VALIDATION OF THE NEUROPSYCHOLOGICAL ASSESSMENT BATTERY SCREENING TOOL (S-NAB) IN PARTICIPANTS WITH TRAUMATIC BRAIN INJURY IN THE UK

by

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CONTENTS

Thesis Introduction

This thesis is comprised of three chapters which encapsulate my research experiences over two different clinical placements. Despite the inclusion of opposing content, I believe that only by synthesising my work into one complete document have I been able to fully reflect upon what I have gained from undertaking the MRes in Clinical Psychology.

Chapter One: An NHS Ethics Application

The primary focus of my autumn research placement was to organise, draft and submit an NHS ethics application. Our project proposed to investigate the validity of the Neuropsychological Assessment Battery Screening Tool (S-NAB) in both patients with traumatic brain injury (TBI) and in orthopaedic controls. In order to gain ethical approval for the research project from the NHS, I was required to complete an online application using the Integrated Research Application System (IRAS).

In order to do this, I firstly researched the subject field at great length to produce a mini literature review and rationale for our research study. I then presented this information at a research team meeting, which was used in conjunction with the expertise of others, to inform a number of decisions prior to finalising the research design and completing the online form to the level of detail required. After submitting the application, myself and two members of the research team were required to attend a National Research Ethics Service (NRES) committee meeting to discuss our research proposal with a panel of experts. Following this, and after making appropriate amendments, we obtained a favourable opinion to proceed with the research.

Thus, Chapter One of this thesis describes four of the core decisions that were made by the research team prior to submission for ethical approval.

Chapter Two: Qualitative Data Analysis

For my second research placement I conducted Interpretative Phenomenological Analysis (IPA) on the transcripts from semi-structured interviews with six young girls diagnosed with either Central Precocious Puberty (CPP) or Premature Adrenarche (PA). As I used IPA in my Undergraduate dissertation, I was eager to improve upon the basic skills that I had developed previously.

I obtained the dataset fully transcribed and briefly met with the researcher who had conducted the interviews in order to gain background information on the sample. At this stage of the placement, I was keen to work independently in order to challenge my own research skillset. Thus, I completed the systematic process of coding and theme-building and attempted to generate a coherent portrayal of the data. Following peer supervision and discussion of themes, I was able to produce an analysis which I believe accurately depicts the experiences of these young girls with CPP/PA.

Chapter Three: An Empirical Research Study

The third and final chapter of this thesis contains a quantitative research study detailing an initial investigation into the construct validity of the S-NAB in persons with TBI. After obtaining approval from the Research and Development trust at University Hospitals Birmingham (UHB), I was able to collect some of the data included in the analysis.

The analysis revealed significant associations between the S-NAB and the comparative battery of neuropsychological tests, which provides initial support for the construct validity of the S-NAB in persons with TBI. As the data collected for this thesis was collected for

preliminary investigation alone, the results obtained will be used to guide a larger study which is planned to take place over the next few years.

Reflection

Instead of discussing each of my clinical research placements separately, I have chosen to reflect upon my experiences of the MRes in Clinical Psychology as a whole. Upon commencement of the course, I set myself a number of goals which I hoped to achieve over the 12-month research degree:

- I wished to improve upon my skills in both qualitative and quantitative research, and apply these within more than one clinical population.
- I aimed to improve upon a number of key transferable skills that would enhance my credentials as an aspiring professional within the field of Clinical Psychology.
- I hoped to undertake a research placement within an NHS setting in order to gain first-hand experience of working within a clinical service and conducting research within the NHS.

In terms of my set goals, I was fortunate enough to complete two very different clinical placements that allowed me to produce both quantitative and qualitative research in two extremely diverse clinical populations. Prior to this course, I had no experience with either TBI or CPP/PA and so I feel very fortunate to have widened my knowledge of two further clinical populations.

For both research placements I was required to utilise very different transferable skills. On placement two, I worked independently by managing my own workload and setting myself personal targets. In particular, I had to ensure that I carefully stuck to deadlines by

managing my time effectively, which is extremely challenging when conducting thorough qualitative analysis. In addition to this, I developed self-awareness, improved my attention to detail and took responsibility for the quality of my own work.

On the other hand, as a research assistant on the S-NAB project I was expected to contribute as part of a highly specialised clinical research team. I was required to complete numerous set tasks and communicate effectively with team members over multiple NHS sites. Thus, as a result of such differing experiences, I believe I have had the opportunity to develop a multitude of transferable skills that I will take forward and utilise extensively.

In regards to personal development, I feel as though I played an active and integral role in the decision-making process on the S-NAB project. Despite all other members of the research team specialising in TBI, I felt as though my contribution was valued and influential over the decisions made regarding the research project. This experience provided me with the confidence to enter into my summer-term placement with enthusiasm and a good understanding of the assessment procedure involved in testing.

Finally, as part of the S-NAB research project I was given the opportunity to contribute towards data collection by completing testing sessions with individuals who had sustained a TBI. Thus, I obtained an honorary contract as an Assistant Psychologist within the Neuropsychology department at UHB. Not only did this enhance my clinical skills and provide me with the opportunity to conduct neuropsychological assessments, as a result of this experience I gained a first-hand insight into the day-to-day functioning of the NHS.

After now completing my thesis, I believe that all of my initial targets were achieved throughout my clinical placements. Moreover, I feel as though this research degree has

provided me with a platform on which I have developed both personally and professionally. As a research assistant, I have been given the opportunity to work independently and build confidence in my own abilities. Thus, I am extremely proud of the content included in this research thesis, which has been produced as a result of my own hard work and dedication.

CHAPTER ONE:

AN NHS ETHICS APPLICATION: EXPLORATION OF KEY DECISIONS IN THE S-NAB RESEARCH DESIGN

Introduction

Traumatic brain injury (TBI) is one of the most cited causes of acquired cognitive deficiency in individuals of all ages (Thurman, Coronado & Selassie, 2007). Impairment is variable; injuries occur on a continuum of severity ranging from minor complaints requiring minimal medical attention, to critical incidents that result in permanent disability or even death (Iverson, Holdnack, & Lange, 2013). The administration of neuropsychological tests is an essential component involved in post-injury assessment (Iverson, Brooks & Holdnack, 2008). Literature indicates that accurate identification of cognitive impairment following a TBI is predictive of an individual's future prognosis; results are used to guide the recommendation of interventions to alleviate injury and the amount of future support required by individuals (Powell, Ferraro, Dikmen, Temkin & Bell, 2008). Ideally, patients undergo a thorough neuropsychological assessment that provides a comprehensive evaluation of the five principle cognitive domains (language, memory, executive functioning [EF], attention and spatial reasoning) following head trauma (Hofgren, 2009). However, this assessment procedure requires extensive administration time, which often results in patient frustration due to lower tolerance levels and heightened fatigue in people who are in acute and post-acute settings (Zgaljardic & Temple, 2010). Allen, Thaler, Cross and Mayfield (2013) suggest that a brief cognitive screening tool would be a more effective method of assessment during this time. A well validated and reliable screening tool would serve as a means of highlighting immediate cognitive strengths and limitations following a TBI, which can then be investigated in more depth during the initial stages of rehabilitation (Zgaljardic & Temple, 2010).

The research team were required to make a number of imperative choices regarding the design of the project prior to the application for NHS ethical approval. In this chapter, four of the most fundamental decisions are discussed in terms of scientific and practical reasoning:

(1) What is the rationale for selecting the Neuropsychological Assessment Battery Screening Tool (S-NAB) as a potential screening assessment for persons with a TBI?
(2) What is the rationale for selecting the Neuropsychological assessments included in the comparative test battery?
(3) What is the rationale for the inclusion of performance validity tests?
(4) What is the rationale for the inclusion of orthopaedic controls?

What is the Rationale for Selecting the Neuropsychological Assessment Battery Screening Tool (S-NAB) as a Potential Screening Assessment for Persons with a TBI?

