Change in Pain Frequency and Coping Strategies Over Time. Journal of Pediatric Psychology, 18(5), 621–637. https://doi.org/10.1093/JPEPSY/18.5.621

Gill, F. M., Sleeper, L. A., Weiner, S. J., Brown, A. K., Bellevue, R., Grover, R., Pegelow, C. H., & Vichinsky, E. (1995). Clinical events in the first decade in a cohort of infants with sickle cell disease. Cooperative Study of Sickle Cell Disease [see comments]. Blood, 86(2), 776–783. https://doi.org/10.1182/BLOOD.V86.2.776.BLOODJOURNAL862776

Gillissie, E. S., Lui, L. M. W., Ceban, F., Miskowiak, K., Gok, S., Cao, B., Teopiz, K. M., Ho, R., Lee, Y., Rosenblat, J. D., & McIntyre, R. S. (2022). Deficits of social cognition in bipolar disorder: Systematic review and meta-analysis. Bipolar Disorders, 24(2), 137–148. https://doi.org/https://doi.org/10.1111/bdi.13163

Goffman, E. (1986). Stigma: Notes on the Management of Spoiled Identity (1st ed.). Simon & Schuster. https://books.google.co.uk/books?id=zuMFXuTMAqAC

Green, M. F., & Plaza, W. (2016). Impact of Cognitive and Social Cognitive Impairment on Functional Outcomes in Patients With Schizophrenia. The Journal of Clinical Psychiatry, 77(suppl 2), 8569. https://doi.org/10.4088/JCP.14074SU1C.02

Griesler, P. C., Hu, M.-C., Wall, M. M., & Kandel, D. B. (2021). Assessment of Prescription Opioid Medical Use and Misuse Among Parents and Their Adolescent Offspring in the US. JAMA Network Open, 4(1), e2031073–e2031073. https://doi.org/10.1001/jamanetworkopen.2020.31073

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. Handbook of Qualitative Research, 2(163–194), 105.

Hackshaw, A. (1991). Small studies: strengths and limitations. European Respiratory Journal, 32(5), 1141–1143. https://doi.org/10.1183/09031936.00136408

Halasa, N. B., Shankar, S. M., Talbot, T. R., Arbogast, P. G., Mitchel, E. F., Wang, W. C., Schaffner, W., Craig, A. S., & Griffin, M. R. (2007). Incidence of invasive pneumococcal disease among individuals with sickle cell disease before and after the introduction of the pneumococcal conjugate vaccine. Clinical Infectious Diseases, 44(11), 1428–1433. https://doi.org/10.1086/516781/2/44-11-1428-TBL001.GIF

Happé, F. G. E. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. Journal of Autism and Developmental Disorders, 24(2), 129–154. https://doi.org/10.1007/BF02172093

Hariman, L. M. F., Griffith, E. R., Hurtig, A. L., & Keehn, M. T. (1991). Functional outcomes of children with sickle-cell disease affected by stroke. Archives of Physical Medicine and Rehabilitation, 72(7), 498–502. https://doi.org/10.5555/URI:PII:000399939190195O

Hasan, S. P., Hashmi, S., Alhassen, M., Lawson, W., & Castro, O. (2003). Depression in sickle cell disease. Journal of the National Medical Association, 95(7), 533. /pmc/articles/PMC2594635/?report=abstract

Hassan, A., & Markus, H. S. (2000). Genetics and ischaemic stroke. Brain, 123(9), 1784–1812. https://doi.org/10.1093/BRAIN/123.9.1784

Hassell, K. (2005). Pregnancy and sickle cell disease. Hematology/Oncology Clinics of North America, 19(5), 903–916. https://doi.org/10.1016/j.hoc.2005.07.003

Hayes, S. C., Luoma, J. B., Bond, F. W., Masuda, A., & Lillis, J. (2006). Acceptance and Commitment Therapy: Model, processes and outcomes. Behaviour Research and Therapy, 44(1), 1–25. https://doi.org/10.1016/J.BRAT.2005.06.006

Haywood, C., Lanzkron, S., Bediako, S., Strouse, J. J., Haythornthwaite, J., Carroll, C. P., Diener-West, M., Onojobi, G., & Beach, M. C. (2014). Perceived Discrimination, Patient Trust, and Adherence to Medical Recommendations Among Persons with Sickle Cell Disease. Journal of General Internal Medicine, 29(12), 1657–1662. https://doi.org/10.1007/S11606-014-2986-7/METRICS

Hazzard, A., Celano, M., Collins, M., & Markov, Y. (2002). Effects of STARBRIGHT World on Knowledge, Social Support, and Coping in Hospitalized Children With Sickle Cell Disease and Asthma. Children's Health Care, 31(1), 69–86. https://doi.org/10.1207/S15326888CHC3101_5

Hebbel, R. P., Yamada, O., Moldow, C. F., Jacob, H. S., White, J. G., & Eaton, J. W. (1980). Abnormal Adherence of Sickle Erythrocytes to Cultured Vascular Endothelium: POSSIBLE MECHANISM FOR MICROVASCULAR OCCLUSION IN SICKLE CELL DISEASE. The Journal of Clinical Investigation, 65(1), 154–160. https://doi.org/10.1172/JCI109646

Henry, J. D., Cowan, D. G., Lee, T., & Sachdev, P. S. (2015). Recent trends in testing social cognition. Current Opinion in Psychiatry, 28(2). https://journals.lww.com/co-psychiatry/fulltext/2015/03000/recent_trends_in_testing_social_cognition.11.aspx

Henry, J. D., Von Hippel, W., Molenberghs, P., Lee, T., & Sachdev, P. S. (2015). Clinical assessment of social cognitive function in neurological disorders. Nature Reviews Neurology 2015 12:1, 12(1), 28–39. https://doi.org/10.1038/nrneurol.2015.229

Hensler, M., Wolfe, K., Lebensburger, J., Nieman, J., Barnes, M., Nolan, W., King, A., & Madan-Swain, A. (2014). Social Skills and Executive Function Among Youth With Sickle Cell Disease: A Preliminary Investigation. Journal of Pediatric Psychology, 39(5), 493–500. https://doi.org/10.1093/JPEPSY/JST138

Herrick, J. B. (1910). Peculiar Elongated and Sickle-Cell Shaped Red Blood Corpuscles in a case of Severe Anemia. Archives of Internal Medicine, VI(5), 517–521. https://doi.org/10.1001/ARCHINTE.1910.00050330050003