Before selecting which cognitive screening instrument to investigate, a literature review was produced in order to ascertain the tests that are routinely used to identify cognitive impairment in patients with a TBI.

Due to the heterogeneity in cognitive impairment following a serious head injury, comprehensive neuropsychological evaluation is conducted to attain detailed information that can be used by clinicians to inform treatment planning (Allen et al., 2013). As a result of the diversity associated with acquired neuropsychological impairment, a substantial number of cognitive screening tests have been developed in order to assess various clinical populations (as discussed in the review by Cullen, O'Neill, Evans, Coen & Lawlor, 2007). Despite the large number of neuropsychological screening tools in existence, no single

instrument has received adequate agreement across professionals to warrant worldwide administration (Brodaty et al., 1998; Cullen et al., 2007). Further to this, few assessments have been validated within specific clinical populations such as TBI (McKay, Casey, Wertheimer & Fichtenberg, 2007).

In their review of neuropsychological batteries, Pawlowski, Segabinazi, Wagner and Bandeira (2013) identified five key screening instruments which are currently administered to patients who have suffered a TBI:

(a) The Mini Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975),
(b) The Addenbrooke's Cognitive Examination- Revised (ACE-R; Mioshi, Dawson, Mitchell, Arnold & Hodges, 2006),
(c) The Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005),
(d) The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, Tierney, Mohr & Chase, 1998),
(e) The Neuropsychological Assessment Battery Screening Tool (S-NAB; Stern & White, 2003)

In general, neuropsychological instruments should meet particular requirements before being considered for use within clinical care (Hofgren, 2009). A number of key prerequisites were identified following a review of the literature available. As previously stated, research has placed great emphasis on the need for brief Neuropsychological evaluation in the immediate aftermath of a TBI occurring (Zgaljardic & Temple, 2010). Further to this, and as a result of the lengthy rehabilitation required post-injury, parallel versions of a screening tool allow for clinicians to monitor the progression of an individuals' cognitive functioning over time (Allen et al., 2013). Ultimately, a comprehensive Neuropsychological assessment

should provide results on the functioning of all five core cognitive domains (Temple et al., 2009). In addition to this, an adequate screening tool should demonstrate sensitivity and specificity to cognitive impairment, which ensures that Type 1 and Type 2 errors are minimised (Pawlowski et al., 2013). The existing literature outlines that minimum acceptable levels of sensitivity and specificity should be above 0.60 for clinical utility (McKay, Wetheimer, Fichtenberg & Casey, 2008). In order to achieve this, Neuropsychological tests should have extensive normative data that accounts for age, gender and educational attainment, which allows for more accurate identification of impairment across all demographic backgrounds (Temple et al., 2009). Finally, it is imperative that cognitive screening tools are validated within the particular clinical populations for which they intend to be implemented (Donders & Levitt, 2012); verification is typically achieved through adequate research support. The following quality criterion was therefore developed in order to examine the suitability of using each of the five cognitive screening tests to assess patients with a TBI:

Table 1:
Quality criterion for screening tests

1. Can the screening instrument be administered in less than 1 hour?	Yes/No
2. Are there parallel versions of the screening tool available to allow for repeat testing?	Yes/No
3. Does the screening instrument cover all 5 cognitive domains?	Yes/No
4. Is there adequate research to demonstrate specificity and sensitivity for cognitive impairment?	Yes/No
5. Does the screening instrument have normative data that accounts for gender, age and previous education?	Yes/No

6. Is the screening instrument considered suitable for people with a TBI?	Yes/No

The screening tools listed above were assessed against these criteria.

The Mini Mental State Examination (MMSE)

The MMSE is considered the most widespread screening tool used to briefly assess cognitive deficiency in people with varying conditions worldwide (Cullen et al., 2007). Although predominantly used to identify dementia, the MMSE is cited within the literature as a candidate screening tool for TBI (Damian et al., 2011). The MMSE can be administered in approximately 10 minutes, giving a score that is "useful in quantitatively estimating the severity of cognitive impairment" (Tombaugh & McIntyre, 1992). Additionally, as a result of its extensive use, the test boasts a respectable amount of normative data that controls for differences in both age and previous education attainment (Crum, Anthony, Bassett & Folstein, 1993). However, the absence of parallel versions limits the opportunity for repeat testing. Further to this, despite an overwhelming presence throughout the literature, some research suggests that the MMSE is now outdated and largely insensitive to screening for cognitive impairment (Carone, Burns, Gold & Mittenberg, 2004; Gaber, 2008), especially when differentiating between adequately functioning individuals and those presenting with mild cognitive deficit (Pendlebury, Cuthbertson, Welch, Mehta & Rothwell, 2010). Fundamentally, the MMSE is unable to assess all five core cognitive domains, as its highly verbal content results in an absence of visuoperceptual and visuoconstructional data (Hofgren, 2009). In addition to this, the specificity and sensitivity of the MMSE has been continually questioned within the literature (Damian et al., 2011; Gaber, 2008; Naugle &

Kawczak, 1989). Originally, Nelson, Fogel and Faust (1986) observed very high false negative scores when using the MMSE. Most recently, Galioto and colleagues (2013) reported low sensitivity and specificity in detecting cognitive impairment, despite applying the most stringent cut-off values during data analysis. The inability to differentiate between individuals with and without dysfunction ultimately results in an inaccurate functional outcome prediction (Feher et al., 1992), and, in some cases, failure to detect gross cognitive impairment altogether (Gaber, 2008; Srikanth, Quinn, Donnan, Saling & Thrift, 2006). Finally, a number of studies have rejected the notion of the MMSE as a suitable cognitive screen following a TBI due to the discrepancies previously discussed (Gaber, 2008; Nys et al., 2005; Srivastava et al., 2006). In sum, Larner (2013) postulated that despite the inaccuracy and ineffectiveness of the MMSE, it provides a useful "benchmark" to compare against alternative cognitive screening tools.

Addenbrooke's Cognitive Examination (ACE-R)

The ACE-R was developed as a response to the criticisms of the MMSE (Gaber, 2008). It takes approximately 20 minutes to administer and was specifically designed to identify individuals with dementia (Mathuranath, Nestor, Berrios, Rakowicz & Hodges, 2000). The ACE-R is comprised of the MMSE, as well as further assessment material with a focus on memory and spatial functioning (Pendlebury, Mariz, Bull, Mehta & Rothwell, 2012). There are no parallel versions to allow for repeat testing. The ACE-R has demonstrated good sensitivity and specificity when administered on people with dementia (Larner, 2007; Larner & Mitchell, 2014), however, only one study to date has utilised the ACE-R on a sample of individuals with a TBI (Gaber, 2008). Their results evidenced that the ACE-R scored 72% sensitivity to cognitive impairment, in comparison to 36%, which was reported following the

administration of the MMSE on the same sample. However, despite reporting good sensitivity and specificity in their TBI study, Gaber (2008) proposed that clinical utility of the ACE-R is restricted by the distinct lack of normative data available. Existing normative data is limited to either healthy middle-aged and elderly performance or values for individuals diagnosed with dementia from the ages of 46 to 86 (Amaral-Carvalho & Caramelli, 2012). Thus, there is an absence of normative data in younger age groups (as detailed in Mioshi et al., 2006). With regards to administration of the ACE-R on individuals with a TBI, only Gaber's (2008) study is in existence. Until further research is conducted, the ACE-R cannot be considered as a suitable cognitive screening tool following a TBI.