Heyes, C. M., & Frith, C. D. (2014). The cultural evolution of mind reading. Science, 344(6190), 1243091. https://doi.org/10.1126/science.1243091
Higgins, E. T., & Bargh, J. A. (1987). Social Cognition and Social Perception. Annual Review of Psychology, 38(1), 369–425. https://doi.org/10.1146/annurev.ps.38.020187.002101
Hijmans, C. T., Fijnvandraat, K., Grootenhuis, M. A., Van Geloven, N., Heijboer, H., Peters, M., & Oosterlaan, J. (2011). Neurocognitive Deficits in Children With Sickle Cell Disease: A Comprehensive Profile. Pediatr Blood Cancer, 56, 783–788. https://doi.org/10.1002/pbc.22879
Hill, C. A., Suzuki, S., Polania, R., Moisa, M., O'doherty, J. P., & Ruff, C. C. (2017). A causal account of the brain network computations underlying strategic social behavior. Nature Neuroscience 2017 20:8, 20(8), 1142–1149. https://doi.org/10.1038/nn.4602
Hogan, A. M., Isaacs, E. B., Kirkham, F. J., Vargha-Khadem, F., & Wade, A. M. (2005). Intellectual decline in children with moyamoya and sickle cell anaemia. Developmental Medicine & Child Neurology, 47(12), 824–829. https://doi.org/DOI: 10.1017/S001216220500174X
Hogan, R. (1969). Development of an empathy scale. Journal of Consulting and Clinical Psychology, 33(3), 307–316. https://doi.org/10.1037/h0027580
Hogrefe, G.-J., Wimmer, H., & Perner, J. (1986). Ignorance versus False Belief: A Developmental Lag in Attribution of Epistemic States. Child Development, 57(3), 567. https://doi.org/10.2307/1130337
Holmes, A. P., Hatch, J., & Robinson, G. A. (1992). A lay educator approach to sickle cell disease education. Journal of National Black Nurses' Association : JNBNA, 5(2), 26–36. https://europepmc.org/article/med/1556571
Homack, S., Lee, D., & Riccio, C. A. (2005). Test Review: Delis-Kaplan Executive Function System. Journal of Clinical and Experimental Neuropsychology, 27(5), 599–609. https://doi.org/10.1080/13803390490918444
Hood, A. M., King, A. A., Fields, M. E., Ford, A. L., Guilliams, K. P., Hulbert, M. L., Lee, J. M., & White, D. A. (2019). Higher executive abilities following a blood transfusion in children and young adults with sickle cell disease. Pediatric Blood & Cancer, 66(10), e27899. https://doi.org/10.1002/PBC.27899
Hsu, L., & Debaun, M. R. (2001). Poor School performance and cognitive deficits in children with silent cerebral infarcts and sickle cell disease. https://doi.org/10.1212/WNL.56.8.1109
IBM SPSS . (2024). https://www.ibm.com/products/spss-statistics?utm_content=SRCWW&p1=Search&p4=43700077589717683&p5=p&p9=58700008510998110&gad_source=1&gclid=EAIaIQobChMIgrP088OXhgMVaphQBh3EZAJpEAAYASAAEgJhifD_BwE&gclsrc=aw.ds
Ifeanyi, E., Ogechi, B., & Emmanuel Ifeanyi, O. (2015). Sickle Cell Anaemia: A Review. Scholars Journal of Applied Medical Sciences (SJAMS, 3(6B), 2244–2252. https://doi.org/10.36347/sjams.2015.v03i06.017
Inusa, B. P. D., Hsu, L. L., Kohli, N., Patel, A., Ominu-Evbota, K., Anie, K. A., & Atoyebi, W. (2019). Sickle Cell Disease-Genetics, Pathophysiology, Clinical Presentation and Treatment. International Journal of Neonatal Screening, 5(2). https://doi.org/10.3390/IJNS5020020
Jenerette, C. M., Brewer, C. A., Edwards, L. J., Mishel, M. H., & Gil, K. M. (2013). An Intervention to Decrease Stigma in Young Adults With Sickle Cell Disease. Http://Dx.Doi.Org/10.1177/0193945913512724, 36(5), 599–619. https://doi.org/10.1177/0193945913512724

Jones, P. (2008). Sickle cell disease. Chelsea House Publishers.
Kail, R., & Salthouse, T. A. (1994). Processing speed as a mental capacity. Acta Psychologica, 86(2), 199–225. https://doi.org/https://doi.org/10.1016/0001-6918(94)90003-5
Kandalaft, M. R., Didehbani, N., Cullum, C. M., Krawczyk, D. C., Allen, T. T., Tamminga, C. A., & Chapman, S. B. (2012). The Wechsler ACS social perception subtest: a preliminary comparison with other measures of social cognition. Journal of Psychoeducational Assessment, 30(5), 455–465.
Kane, I., Kumar, A., Atalla, E., & Nagalli, S. (2023). Splenic Sequestration Crisis. StatPearls Publishing, Treasure Island (FL). http://europepmc.org/abstract/MED/31985957
Kang, H. (2021). Sample size determination and power analysis using the G*Power software. Journal of Educational Evaluation for Health Professions, 18. https://doi.org/10.3352/JEEHP.2021.18.17
Kanwisher, N., & Yovel, G. (2006). The fusiform face area: a cortical region specialized for the perception of faces. Philosophical Transactions of the Royal Society B: Biological Sciences, 361(1476), 2109–2128. https://doi.org/10.1098/rstb.2006.1934
Kassim, A. A., & DeBaun, M. R. (2013). Sickle Cell Disease, Vasculopathy, and Therapeutics. Annual Review of Medicine, 64(1), 451–466. https://doi.org/10.1146/annurev-med-120611-143127
Kaufman, A., & Kaufman, N. (2004). Kaufman Brief Intelligence Test, Second Edition (KBIT-2). Pearson. https://doi.org/10.53841/BPSTEST.2004.KBIT2
Kavanagh, P. L., Fasipe, T. A., & Wun, T. (2022). Sickle Cell Disease: A Review. JAMA, 328(1), 57–68. https://doi.org/10.1001/jama.2022.10233
Kennedy, D. P., & Adolphs, R. (2012). The social brain in psychiatric and neurological disorders. Trends in Cognitive Sciences, 16(11), 559–572. https://doi.org/10.1016/j.tics.2012.09.006
Khatib, R., Rabah, R., & Sarnaik, S. A. (2009). The spleen in the sickling disorders: an update. Pediatric Radiology, 39(1), 17–22. https://doi.org/10.1007/s00247-008-1049-9
Kilford, E. J., Garrett, E., & Blakemore, S.-J. (2016). The development of social cognition in adolescence: An integrated perspective. Neuroscience & Biobehavioral Reviews, 70, 106–120. https://doi.org/https://doi.org/10.1016/j.neubiorev.2016.08.016
King, A. A., Strouse, J. J., Rodeghier, M. J., Compas, B. E., Casella, J. F., McKinstry, R. C., Noetzel, M. J., Quinn, C. T., Ichord, R., Dowling, M. M., Miller, J. P., & DeBaun, M. R. (2014). Parent education and biologic factors influence on cognition in sickle cell anemia. American Journal of Hematology, 89(2), 162–167. https://doi.org/https://doi.org/10.1002/ajh.23604
Klings, E. S., Machado, R. F., Barst, R. J., Morris, C. R., Mubarak, K. K., Gordeuk, V. R., Kato, G. J., Ataga, K. I., Gibbs, J. S., Castro, O., Rosenzweig, E. B., Sood, N., Hsu, L., Wilson, K. C., Telen, M. J., DeCastro, L. M., Krishnamurti, L., Steinberg, M. H., Badesch, D. B., & Gladwin, M. T. (2014). An Official American Thoracic Society Clinical Practice Guideline: Diagnosis, Risk Stratification, and Management of Pulmonary Hypertension of Sickle Cell Disease. American Journal of Respiratory and Critical Care Medicine, 189(6), 727–740. https://doi.org/10.1164/rccm.201401-0065ST
Kotila, T. R. (2016). Sickle Cell Trait: A Benign State? Acta Haematologica, 136(3), 147–151. https://doi.org/10.1159/000446526

Kovács, Á. M., Téglás, E., & Endress, A. D. (2010). The social sense: Susceptibility to others' beliefs in human infants and adults. Science, 330(6012), 1830–1834. https://doi.org/10.1126/SCIENCE.1190792/SUPPL_FILE/KOVACS_SOM.PDF
Kral, M. C., Brown, R. T., & Hynd, G. W. (2001). Neuropsychological aspects of pediatric Sickle Cell Disease. Neuropsychology Review, 11(4), 179–196. https://doi.org/10.1023/A:1012901124088
Kruglanski, A. W., & Stroebe, W. (2012). Handbook of the History of Social Psychology. Taylor & Francis. https://books.google.co.uk/books?id=vS0QrvMGwhMC
Kumar, V., Abbas, A. K., Fausto, N., & Aster, J. C. (2014). Robbins and Cotran pathologic basis of disease, professional edition e-book. Elsevier health sciences.
Labore, N., Mawn, B., Dixon, J., & Andemariam, B. (2015). Exploring Transition to Self-Management Within the Culture of Sickle Cell Disease. Http://Dx.Doi.Org/10.1177/1043659615609404, 28(1), 70–78. https://doi.org/10.1177/1043659615609404
Lau, F., & Kuziemsky, C. (2016). Handbook of eHealth evaluation: an evidence-based approach. https://www.ncbi.nlm.nih.gov/books/NBK481614/
Lawrence, E. J., Shaw, P., Baker, D., Baron-Cohen, S., & David, A. S. (2004). Measuring empathy: reliability and validity of the Empathy Quotient. Psychological Medicine, 34(5), 911–920. https://doi.org/10.1017/S0033291703001624
Lawson, J., Baron-Cohen, S., & Wheelwright, S. (2004). Empathising and Systemising in Adults with and without Asperger Syndrome. Journal of Autism and Developmental Disorders, 34(3), 301–310. https://doi.org/10.1023/B:JADD.0000029552.42724.1b
Leach, L., Kaplan, E., Rewilak, D., Richards, B., & Proulx, G. B. (2000). The Kaplan Baycrest Neurocognitive Assessment. San Antonio, TX: The Psychological Corporation. https://doi.org/https://doi.org/10.1037/t15108-000
Leonard, A., & Tisdale, J. F. (2023). Gene therapy for sickle cell disease. Hematology, 2023(1), 542–547. https://doi.org/10.1182/hematology.2023000487
Levenson, J. L., McClish, D. K., Dahman, B. A., Bovbjerg, V. E., de A. Citero, V., Penberthy, L. T., Aisiku, I. P., Roberts, J. D., Roseff, S. D., & Smith, W. R. (2008). Depression and Anxiety in Adults With Sickle Cell Disease: The PiSCES Project. Psychosomatic Medicine, 70(2). https://journals.lww.com/psychosomaticmedicine/fulltext/2008/02000/depression_and_anxiety_in_adults_with_sickle_cell.9.aspx
Lew, V. L., Ortiz, O. E., & Bookchin, R. M. (1997). Stochastic nature and red cell population distribution of the sickling-induced Ca2+ permeability. The Journal of Clinical Investigation, 99(11), 2727–2735. https://doi.org/10.1172/JCI119462
Lezak, M. D., Howieson, D. B., Bigler, E. D., & Tranel, D. (2012). Neuropsychological Assessment . In Neuropsychological Assessment (5th ed.). OUP USA.
Lim, J. I. (2012). Ophthalmic manifestations of sickle cell disease: update of the latest findings. Current Opinion in Ophthalmology, 23(6). https://journals.lww.com/co-ophthalmology/fulltext/2012/11000/ophthalmic_manifestations_of_sickle_cell_disease_.15.aspx
Link, B. G., & Phelan, J. C. (2001). Conceptualizing Stigma. Annual Review of Sociology, 27, 363–385.

Mackin, R. S., Insel, P., Truran, D., Vichinsky, E. P., Neumayr, L. D., Armstrong, F. D., Gold, J. I., Kesler, K., Brewer, J., Weiner, M. W., & Group, =Neuropsychological Dysfunction and Neuroimaging Adult Sickle Cell Anemia Study. (2014). Neuroimaging abnormalities in adults with sickle cell anemia: associations with cognition. Neurology, 82(10), 835–841. https://doi.org/10.1212/wnl.0000000000000188

Manly, J. J. (2008). Critical issues in cultural neuropsychology: Profit from diversity. Neuropsychology Review, 18(3 SPEC. ISS.), 179–183. https://doi.org/10.1007/S11065-008-9068-8/METRICS

Mantadakis, E., Ewalt, D. H., Cavender, J. D., Rogers, Z. R., & Buchanan, G. R. (2000). Outpatient penile aspiration and epinephrine irrigation for young patients with sickle cell anemia and prolonged priapism. Blood, 95(1), 78–82. https://doi.org/10.1182/BLOOD.V95.1.78

Mason, V. R. (1922). Sickle Cell Anemia. Journal of the American Medical Association, 79(16), 1318–1320. https://doi.org/10.1001/jama.1922.02640160038012

Mastandréa, É. B., Lucchesi, F., Kitayama, M. M. G., Figueiredo, M. S., & de Albuquerque Citero, V. (2015). The relationship between genotype, psychiatric symptoms and quality of life in adult patients with sickle cell disease in São Paulo, Brazil: A cross-sectional study. Sao Paulo Medical Journal, 133(5), 421 – 427. https://doi.org/10.1590/1516-3180.2015.00171105

Masuda, A., Cohen, L. L., Wicksell, R. K., Kemani, M. K., & Johnson, A. (2011). A Case Study: Acceptance and Commitment Therapy for Pediatric Sickle Cell Disease. Journal of Pediatric Psychology, 36(4), 398–408. https://doi.org/10.1093/JPEPSY/JSQ118

McAnearney, S., & McCall, D. (2015). Salmonella Osteomyelitis. The Ulster Medical Journal, 84(3), 171–172. http://europepmc.org/abstract/MED/26668420

Mccormick, M., Awo Osei-Anto, H., & Martinez, R. M. (2020). Committee on Addressing Sickle Cell Disease: A Strategic Plan and Blueprint for Action A Consensus Study Report of. https://doi.org/10.17226/25632

McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. The Journal of Head Trauma Rehabilitation, 18(3), 219–238. https://doi.org/10.1097/00001199-200305000-00001

McDougall, W. (1908). An Introduction to Social Psychology. In An Introduction to Social Psychology (1st Edition). Psychology Press. https://doi.org/10.4324/9781315724256

McGann, P. T., & Ware, R. E. (2011). Hydroxyurea for sickle cell anemia: what have we learned and what questions still remain? Current Opinion in Hematology, 18(3), 158–165. https://doi.org/10.1097/moh.0b013e32834521dd

McMahon, C., Callaghan, C. O., O'Brien, D., & Smith, O. P. (2001). The increasing prevalence of childhood sickle-cell disease in Ireland. Irish Journal of Medical Science, 170(3), 183–185. https://doi.org/10.1007/BF03173886/METRICS

Mehrabian, A. (2000). Beyond IQ: Broad-based measurement of individual success potential or "emotional intelligence." Genetic, Social, and General Psychology Monographs, 126(2), 133–239. https://www.proquest.com/scholarly-journals/beyond-iq-broad-based-measurement-individual/docview/231581265/se-2?accountid=11862