The Montreal Cognitive Assessment (MoCA)

Fundamentally, designed as a short screen for global cognitive functioning, the MoCA was originally intended to identify mild cognitive deficit (Nasreddine et al., 2005). The test can be administered in approximately 10 minutes but does not possess parallel versions for repeat testing. Similar to the ACE-R, the MoCA assesses attention, memory, language, spatial and EF (Nasreddine et al., 2005). Research investigating the clinical utility of the MoCA has demonstrated good sensitivity and specificity in persons with dementia (Freitas, Simões, Marôco, Alves & Santana, 2012), Parkinson's disease (Nazem et al., 2009) and with individuals post-stroke (Cumming, Bernhardt & Linden, 2011). However, discrepancies can be found within the literature, as demonstrated by Godefroy and colleagues (2011) who reported that the high sensitivity of the MoCA was at the expense of low specificity. A further limitation of the MoCA surrounds the substantial absence of normative data available. Most recently, Julayanont, Phillips, Chertkow and Nasreddine (2013) suggested that further accumulation of normative data is required before the MoCA can be routinely

used within routine clinical practice. In addition to this, there is a limited amount of research available demonstrating the application of the MoCA on patients with TBI. Of the studies in existence, Wong and colleagues (2013) reported that the MoCA is "a useful and psychometrically valid tool for the assessment of gross cognitive functioning" in persons with a TBI. Conversely, de Guise and colleagues (2013) concluded that the MoCA was no better at identifying cognitively impaired individuals with a TBI than the MMSE; both tests demonstrated poor sensitivity to impairment following head trauma. Thus, further research is required to expand upon both normative and TBI data in regards to clinical utility of the MoCA.

The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

The review by Pawlowski and colleagues (2013) identified the RBANS as the most widely used cognitive screening instrument used to measure impairment in patients with TBI. Overall, the literature indicates that the RBANS is a reliable tool that provides a global impairment total, along with 5 individual index scores that are generated from the scores of 12 subtests. The five neurocognitive index scores explore Immediate Memory, Visuospatial/Constructional functioning, Language, Attention and Delayed Memory (Randolph et al., 1998). Administration of the RBANS has become more popular since its initial development due to advantages such as being brief in application, the provision of extensive normative data and the availability of parallel versions which allow for repeat administration (McKay, Casey, Wertheimer & Fichtenberg, 2007). As with the previously discussed cognitive screens, the RBANS was initially developed to assess for dementia (Randolph, 1998), however, it has since been utilised as a cognitive screening tool in a number of clinical populations such as Parkinson's disease (Yang, Garrett-Mayer, Schneider,

Gollomp & Tilley, 2009), Multiple Sclerosis (Beatty, 2004) and Huntington's disease (Randolph et al., 1998). The overall RBANS impairment total has been explored in depth, demonstrating good sensitivity and specificity (as summarised in McKay et al., 2008), however, validation of the individual index scores is lacking. McKay and colleagues (2007) highlighted this paucity in the literature and examined construct validity by correlating each of the five RBANS index scores with a battery of well-established neuropsychological tests. Two cognitive domains (Immediate and delayed memory, visuospatial/constructional) revealed moderate to strong correlations, however, the attention and language index scores demonstrated weak construct validity. This mirrors the findings of Larson, Kirschner, Bode, Heinemann and Goodman (2005). The RBANS has been used extensively to detect impairment following Acquired Brain Injury (Pachet, 2007) and TBI (Carone et al., 2004). Despite this, the RBANS fails to adequately assess EF, which is a core neurocognitive domain that is frequently disrupted in individuals with a TBI (Bivona et al., 2008). In addition to this, Zgaljardic and Temple (2010) hold the view that the RBANS is not specialised enough to accurately discriminate between the diverse neuropsychological presentations often observed following head trauma. Thus, despite the large number of advantages associated with the RBANS, an alternative screening tool which has been developed for specialised use within a TBI setting could prove more clinically useful (Zgaljardic & Temple, 2010).

The Neuropsychological Assessment Battery Screening Tool (S-NAB)

The NAB Screening module is one of the six components that make up the full Neuropsychological Assessment Battery. The S-NAB takes approximately 45 minutes to administer and has two parallel versions to allow for repeat testing (Stern & White, 2003). In addition to this, the S-NAB boasts substantial demographically corrected normative data

that accounts for age, gender and previous educational attainment (White & Stern, 2003). The S-NAB is structurally similar to the RBANS, as it provides an examination of overall cognitive functioning as well as five individual cognitive index scores: Attention, Language, Executive Functions, Memory and Visuospatial functioning. Most of the existing empirical research on the S-NAB has focused on patients with TBI, however, only six studies are available to date (Cannizzaro, Elliott, Stohl, Hasin & Aharonovich, 2014; Grohman & Fals-Stewart, 2004; Iverson, Williamson, Ropacki & Reilly, 2007; Temple et al., 2009; Zgaljardic & Temple, 2010; Zgaljardic, Yancy, Temple, Watford & Miller, 2011). Thus, validation of the S-NAB has been largely unexplored, specifically in regards to the construct validity of each of the individual index scores, and the sensitivity and specificity of the S-NAB in differentiating between impairment and adequate functioning. Initial research has demonstrated good sensitivity and specificity following the administration of the S-NAB on persons with a TBI (Temple et al., 2009). This preliminary research points towards the potential utility of the S-NAB compared with the other four tests discussed within both inpatient and rehabilitation settings following TBI (Zgaljardic & Temple, 2010). Thus, this gap in the literature provides an ideal platform on which to base the current research question.

Table 2:
Assessment of five neuropsychological screening tools against the quality criteria

	The MMSE	**ACE-R**	**The MoCA**	**The RBANS**	**The S-NAB**
1. Can the screening instrument be administered in less than 1 hour?	✓	✓	✓	✓	✓
2. Are there parallel versions of the screening tool available to allow for repeat testing?	✗	✗	✗	✓	✓
3. Does the cognitive screening instrument assess all five cognitive domains?	✗ (Absence of Spatial examination)	✓	✓	✗ (Absence of Executive Function examination)	✓
4. Is there adequate research to demonstrate specificity and sensitivity for cognitive impairment?	✗	✓ - In Dementia ✗ - In TBI	Mixed results	✓	✗ (Insufficient research available)
5. Does the screening tool have normative data that accounts for gender, age and previous education?	✓	✗	✗	✓	✓
6. Is the screening instrument considered suitable for use on persons with a TBI?	✗	✗	✗	✓	✓

What is the Rationale for Selecting the Neuropsychological Assessments Included in the Comparative Test Battery?

In order to test for the construct validity of the S-NAB index domains, a correlation between each index total and the scores from a matched "gold standard" neurocognitive test was deemed most appropriate. The following well-established neuropsychological assessments were selected following a review of the literature:

The Wechsler Adult Intelligence Scale (WAIS-IV; Wechsler, 2008) and Wechsler Memory Scale (WMS-IV; Wechsler, 2009)

Often paired together in clinical practice, the WAIS-IV and WMS-IV were considered ideal neuropsychological tests to validate the memory, language, attention and visuospatial S-NAB index scores. The WAIS-IV is comprised of four index domains that measure Verbal Comprehension, Perceptual Reasoning, Working Memory and Processing Speed (Wechsler, 2008). Alternatively, Auditory Memory, Visual Memory, Visual Working Memory, Immediate Memory and Delayed Memory are the five index scores assessed by the WMS-IV (Wechsler, 2009). The WAIS-IV and WMS-IV are considered "part of a comprehensive battery for assessing cognition" and have been used extensively to detect impairment following TBI (McKay et al., 2008). There is a wealth of validation data available which details the sensitivity and specificity of the WAIS-IV and WMS-IV (and previously the WAIS-III and WMS-III) when identifying cognitive impairment following a TBI (Iverson, Holdnack & Lange, 2013). In addition to this, both tests boast a comprehensive set of demographically adjusted norms that take into account age, gender and education (Iverson, Holdnack & Lange, 2013; Wechsler, 2009).

The Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan & Kramer, 2001)

The D-KEFS is an extremely well-established measure of EF in both clinical and non-clinical populations (as reviewed in Delis, Kramer, Kaplan & Holdnack, 2004). The test comprehensively examines the components associated with EF by exploring verbal and spatial performance in tasks which demand the demonstration of planning, inhibition and problem solving abilities (Delis & Kramer, 2004). The D-KEFS is comprised of a number of "established" tasks (e.g., Stroop) as well as more recently designed procedures as one comprehensive measure of EF (Delis, Kaplan & Kramer, 2001). It has comprehensive normative data and extremely high validity, as supported by a wealth of literature (as summarised in Homack, Lee & Riccio, 2005). The D-KEFS has been utilised within numerous neuropsychological studies and individuals with TBI are one of the most extensively studied clinical populations (Heled, Hoofien, Margalit, Notavich & Agranov, 2012).