Milders, M. (2018). Brain Injury Relationship between social cognition and social behaviour following traumatic brain injury Relationship between social cognition

and social behaviour following traumatic brain injury. https://doi.org/10.1080/02699052.2018.1531301
Miller, L. A., Hsieh, S., Lah, S., Savage, S., Hodges, J. R., & Piguet, O. (2012). One Size Does Not Fit All: Face Emotion Processing Impairments in Semantic Dementia, Behavioural-Variant Frontotemporal Dementia and Alzheimer's Disease Are Mediated by Distinct Cognitive Deficits. Behavioural Neurology, 25, 683052. https://doi.org/10.3233/BEN-2012-0349
Morin, C., & Waring, E. M. (1981). Depression and sickle cell anemia. Southern Medical Journal, 74(6), 766–768. https://doi.org/10.1097/00007611-198106000-00035
Nagel, R. L. (2003). Hemoglobin Disorders (1st ed., Vol. 82). Humana Totowa, NJ. https://doi.org/10.1385/1592593739
Nash, K. B., & Kramer, K. D. (1993). Self-Help for Sickle Cell Disease in African American Communities. Https://Doi.Org/10.1177/0021886393292005, 29(2), 202–215. https://doi.org/10.1177/0021886393292005
Nelson, S. C., & Hackman, H. W. (2013). Race matters: Perceptions of race and racism in a sickle cell center. Pediatric Blood and Cancer, 60(3), 451–454. https://doi.org/10.1002/PBC.24361
Neumayr, L. D., Hoppe, C. C., & Brown, C. (2019). Sickle cell disease: current treatment and emerging therapies. The American Journal of Managed Care, 25(18 Suppl), S335–S343. https://europepmc.org/article/med/31809007
NICE. (2021). Prevalence | Background information | Sickle cell disease | CKS | NICE. https://cks.nice.org.uk/topics/sickle-cell-disease/background-information/prevalence/
Nickerson, R. S. (2000). Null hypothesis significance testing: a review of an old and continuing controversy. Psychological Methods, 5(2), 241–301. https://doi.org/10.1037/1082-989X.5.2.241
Niihara, Y., Matsui, N. M., Shen, Y. M., Akiyama, D. A., Johnson, C. S., Sunga, M. A., Magpayo, J., Embury, S. H., Kalra, V. K., Cho, S. H., & Tanaka, K. R. (2005). L-glutamine therapy reduces endothelial adhesion of sickle red blood cells to human umbilical vein endothelial cells. BMC Blood Disorders, 5(1), 1–7. https://doi.org/10.1186/1471-2326-5-4/FIGURES/3
Niihara, Y., Miller, S. T., Kanter, J., Lanzkron, S., Smith, W. R., Hsu, L. L., Gordeuk, V. R., Viswanathan, K., Sarnaik, S., Osunkwo, I., Guillaume, E., Sadanandan, S., Sieger, L., Lasky, J. L., Panosyan, E. H., Blake, O. A., New, T. N., Bellevue, R., Tran, L. T., … Vichinsky, E. P. (2018). A Phase 3 Trial of l -Glutamine in Sickle Cell Disease . New England Journal of Medicine, 379(3), 226–235. https://doi.org/10.1056/NEJMOA1715971/SUPPL_FILE/NEJMOA1715971_DISCLOSURES.PDF
Noll, R. B., Reiter-Purtill, J., Vannatta, K., Gerhardt, C. A., & Short, A. (2007). Peer Relationships and Emotional Well-Being of Children with Sickle Cell Disease: A Controlled Replication. Child Neuropsychology, 13(2), 173–187. https://doi.org/10.1080/09297040500473706
Noll, R. B., Yosua, L. A., Vannatta, K., Kalinyak, K., Bukowski, W. M., & Davies, W. H. (1995). Social Competence of Siblings of Children with Sickle Cell Anemia. Journal of Pediatric Psychology, 20(2), 165–172. https://doi.org/10.1093/JPEPSY/20.2.165
Ohene-Frempong, K., Weiner, S. J., Sleeper, L. A., Miller, S. T., Embury, S., Moohr, J. W., Wethers, D. L., Pegelow, C. H., Gill, F. M., & Sickle Cell Disease, the C. S.

of. (1998). Cerebrovascular Accidents in Sickle Cell Disease: Rates and Risk Factors. Blood, 91(1), 288–294. https://doi.org/10.1182/blood.V91.1.288
Ola, B. A., Yates, S. J., & Dyson, S. M. (2016). Living with sickle cell disease and depression in Lagos, Nigeria: A mixed methods study. Social Science & Medicine (1982), 161, 27–36. https://doi.org/10.1016/j.socscimed.2016.05.029
Old, J. (1996). Haemoglobinopathies. Prenatal Diagnosis, 16(13), 1181–1186. https://doi.org/https://doi.org/10.1002/(SICI)1097-0223(199612)16:13<1181::AID-PD93>3.0.CO;2-N
Osegbe, D. N., Akinyanju, O., & Amaku, E. O. (1981). Fertility in males with sickle cell disease. The Lancet, 318(8241), 275–276. https://doi.org/https://doi.org/10.1016/S0140-6736(81)90525-0
Panepinto, J. A. (2008). Health-related quality of life in sickle cell disease. Pediatric Blood & Cancer, 51(1), 5–9. https://doi.org/10.1002/PBC.21557
Parke, E. M., Becker, M. L., Graves, S. J., Baily, A. R., Paul, M. G., Freeman, A. J., & Allen, D. N. (2018). Social Cognition in Children With ADHD. Journal of Attention Disorders, 25(4), 519–529. https://doi.org/10.1177/1087054718816157
Parshad, O., Stevens, M. C., Preece, M. A., Thomas, P. W., & Serjeant, G. R. (1994). The mechanism of low testosterone levels in homozygous sickle-cell disease. The West Indian Medical Journal, 43(1), 12–14. https://europepmc.org/article/med/8036809
Pauling, L., Itano, H. A., Singer, S. J., & Wells, I. C. (1949). Sickle Cell Anemia, a Molecular Disease. Science, 110(2865), 543–548. https://doi.org/10.1126/science.110.2865.543
Pearson, N. C. S. (2009). Advanced clinical solutions for WAIS-IV and WMS-IV: Administration and scoring manual. San Antonio: The Psychological Corporation, 7.
Pechtel, P., & Pizzagalli, D. A. (2011). Effects of early life stress on cognitive and affective function: An integrated review of human literature. Psychopharmacology, 214(1), 55–70. https://doi.org/10.1007/S00213-010-2009-2/FIGURES/1
Pecker, L. H., Sharma, D., Nero, A., Paidas, M. J., Ware, R. E., James, A. H., & Smith-Whitley, K. (2021). Knowledge gaps in reproductive and sexual health in girls and women with sickle cell disease. British Journal of Haematology, 194(6), 970–979. https://doi.org/https://doi.org/10.1111/bjh.17658
Piel, F. B., Patil, A. P., Howes, R. E., Nyangiri, O. A., Gething, P. W., Dewi, M., Temperley, W. H., Williams, T. N., Weatherall, D. J., & Hay, S. I. (2013a). Global epidemiology of Sickle haemoglobin in neonates: A contemporary geostatistical model-based map and population estimates. The Lancet, 381(9861), 142–151. https://doi.org/10.1016/S0140-6736(12)61229-X
Piel, F. B., Patil, A. P., Howes, R. E., Nyangiri, O. A., Gething, P. W., Dewi, M., Temperley, W. H., Williams, T. N., Weatherall, D. J., & Hay, S. I. (2013b). Global epidemiology of Sickle haemoglobin in neonates: A contemporary geostatistical model-based map and population estimates. The Lancet, 381(9861), 142–151. https://doi.org/10.1016/S0140-6736(12)61229-X
Portela, G. T., Butters, M. A., Brooks, M. M., Candra, L., Rosano, C., & Novelli, E. M. (2022). Comprehensive assessment of cognitive function in adults with moderate and severe sickle cell disease. American Journal of Hematology, 97(9), E344. https://doi.org/10.1002/AJH.26643
Powars, D., Weidman, J. A., Odom-Maryon, T., Niland, J. C., Johnson, C., Mohler, J. G., & MacLaughlin, E. (1988). Sickle cell chronic lung disease: Prior morbidity

and the risk of pulmonary failure. Medicine (United States), 67(1), 66–76. https://doi.org/10.1097/00005792-198801000-00005
Power-Hays, A., & McGann, P. T. (2020). When Actions Speak Louder Than Words — Racism and Sickle Cell Disease. New England Journal of Medicine, 383(20), 1902–1903. https://doi.org/10.1056/NEJMP2022125
Queiroz, A. M., Lobo, C. L. de C., & Ballas, S. K. (2021). Menopause in Brazilian women with sickle cell anemia with and without hydroxyurea therapy. Hematology, Transfusion and Cell Therapy, 43(3), 386–388. https://doi.org/10.1016/j.htct.2020.06.009
Raelin, J. A. (2017). Toward an Epistemology of Practice. Https://Doi.Org/10.5465/Amle.2007.27694950, 6(4), 495–519. https://doi.org/10.5465/AMLE.2007.27694950
Rahimy, M. C., Gangbo, A., Ahouignan, G., Adjou, R., Deguenon, C., Goussanou, S., & Alihonou, E. (2003). Effect of a comprehensive clinical care program on disease course in severely ill children with sickle cell anemia in a sub-Saharan African setting. Blood, 102(3), 834–838. https://doi.org/10.1182/BLOOD-2002-05-1453
Rankin, K. P. (2020). Brain Networks Supporting Social Cognition in Dementia. Current Behavioral Neuroscience Reports, 7(4), 203–211. https://doi.org/10.1007/S40473-020-00224-3/FIGURES/1
Reader, S. K., Rockman, L. M., Okonak, K. M., Ruppe, N. M., Keeler, C. N., & Kazak, A. E. (2020). Systematic Review: Pain and Emotional Functioning in Pediatric Sickle Cell Disease. Journal of Clinical Psychology in Medical Settings, 27(2), 343–365. https://doi.org/10.1007/S10880-019-09647-X/TABLES/2
Rees, D. C., Williams, T. N., & Gladwin, M. T. (2010). Sickle-cell disease. The Lancet, 376(9757), 2018–2031. https://doi.org/10.1016/S0140-6736(10)61029-X
Reniers, R. L. E. P., Corcoran, R., Drake, R., Shryane, N. M., & Völlm, B. A. (2011). The QCAE: A Questionnaire of Cognitive and Affective Empathy. Journal of Personality Assessment, 93(1), 84–95. https://doi.org/10.1080/00223891.2010.528484
Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). “Oops!”: performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. Neuropsychologia, 35(6), 747–758. https://doi.org/10.1016/S0028-3932(97)00015-8
Rodrigue, J. R., Streisand, R., Banko, C., Kedar, A., & Pitel, P. A. (1996). Social Functioning, Peer Relations, and Internalizing and Externalizing Problems Among Youth With Sickle Cell Disease. Children’s Health Care, 25(1), 37–52. https://doi.org/10.1207/S15326888CHC2501_4
Rogovik, A. L., Persaud, J., Friedman, J. N., Kirby, M. A., & Goldman, R. D. (2011). Pediatric Vasoocclusive Crisis and Weather Conditions. The Journal of Emergency Medicine, 41(5), 559–565. https://doi.org/10.1016/J.JEMERMED.2010.05.006
Ross, E. A. (1908). Social psychology: An Outline and Source Book. In Social psychology: An outline and source book. (1st ed.). MacMillan Co. https://doi.org/10.1037/11416-000
Sahu, T., Pande, B., Sinha, M., Sinha, R., & Verma, H. K. (2022). Neurocognitive Changes in Sickle Cell Disease: A Comprehensive Review. Annals of Neurosciences, 29(4), 255–268. https://doi.org/10.1177/09727531221108871
Sanger, M., Jordan, L., Pruthi, S., Day, M., Covert, B., Merriweather, B., Rodeghier, M., DeBaun, M., & Kassim, A. (2016). Cognitive deficits are associated with

unemployment in adults with sickle cell anemia. Journal of Clinical and Experimental Neuropsychology, 38(6), 661–671. https://doi.org/10.1080/13803395.2016.1149153
Savla, G. N., Vella, L., Armstrong, C. C., Penn, D. L., & Twamley, E. W. (2013). Deficits in Domains of Social Cognition in Schizophrenia: A Meta-Analysis of the Empirical Evidence. Schizophrenia Bulletin, 39(5), 979–992. https://doi.org/10.1093/schbul/sbs080
Schatz, J., Brown, R. T., Pascual, J. M., Hsu, L., & DeBaun, M. R. (2001). Poor school and cognitive functioning with silent cerebral infarcts and sickle cell disease. Neurology, 56(8), 1109–1111. https://doi.org/10.1212/WNL.56.8.1109
Schatz, J., Puffer, E. S., Sanchez, C., Stancil, M., & Roberts, C. W. (2009). Language Processing Deficits in Sickle Cell Disease in Young School-Age Children. Developmental Neuropsychology, 34(1), 122–136. https://doi.org/10.1080/87565640802499191
Scheffels, J. F., Ballasch, I., Scheichel, N., Voracek, M., Kalbe, E., & Kessler, J. (2023). The Influence of Age, Gender and Education on Neuropsychological Test Scores: Updated Clinical Norms for Five Widely Used Cognitive Assessments. Journal of Clinical Medicine, 12(16), 5170. https://doi.org/10.3390/JCM12165170/S1
Scherer, K. R. (1995). Expression of emotion in voice and music. Journal of Voice, 9(3), 235–248. https://doi.org/10.1016/S0892-1997(05)80231-0
Schneider, D., Slaughter, V. P., Becker, S. I., & Dux, P. E. (2014). Implicit false-belief processing in the human brain. NeuroImage, 101, 268–275. https://doi.org/10.1016/J.NEUROIMAGE.2014.07.014
Schoemaker, K., Mulder, H., Deković, M., & Matthys, W. (2013). Executive Functions in Preschool Children with Externalizing Behavior Problems: A Meta-Analysis. Journal of Abnormal Child Psychology, 41(3), 457–471. https://doi.org/10.1007/s10802-012-9684-x
Scott, A. W. (2016). Ophthalmic manifestations of sickle cell disease. Southern Medical Journal, 109(9), 542–548. https://doi.org/10.14423/SMJ.0000000000000525
Serjeant, G. R. (1997). Sickle-cell disease. Lancet (London, England), 350(9079), 725–730. https://doi.org/10.1016/S0140-6736(97)07330-3
Shamay-Tsoory, S. G., & Aharon-Peretz, J. (2007). Dissociable prefrontal networks for cognitive and affective theory of mind: A lesion study. Neuropsychologia, 45(13), 3054–3067. https://doi.org/https://doi.org/10.1016/j.neuropsychologia.2007.05.021
Sharma, D., Day, M. E., Stimpson, S. J., Rodeghier, M., Ghafuri, D., Callaghan, M., Zaidi, A. U., Hannan, B., Kassim, A., Zempsky, W., Wellons, M., James, A., Bruehl, S., & Debaun, M. R. (2019). Acute Vaso-Occlusive Pain is Temporally Associated with the Onset of Menstruation in Women with Sickle Cell Disease. Https://Home.Liebertpub.Com/Jwh, 28(2), 162–169. https://doi.org/10.1089/JWH.2018.7147
Siado, J. P., Hernández, J. L., Siado, J. P., & Hernández, J. L. (2015). Acute Splenic Sequestration Crisis. Inherited Hemoglobin Disorders. https://doi.org/10.5772/60811
Simon, K., Barakat, L. P., Patterson, C. A., & Dampier, C. (2009). Symptoms of Depression and Anxiety in Adolescents with Sickle Cell Disease: The Role of Intrapersonal Characteristics and Stress Processing Variables. Child Psychiatry