What is the Rationale for the Inclusion of Performance Validity Tests?

The issue of performance legitimacy during cognitive testing has been researched in depth for many years (Larrabee, 2012). Guidelines from the British Psychological Society (BPS) support the inclusion of performance validity testing as part of routine clinical assessment of cognition in adults (BPS, 2009). Investigating the validity of participants' assessment performance is imperative, as failure to detect invalid test scores may result in inaccurate impairment diagnosis (Larrabee, 2012). The term "performance validity" was put forward by Larrabee (2012) to replace previously utilised, less accurate terms such as "response bias" or "effort". The possibility that individuals inaccurately report symptoms or underperform on psychometric testing for external incentives such as material gain (often compensation or disability claims) or avoidance of legal responsibility (such as military duties, criminal

sentencing) has been a concern raised worldwide (Binder, 1990). Larrabee, Greiffenstein, Greve and Bianchini (2007) opined that a number of factors must be present to warrant the use of terminology such as "Malingered Neurocognitive Dysfunction": the individual must (1) have a significant external incentive, (2) consistently demonstrate invalid test performance on numerous assessments, and (3) demonstrate performance that would be considered atypical of severe impairment.

In general, performance validity testing is designed to be simple to complete and is validated to be insensitive to all but the most profound cognitive impairment (e.g. Dementia) (BPS, 2009). Thus, failure of performance validity tests is rare, and cannot be explained by potentially confounding factors such as pain, mood, or cognitive functioning (Larrabee, 2012). As a result, failure on such tasks is often considered indicative of performance invalidity, which therefore signals that the individual's results should not be wholly relied upon (Delis & Wetter, 2007).

There exists a wealth of literature demonstrating the impact of invalid performance, which is considered as more prominent in conditions such as mild TBI (Green, Rohling, Lees-Haley & Allen, 2001). Binder (1993) reported that 33% of their participants with a mild TBI who were involved in compensation claims had exaggerated cognitive impairments. Further to this, in a study by Green (2007), results obtained from conducting the California Verbal Learning Test were not able to discriminate between impairment and adequate functioning in individuals following a TBI until those who failed a performance validity test were removed. A comprehensive evaluation of further studies detailing the impact of performance invalidity can be found in a review by Rohling and colleagues (2011).

In order to detect inaccurate scoring, a number of performance validity tests have been embedded within well-established neuropsychological batteries used to assess cognitive impairment (Larrabee, 2012). Two of the most clinically utilised performance validity tests are the Word Memory Test (WMT; Green, Allen & Astner, 1996) and the Test of Memory Malingering (TOMM; Tombaugh, 1996). Both measures were developed to recognise performance invalidity and have been researched in depth (Lally, 2003; Gervais, Rohling, Green & Ford, 2004). For example, Stevens, Friedel, Mehren and Merten (2008) found that a pass or failure on the WMT was a better predictor of an individuals' neuropsychological profile rather than severity of injury as recorded at hospital admittance. Both the WMT and TOMM appear largely unaffected by age, educational attainment and moderate cognitive deficit (Larrabee, 2012). Thus, in order to monitor for performance invalidity, the WMT and TOMM were selected as part of the well-established battery of comparative neuropsychological measures included in the current study. It was hypothesised that the inclusion of two measures of performance validity, administered at different stages of testing, would increase sensitivity to detecting invalid performance. Failure to pass the WMT or TOMM would lead to exclusion of participant scores from data analysis.

What is the Rationale for the Inclusion of Orthopaedic Controls?

The second research objective was to examine the sensitivity and specificity of the S-NAB. In order to do this, it was imperative to demonstrate that the S-NAB is able to correctly identify cognitive impairment in persons who had suffered a TBI, and thus differentiate these individuals from persons who had not previously suffered head trauma. Throughout empirical research, the demographic background of both the subject and control group is a factor that is highly influential over the results obtained (Landre, Poppe, Davis, Schmaus &

Hobbs, 2006). Thus, the inclusion of matched controls is essential to any robust study design. In terms of TBI, an adequately matched control group serves as an indicator of the performance of non-injured persons, allowing for observation of the impact of head trauma (Mathias, Dennington, Bowden & Bigler, 2013).

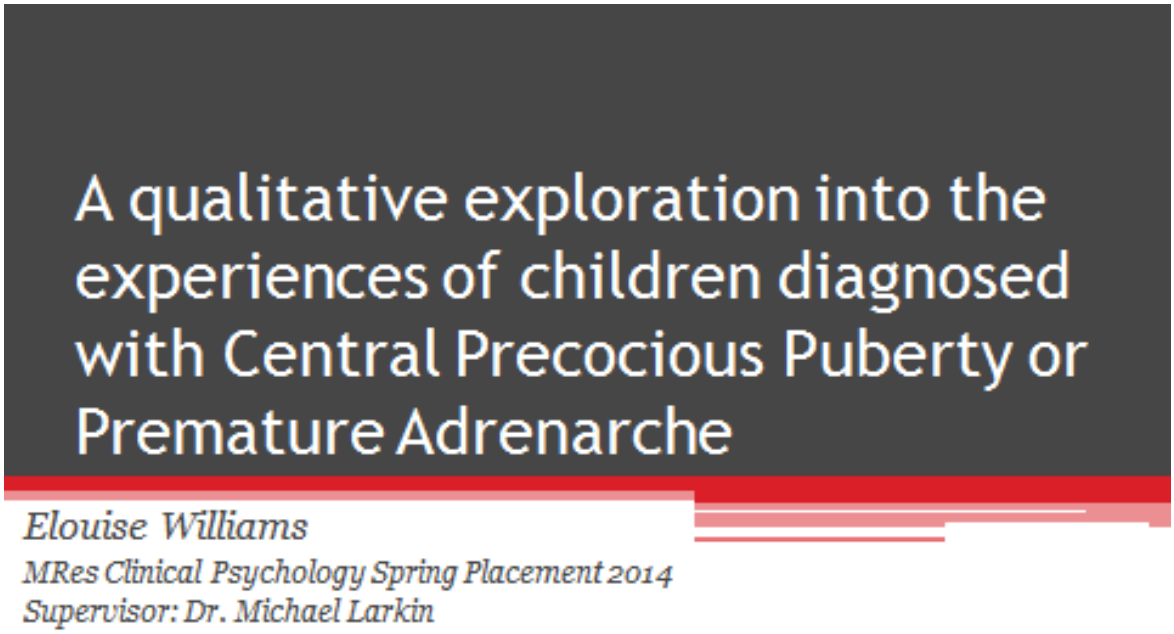
Over recent years, it has been recommended to match individuals who had experienced a TBI with orthopaedic controls who had suffered injury that was devoid of head trauma (Landre et al., 2006; Taylor & Alden, 1997). This is due to similar background profiles of orthopaedic controls, along with their experiences of receiving treatment for an injury (Mathias et al., 2013). More specifically, research has suggested that individuals who experience non-head-related injuries are more likely to have similar demographic (e.g., gender, age, socio-economic background, education attainment), and psychosocial (e.g., risk taking behaviours observed more often in young males) presentations to those who are hospitalised with a TBI (Fischer, Trexler & Gauggel, 2004). In addition to this, due to the time spent in hospital, orthopaedic control subjects are also more likely to have had similar injury-related experiences (e.g., medication administration, pain management, and stress during hospitalisation) to individuals with a previous history of TBI (Satz, et al., 1999). This experience discriminates orthopaedic controls from alternatively demographically matched members of the community, ensuring that orthopaedic subjects are more suitable for use within clinical research on TBI (Mathias et al, 2013).