and Human Development, 40(2), 317–330. https://doi.org/10.1007/s10578-009-0129-x
Smith-Whitley, K. (2014). Reproductive issues in sickle cell disease. Blood, 124(24), 3538–3543. https://doi.org/10.1182/blood-2014-07-577619
Smits, H. L., Oski, F. A., & Brody, J. I. (1969). The hemolytic crisis of sickle cell disease: The role of glucose-6-phosphate dehydrogenase deficiency. The Journal of Pediatrics, 74(4), 544–551. https://doi.org/10.1016/S0022-3476(69)80037-5
Steen, R. G., Fineberg-Buchner, C., Hankins, G., Weiss, L., Prifitera, A., & Mulhern, R. K. (2005). Cognitive deficits in children with sickle cell disease. Journal of Child Neurology, 20(2), 102–107. https://doi.org/10.1177/08830738050200020301
Steinberg, M. H., Barton, F., Castro, O., Pegelow, C. H., Ballas, S. K., Kutlar, A., Orringer, E., Bellevue, R., Olivieri, N., Eckman, J., Varma, M., Ramirez, G., Adler, B., Smith, W., Carlos, T., Ataga, K., DeCastro, L., Bigelow, C., Saunthararajah, Y., … Terrin, M. (2003). Effect of Hydroxyurea on Mortality and Morbidity in Adult Sickle Cell Anemia Risks and Benefits Up to 9 Years of Treatment. JAMA, 289(13), 1645–1651. https://doi.org/10.1001/jama.289.13.1645
Stone, V. E., Baron-Cohen, S., & Knight, R. T. (1998). Frontal Lobe Contributions to Theory of Mind. Journal of Cognitive Neuroscience, 10(5), 640–656. https://doi.org/10.1162/089892998562942
Stotesbury, H., Kawadler, J. M., Hales, P. W., Saunders, D. E., Clark, C. A., & Kirkham, F. J. (2019). Vascular instability and neurological morbidity in sickle cell disease: An integrative framework. Frontiers in Neurology, 10(AUG), 471261. https://doi.org/10.3389/FNEUR.2019.00871/BIBTEX
Stotesbury, H., Kirkham, F. J., Kölbel, M., Balfour, P., Clayden, J. D., Sahota, S., Sakaria, S., Saunders, D. E., Howard, J., Kesse-Adu, R., Inusa, B., Pelidis, M., Chakravorty, S., Rees, D. C., Awogbade, M., Wilkey, O., Layton, M., Clark, C. A., & Kawadler, J. M. (2018). White matter integrity and processing speed in sickle cell anemia. Neurology, 90(23), e2042–e2050. https://doi.org/10.1212/WNL.0000000000005644
Stuart, M. J., & Nagel, R. L. (2004). Sickle-cell disease. The Lancet, 364(9442), 1343–1360. https://doi.org/10.1016/S0140-6736(04)17192-4
Sturgiss, E. A., & Clark, A. M. (2019). Using critical realism in primary care research: an overview of methods. https://doi.org/10.1093/fampra/cmz084
Suchy, Y., & Holdnack, J. A. (2013). Assessing Social Cognition Using the ACS for WAIS–IV and WMS–IV. WAIS-IV, WMS-IV, and ACS: Advanced Clinical Interpretation, 367–406. https://doi.org/10.1016/B978-0-12-386934-0.00008-0
Swerdlow, P. S. (2006). Red Cell Exchange in Sickle Cell Disease. Hematology, 2006(1), 48–53. https://doi.org/10.1182/ASHEDUCATION-2006.1.48
Swift, A. V., Cohen, M. J., Hynd, G. W., Wisenbaker, J. M., McKie, K. M., Makari, G., & McKie, V. C. (1989). Neuropsychologic Impairment in Children With Sickle Cell Anemia. Pediatrics, 84(6), 1077–1085. https://doi.org/10.1542/PEDS.84.6.1077
Tamietto, M., & De Gelder, B. (2010). Neural bases of the non-conscious perception of emotional signals. Nature Reviews Neuroscience 2010 11:10, 11(10), 697–709. https://doi.org/10.1038/nrn2889
Teti, D. M. (2005). Handbook of Research Methods in Developmental Science (1st ed.). Blackwell Publishing.

Thiagarajan, P., Parker, C. J., & Prchal, J. T. (2021). How Do Red Blood Cells Die? Front. Physiol, 12, 655393. https://doi.org/10.3389/fphys.2021.655393

Thomas, J. E., Koshy, M., Patterson, L., Dorn, L., & Thomas, K. (1984). Management of pain in sickle cell disease using biofeedback therapy: A preliminary study. Biofeedback and Self-Regulation, 9(4), 413–420. https://doi.org/10.1007/BF01000558/METRICS

Thomas, V. J., & Taylor, L. M. (2002). The psychosocial experience of people with sickle cell disease and its impact on quality of life: Qualitative findings from focus groups. British Journal of Health Psychology, 7(3), 345–363. https://doi.org/https://doi.org/10.1348/135910702760213724

Thomson, A. M., McHugh, T. A., Oron, A. P., Teply, C., Lonberg, N., Vilchis Tella, V., Wilner, L. B., Fuller, K., Hagins, H., Aboagye, R. G., Aboye, M. B., Abu-Gharbieh, E., Abu-Zaid, A., Addo, I. Y., Ahinkorah, B. O., Ahmad, A., AlRyalat, S. A. S., Amu, H., Aravkin, A. Y., … Kassebaum, N. J. (2023). Global, regional, and national prevalence and mortality burden of sickle cell disease, 2000–2021: a systematic analysis from the Global Burden of Disease Study 2021. The Lancet Haematology, 10(8), e585–e599. https://doi.org/10.1016/S2352-3026(23)00118-7

Tone, E. B., & Tully, E. C. (2014). Empathy as a “risky strength”: A multilevel examination of empathy and risk for internalizing disorders. Development and Psychopathology, 26(4pt2), 1547–1565. https://doi.org/10.1017/S0954579414001199

Toumi, M. L., Merzoug, S., & Boulassel, M. R. (2018). Does sickle cell disease have a psychosomatic component? A particular focus on anxiety and depression. Life Sciences, 210, 96–105. https://doi.org/https://doi.org/10.1016/j.lfs.2018.08.066

Tubman, V. N., & Field, J. J. (2015). Sickle solubility test to screen for sickle cell trait: what’s the harm? Hematology, 2015(1), 433–435. https://doi.org/10.1182/ASHEDUCATION-2015.1.433

Van Kleef, G. A. (2009). How Emotions Regulate Social Life: The Emotions as Social Information (EASI) Model. Current Directions in Psychological Science, 18(3), 184–188. https://doi.org/10.1111/j.1467-8721.2009.01633.x

Vogeley, K. (2017). Two social brains: neural mechanisms of intersubjectivity. Philosophical Transactions of the Royal Society B: Biological Sciences, 372(1727). https://doi.org/10.1098/RSTB.2016.0245

Walters, M. C. (2005). Stem Cell Therapy for Sickle Cell Disease: Transplantation and Gene Therapy. Hematology, 2005(1), 66–73. https://doi.org/10.1182/ASHEDUCATION-2005.1.66

Ware, R. E., de Montalembert, M., Tshilolo, L., & Abboud, M. R. (2017). Sickle cell disease. The Lancet, 390(10091), 311–323. https://doi.org/10.1016/S0140-6736(17)30193-9

Watkins, K. E., Hewes, D. E. M., Connelly, A., Kendall, B. E., Kingsley, D. P. E., Evans, J. E. P., Gadian, D. G., Vargha-Khadem, F., & Kirkham, F. J. (1998). Cognitive deficits associated with frontal-lobe infarction in children with sickle cell disease. Developmental Medicine & Child Neurology, 40(8), 536–543. https://doi.org/https://doi.org/10.1111/j.1469-8749.1998.tb15412.x

Weatherall, D. J. (2010). The importance of micromapping the gene frequencies for the common inherited disorders of haemoglobin. British Journal of Haematology, 149(5), 635–637. https://doi.org/10.1111/J.1365-2141.2010.08118.X

Weatherall, D. J., & Clegg, J. B. (2001). Inherited haemoglobin disorders: an increasing global health problem. Bulletin of the World Health Organization, 79(8), 704. /pmc/articles/PMC2566499/?report=abstract
Wechsler, D. (2008). Wechsler adult intelligence scale–Fourth Edition (WAIS–IV). San Antonio, TX: NCS Pearson, 22(498), 1.
Wechsler, D. (2009a). Test of premorbid functioning. San Antonio, TX: The Psychological Corporation.
Wechsler, D. (2009b). Wechsler Memory Scale - Fourth Edition: Technical and Interpretive Manual. Psychological Corporation.
Weiss, L. G., Keith, T. Z., Zhu, J., & Chen, H. (2013). WAIS-IV and Clinical Validation of the Four-and Five-Factor Interpretative Approaches. Journal of Psychoeducational Assessment, 31(2), 94–113. https://doi.org/10.1177/0734282913478030
Weiss, M. G., Ramakrishna, J., & Somma, D. (2006). Health-related stigma: Rethinking concepts and interventions 1. Psychology, Health & Medicine, 11(3), 277–287. https://doi.org/10.1080/13548500600595053
Werry, A. E., Daniel, M., & Bergström, B. (2019). Group Differences in Normal Neuropsychological Test Performance for Older non-Hispanic White and Black / African American Adults. Neuropsychology, 33(8), 1089. https://doi.org/10.1037/NEU0000579
Wilcox, R. (2003). Applying Contemporary Statistical Techniques. In Applying Contemporary Statistical Techniques. Academic Press. https://doi.org/10.1016/B978-0-12-751541-0.X5021-4
Willshire, D., Kinsella, G., & Prior, M. (1991). Estimating WAIS-R IQ from the national adult reading test: A cross-validation. Journal of Clinical and Experimental Neuropsychology, 13(2), 204–216. https://doi.org/10.1080/01688639108401038
Wilson Schaeffer, J. J., Gil, K. M., Burchinal, M., Kramer, K. D., Nash, K. B., Orringer, E., & Strayhorn, D. (1999). Depression, Disease Severity, and Sickle Cell Disease. Journal of Behavioral Medicine, 22(2), 115–126. https://doi.org/10.1023/A:1018755831101
Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. Cognition, 13(1), 103–128. https://doi.org/https://doi.org/10.1016/0010-0277(83)90004-5
Wong, H. K., Stephen, I. D., & Keeble, D. R. T. (2020). The Own-Race Bias for Face Recognition in a Multiracial Society. Frontiers in Psychology, 11, 509636. https://doi.org/10.3389/FPSYG.2020.00208/BIBTEX
Woods, S. P., & Norman, M. A. (2022). Do Black lives matter to clinical neuropsychologists? An introduction to a special issue. The Clinical Neuropsychologist, 36(2), 209–213. https://doi.org/10.1080/13854046.2021.2020906
Yager, J. A., & Ehmann, T. S. (2006). Untangling Social Function and Social Cognition: A Review of Concepts and Measurement. Psychiatry, 69(1), 47–68. https://www.proquest.com/scholarly-journals/untangling-social-function-cognition-review/docview/220697881/se-2?accountid=11862
Young, L., & Saxe, R. (2009). An fMRI Investigation of Spontaneous Mental State Inference for Moral Judgment. Journal of Cognitive Neuroscience, 21(7), 1396–1405. https://doi.org/10.1162/JOCN.2009.21137
Zwicker, H. M., Fay-McClymont, T. B., Hou, S. H. J., Cho, S., McDonald, K., Guilcher, G. M. T., Yeates, K. O., Brooks, B. L., & Schulte, F. S. M. (2024).

Social adjustment in children diagnosed with sickle cell disease: A retrospective study. Pediatric Blood & Cancer, 71(3), e30807. https://doi.org/https://doi.org/10.1002/pbc.30807

7. APPENDICES

7.1 Appendix A: NHS Ethical Approval

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Miss Sekaylia Gooden
School of Psychology, University of East London
Water Lane
London
E15 4LZ

Email: approvals@hra.nhs.uk
HCRW.approvals@wales.nhs.uk

31 July 2023

Dear Miss Gooden

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**Social Cognition and Sickle Cell Disease**
IRAS project ID:	**323707**
REC reference:	**23/NW/0231**
Sponsor	**University of East London**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

7.2 Appendix B: NHS Hospital Local Access Approval

[redacted]

GSTFT ref: LOA

Date: 22/01/2024

[redacted]

[redacted]
research team before you commence your research at that site.

In accepting this letter[redacted]
confirms your right of access to conduct research through the organisation for the purpose and on the terms and conditions set out below. This right of access commences on **22/01/2024** and ends on **20/09/2024** unless terminated earlier in accordance with the clauses below.