Reflection

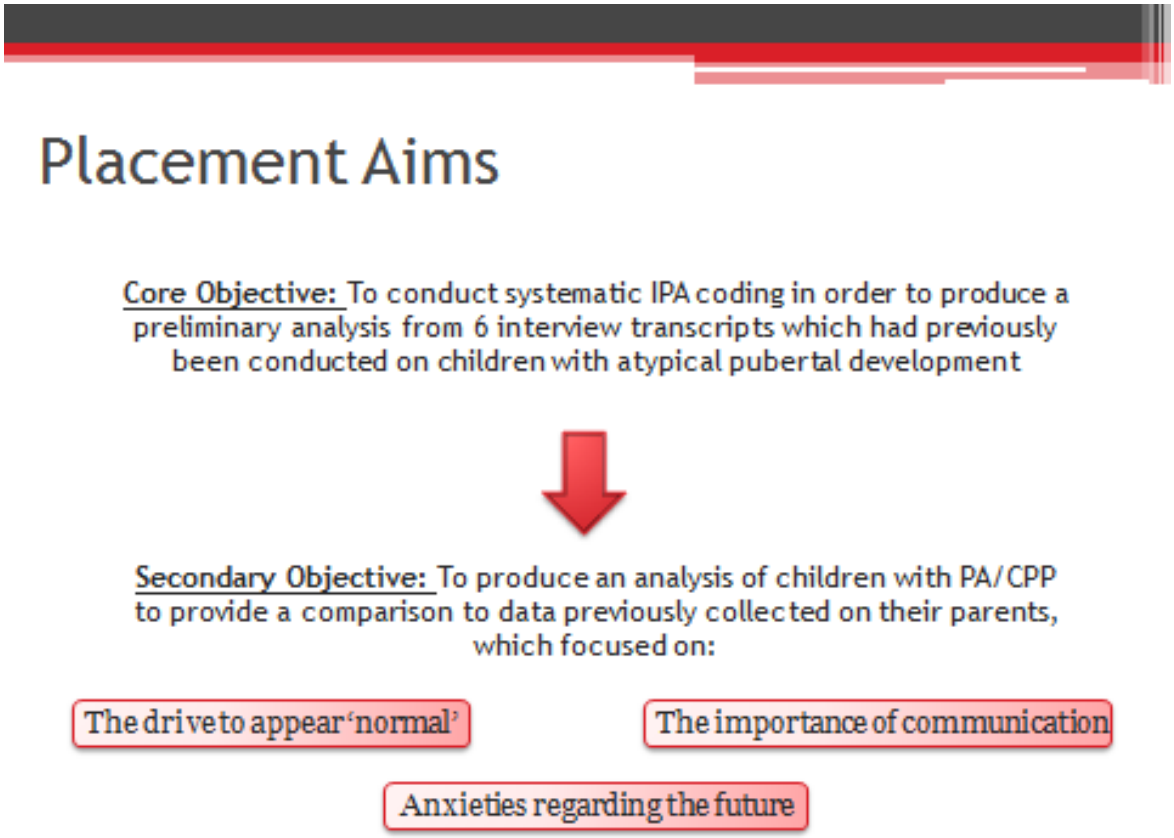
See Appendix 1A for Chapter One reflection.

CHAPTER TWO:

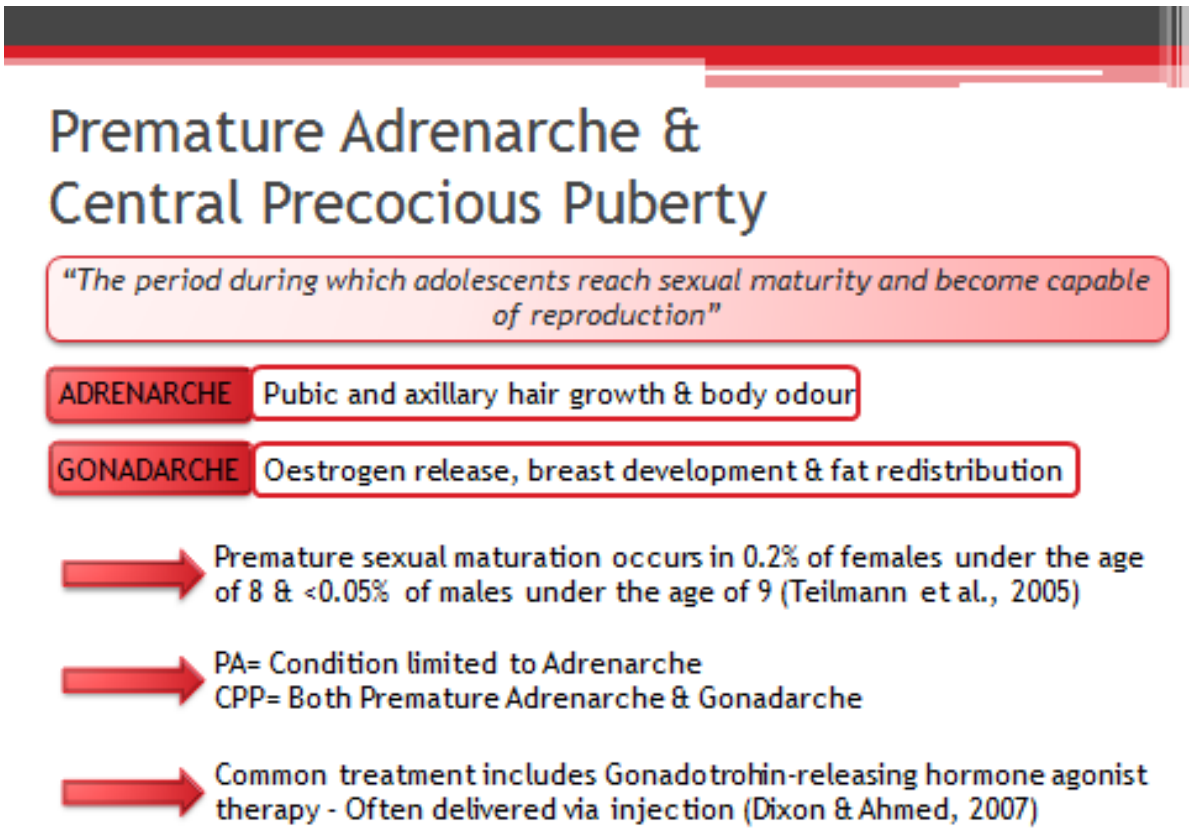
A QUALITATIVE EXPLORATION INTO THE EXPERIENCES OF CHILDREN DIAGNOSED WITH CENTRAL PRECOCIOUS PUBERTY OR PREMATURE ADRENARCHE



For my second placement, I performed a qualitative analysis on six transcripts from interviews that had been previously conducted with young girls diagnosed with Central Precocious Puberty (CPP) or Premature Adrenarche (PA).