As an existing NHS employee you do not require an additional honorary research contract with the participating organisation(s). The organisation(s) is/are satisfied that the research activities that you will undertake in the organisation(s) are commensurate with the activities you undertake for your employer. Your employer is fully responsible for ensuring such checks as are necessary have been carried out. Your employer has confirmed in writing to this organisation that the necessary pre-engagement checks are in place in accordance with the role you plan to carry out in [redacted]

You have a right of access to conduct such research as confirmed in writing in the letter of permission for research from this organisation. Please note that you cannot start the research until the Principal Investigator for the research project has received a letter from us giving the organisation(s) permission to conduct the project.

[redacted]

This Letter of Access is being issued with the understanding that your substantive employer/HEI has undertaken a risk assessment in light of the coronavirus pandemic and has deemed it safe for you to return to work.

[redacted]

7.3 Appendix C: Participant Information Sheet

Investigating Social Cognition And Sickle Cell Disease

PARTICIPANT INFORMATION SHEET

You are invited to participate in a research study conducted by Sekaylia Gooden. Before you agree it is important you understand what your participation would involve. The purpose of this letter is to provide you with the information you need to consider in deciding whether to participate. Please take time to read the following information carefully. Your participation will not affect the care you receive, and there will be no personal benefit from taking part in the research.

Who has approved the study?
The study is sponsored by the University of East London and has received ethical approval.

Who am I?
My name is Sekaylia Gooden, I am a postgraduate student in the School of Psychology at the University of East London. This research is being conducted as part of my Professional Doctorate in Clinical Psychology.

What is the research?
I am conducting research exploring cognitive functioning in people who have a diagnosis of Sickle Cell Disease, with an emphasis on social cognition.

Cognitive functioning includes learning, reasoning, remembering, problem-solving, , and attention. Social cognition refers to the way in which people use these skills in our social lives.

Description
Research suggests that people with a diagnosis of Sickle Cell Disease are more at risk for experiencing difficulties with, for example, attention, memory and organisation. Also, people living with Sickle Cell Disease are more likely to experience difficulties with their well-being and relationships. These findings suggest a potential link between cognitive function, well-being and social relationships for people within the Sickle Cell community.

Why have you been asked to participate?
You have been invited to participate as you have a diagnosis of Sickle Cell Disease, and you are currently receiving treatment within the Haematology department [redacted] Whether you decide to take part or not, this will not affect the care you are receiving within the Haematology department now or in the future.

What will your participation involve?
If you agree to participate, you will be asked to complete a series of paper and pencil tasks which measure cognitive functioning e.g., attention, memory, organisation and social cognition. These tasks will take approximately 1.5 hours to complete.

What are the risks of taking part?
You might find the tasks tiring. To minimise this, you will be offered breaks throughout the meeting. Following your participation, you will receive a letter which will provide a brief summary of your results. Performance on these tasks can sometimes highlight areas of strength and weaknesses in cognitive functioning, your clinician can discuss these with you if you wish.

In the instance that you might become distressed at any stage of testing, a need and risk assessment will be undertaken where appropriate. This might result in signposting to voluntary or third sector services if there is a need. Additionally, if risk to self is reported or there is an additional need for a formal assessment the researcher may also signpost to your GP.

How will we use information about you?
We will record scores from the paper-and-pencil tasks you will complete, and also some. We will also use some information about you. This will include:

- your age
- your sex/gender
- years of education, and
- medical history e.g., sickle cell diagnosis.

Your name will be recorded on the consent form only and will be kept separately from your scores and other information. The information will be used to ensure that data collection is done correctly. Once the study has been completed, we will retain some information to cross check the results. Please note that our reports will be written in a way that no-one can identify you as a participant within the study. All data will be anonymised.

Information you provide will be kept confidential. This means that it will not be shared with anyone apart from where you have asked to share information with the services responsible for your care. However, we may need to tell services (break confidentiality) if you disclose a risk of harm to yourself or others. You will be informed should this happen.

What will happen to the information that you provide?
We plan to publish the findings of the study. All data included in any publications or presentations will be fully anonymised. This information will be accessible to the public via the UEL repository, which is a platform which publishes doctoral research projects.

All identifiable information used for the research study will be kept securely, with hard copies stored in a locked cabinet on an NHS site and electronic data encrypted. All identifiable information used for the study will be destroyed at the end of the study. Anonymised electronic data will be kept for up to 5 years post study, for publication purposes.

What if you want to withdraw?
You are free to withdraw from the research study at any time without giving a reason. There will be no negative impact on the care you receive if you choose to withdraw from the study. You may also request to withdraw your data, even after you have participated, provided that this request is made within 6 weeks of the data being collected (after which point the data will have been anonymised for analysis, so withdrawal will not be possible).

What are your choices about how your information is used?
You can stop being part of the study at any time, without giving a reason, as long as you ask to do this within 6 weeks of the data being collected. After 6 weeks we will have started to analyse the data so it would not be possible to withdraw your data. We need to manage

your records in specific ways for the research to be reliable. This means that we won't be able to let you see or change the data we hold about you.

Where can you find out more about how your information is used?
You can find out more about how we use your information

- at www.hra.nhs.uk/information-about-patients/

Contact Details
If you would like further information or have any questions or concerns, please do not hesitate to contact me:
Main researcher: Sekaylia Gooden
Email: U2195514@UEL.AC.UK

If you have any questions or concerns about how the research has been conducted, please contact the research supervisor and/or the Patient Liaison Service (PALS) of the [redacted]
OR
Dr Matthew Jones Chesters. School of Psychology, University of East London, Water Lane, London E15 4LZ. Email: m.h.jones-chesters@uel.ac.uk
OR
PALS, the hospital's patient liaison services. Freephone: 020 7188 8801 or Email: pals@gstt.nhs.uk

7.5 Appendix D: Consent Form

UNIVERSITY OF EAST LONDON

Consent to participate in a research study

Investigating Social Cognition And Sickle Cell Disease

Please Initial Box

I have read the information sheet and have been given a copy to keep. The nature and purpose of the research have been explained to me, and I have had the opportunity to ask questions about this information.	☐
I understand what is being proposed and the procedures in which I will be involved.	☐
I understand my involvement and the data collected, will remain strictly confidential. Only the researcher(s) involved in the study and clinicians directly related to your care will have access to identifying data. We may break confidentiality if you disclose a risk of harm to yourself or others.	☐
I understand what will happen once the research study has been completed.	☐
I understand that I can withdraw my data from the research study up to 6 weeks from the date of assessment. After 6 weeks, the researcher reserves the right to use my anonymous data.	☐
I understand that the researcher may signpost to voluntary or third sector services and/or my GP should I become distressed at any stage of testing or disclose risk to self.	☐
I consent to participate in the study.	☐

Participant's Name (BLOCK CAPITALS)

……

Participant's Signature

……

Researcher's Name (BLOCK CAPITALS)

……

Researcher's Signature

7.6 Appendix E: Research Integrity

OXFORD UNIVERSITY PRESS

epigeum

Certificate

Number: 0980950383

This is to certify that

Sekaylia Gooden
of University of East London

Successfully completed the course

Research Integrity: Core

Good research conduct	80%
Irresponsible research practices	80%
Planning your research	100%
Managing and recording your research	100%
Data selection, analysis and presentation	100%

as part of the Epigeum Online Course System with a score of 91%.

Dated: 23 June 2022