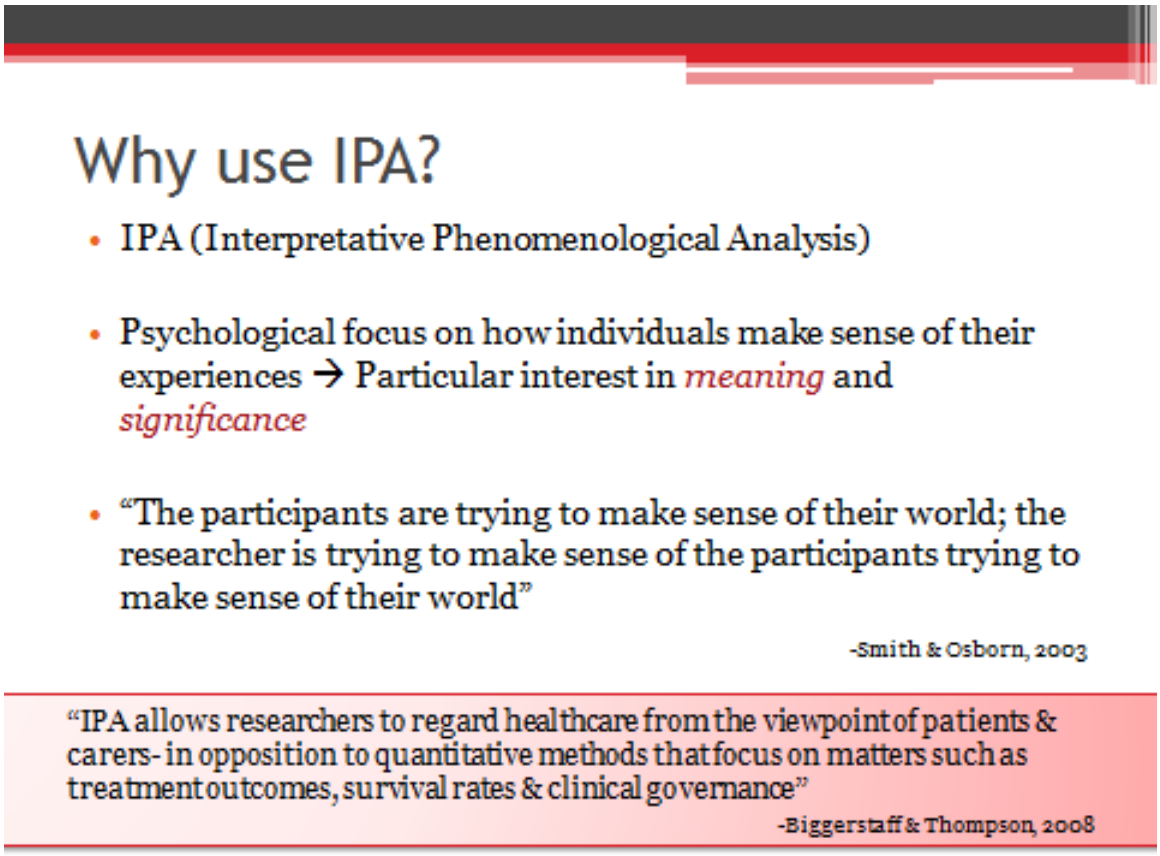
The primary objective of my placement was to produce a detailed phenomenological account of the experiences of young girls with CPP or PA. To do this, I used Interpretative Phenomenological Analysis (IPA) to produce a comprehensive overview of any themes that emerged from the interview data. It was planned that my analysis would contribute as part of a larger study that aimed to gain insight into the lived experiences of premature sexual maturity. Semi-structured interviews had been conducted with the girls' mothers as part of a previous MRes Clinical Psychology placement. Analysis of these exchanges generated three core themes: 'The drive to appear normal', 'Anxieties regarding the future' and 'The importance of communication'. Thus, attainment of the children's data would allow for experiential comparisons, as well as providing a more comprehensive insight into the direct impact of having a diagnosis of PA or CPP.



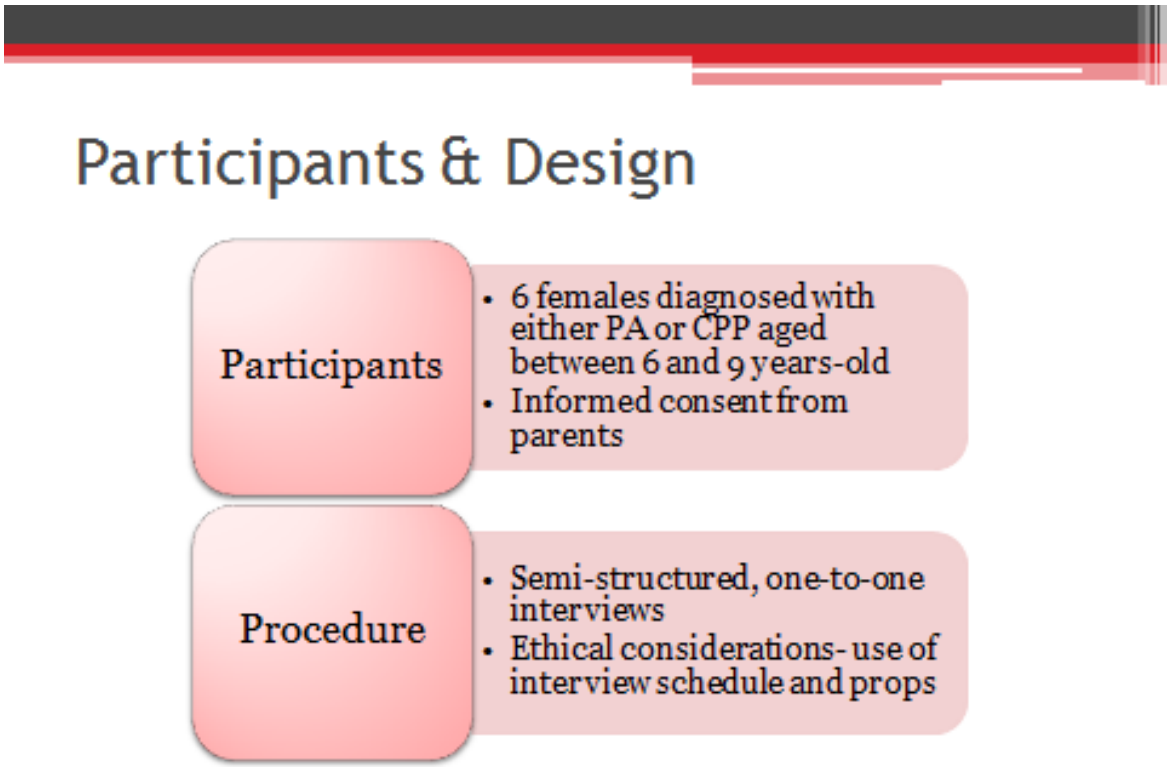
”Puberty” is defined as “The period during which adolescents reach sexual maturity and become capable of reproduction” (“Puberty,” Oxford English online dictionary). Puberty is a stage of considerable physical, cognitive and social development that results from two separate processes: Adrenarche (Primarily the growth of pubic and axillary hair) and Gonadarche (The release of oestrogen that leads to breast development and fat redistribution) (Dixon & Ahmed, 2007). Typically, Adrenarche and Gonadarche occur in parallel, leading to the maturation of secondary sexual characteristics in girls and boys over the ages of 8 and 9, respectively. However, a small proportion of young children experience pubertal development before these milestones.

Sexual precocity occurs in 0.2% of females under the age of 8 years-old, whilst fewer than <0.05% of males experience characteristics of puberty before the age of 9 (Teilmann,

Pedersen, Jensen, Skakkebæk & Juul, 2005). Early pubertal development can take place in alternative forms and may consist of a multitude of physical repercussions. Two of the most common diagnoses are 'Premature Adrenarche' and 'Central Precocious Puberty'. Children diagnosed with CPP experience both Adrenarche and Gonadarche, which includes the commencement of menstrual bleeding in girls. Alternatively, a diagnosis of PA is limited to Adrenarche alone. Individuals diagnosed with early onset puberty often receive treatment in the form of Gonadotropin-releasing hormone agonist therapy, where regular injections are administered in an attempt to delay sexual development.



Interpretative Phenomenological Analysis is a qualitative approach that encourages the researcher to explore a phenomenon through the exploration of individuals' lived experiences. IPA has been used extensively by researchers attempting to gain insight into the experiences of a number of distinct clinical populations (Biggerstaff & Thompson, 2008). In terms of the current research project, IPA was selected as a useful analysis style for thoroughly exploring the experiences of a relatively novel clinical population.

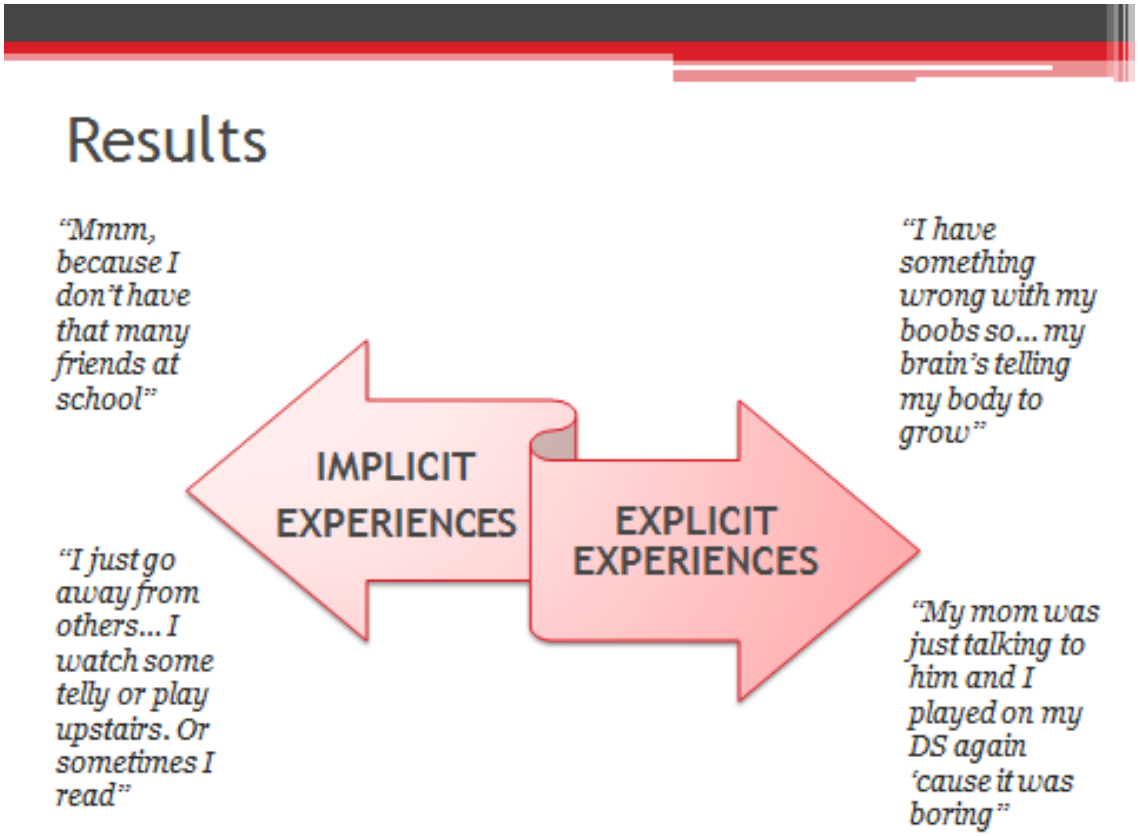


Six girls between the ages of 6 and 9 years-old who had been diagnosed with either PA or CPP were interviewed by a separate researcher. Prior to each semi-structured interview, informed written consent was obtained from parents who were present with their child throughout. Due to the sensitive nature of the research topic and the young age of participants, the researcher was not permitted to directly question children about their diagnosis unless the topic had been raised by participants first. Thus, the researcher used a number of indirect techniques in order to provoke conversation relating to their experiences of PA/CPP. One way in which this was achieved was through the use of props. For example, participants were presented with a selection of 'worry cards', which showed images of general everyday childhood worries (such as the dentist and monsters) alongside issues that may be associated with a diagnosis of early onset puberty (i.e., needles and self-image). A number of different child-based props were utilised throughout the interviews to indirectly

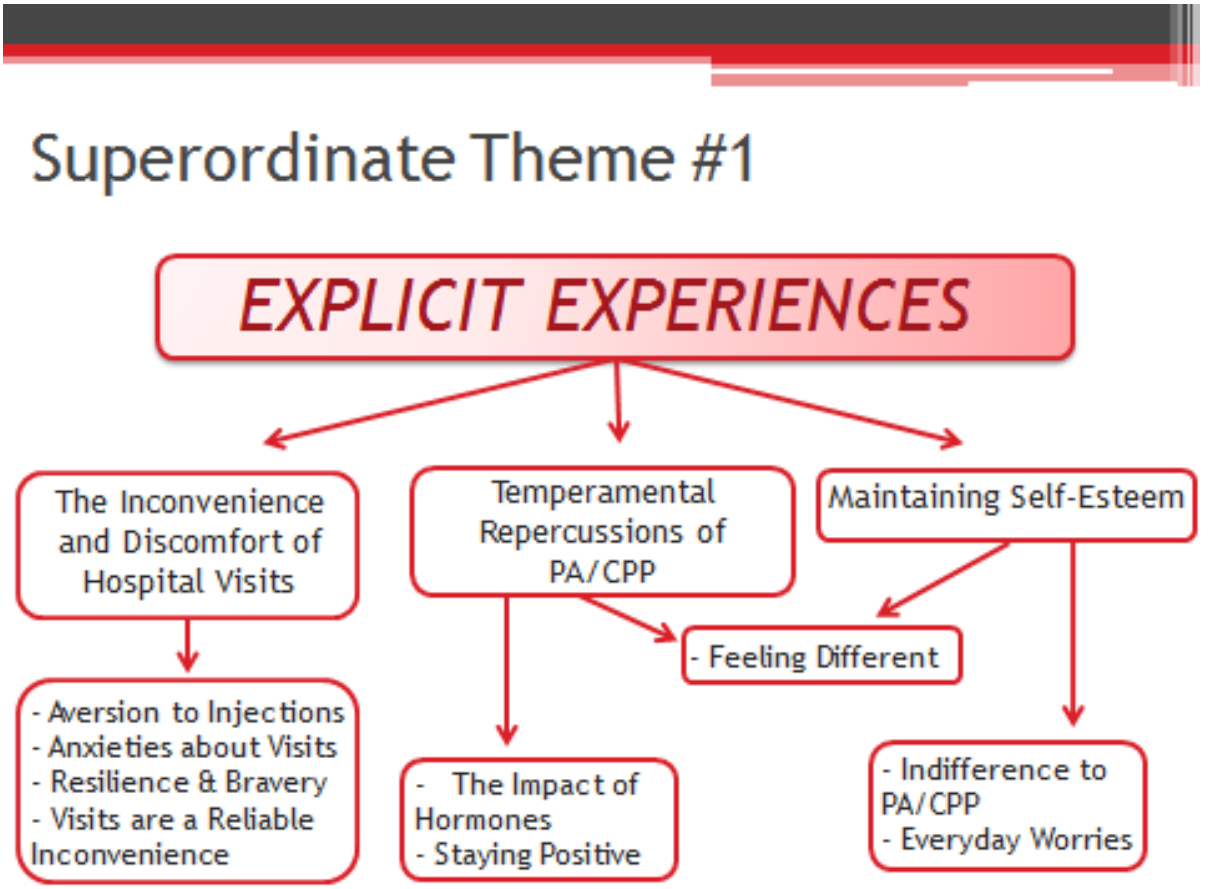
facilitate conversation that related to the girls' experiences of having a diagnosis of PA/CPP. Interviews were recorded and transcribed verbatim by the alternative researcher.

At the beginning of my placement, I obtained all six interviews fully transcribed. Throughout the analytical process, I followed the guidelines outlined by Smith, Flowers and Larkin (2009). To familiarise myself with the data, I read through each transcript and noted down my immediate impressions. This process made up the free coding stage of analysis. I then revisited each transcript separately and conducted thorough line-by-line coding, where I identified the personal topics of importance for each individual (objects of concern), alongside their meaning (experiential claims) and participants' feelings towards them (their stance). For this stage of IPA, I was required to use my personal interpretation of individual experiences. After completing the line-by-line coding on multiple transcripts, I began to recognise the emergence of a number of tentative themes. Next, I grouped together similar topics into groups of subthemes, whilst cautiously attempting to preserve the complexity of

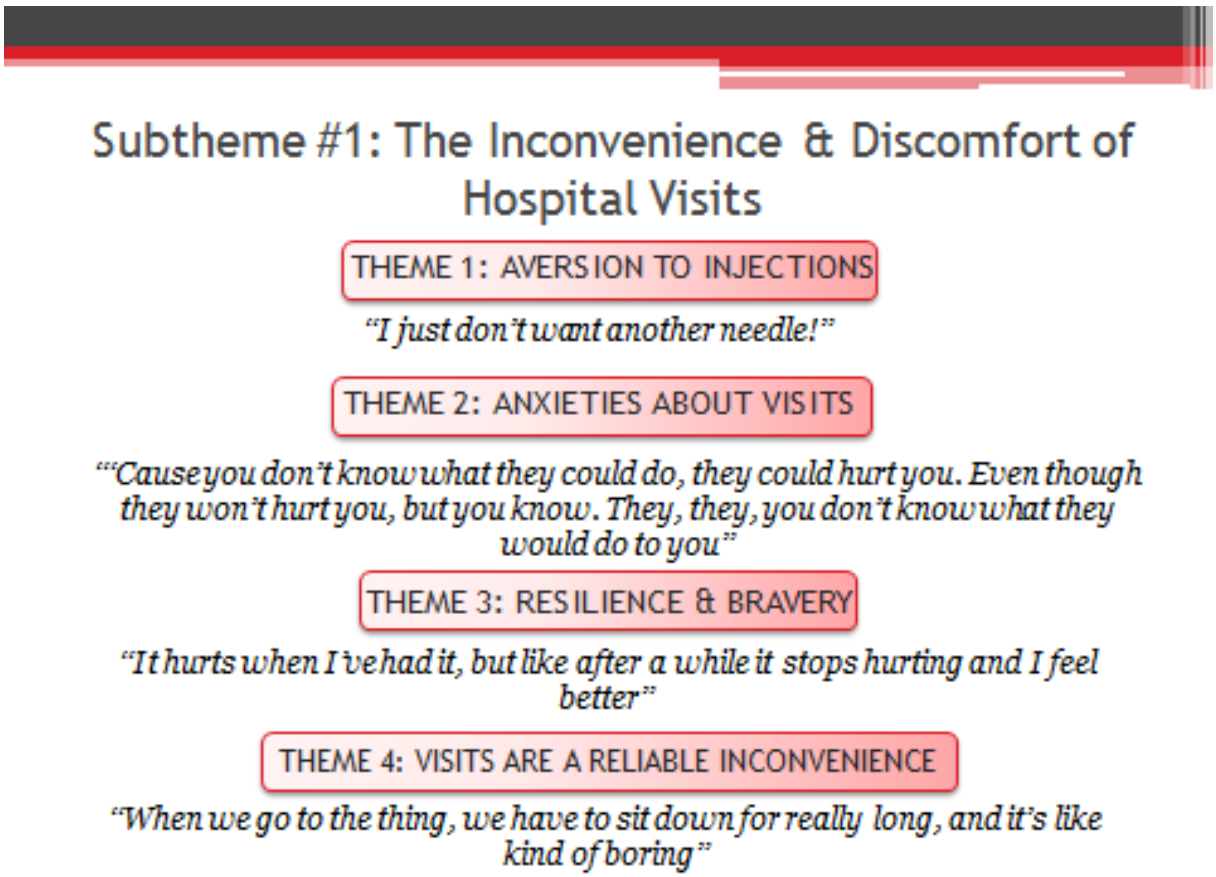
the dataset. At this stage, I was able to arrange subthemes under two superordinate themes which I believed most suitably encapsulated the overall story of the data.



My analysis produced two sets of superordinate themes: The explicit experiences of being diagnosed with PA or CPP versus the implicit repercussions of living with the conditions. In general, the children explicitly discussed their healthcare experiences as being largely passive; the general consensus implied that their medical condition was an inconvenience to life that they simply had to "get on with". Despite this perceived resilience, as a group, the girls alluded to aspects of social impairment whilst describing a number of interactions within their social world. Although not explicitly stated, the underlying connections between their experiences of having PA/CPP and their perceived subsequent social fragility should be considered.



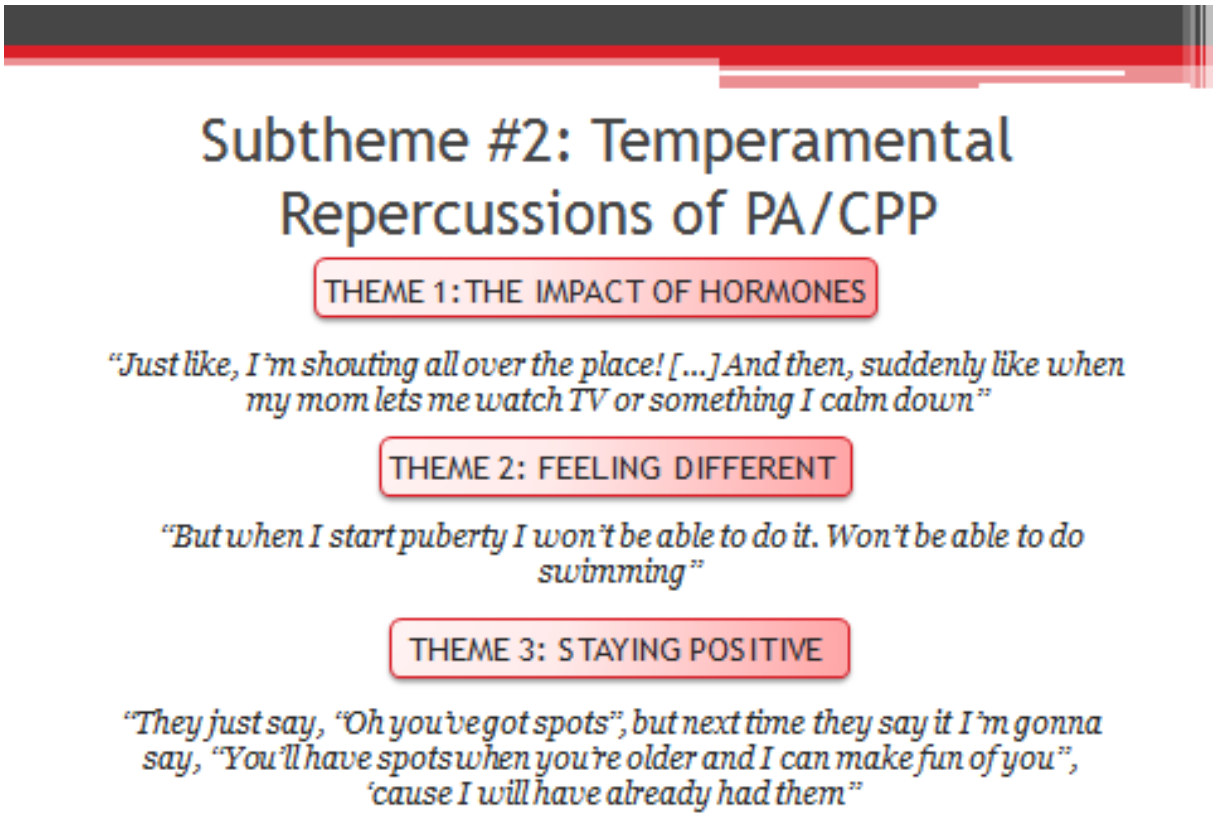
The first superordinate theme to emerge from the data concerned participants' explicit experiences of being diagnosed with PA or CPP. Following IPA, I thought it was most appropriate to separate this into a hierarchy comprising three core subthemes: 'The Inconvenience and Discomfort of Hospital Visits', 'Temperamental Repercussions of having PA/CPP' and 'Maintaining Self-esteem'. Each subtheme integrated numerous related topics that were discussed by more than one participant. The diagram above provides a visual illustration of how IPA allows for the complexities of qualitative data to be arranged in a way that forms a coherent experiential account of a particular phenomenon.



The first subtheme encapsulated the girls' experiences of attending compulsory hospital visits. Many participants discussed their aversion to the injections they receive as part of their treatment plan. Further to this, some girls expressed anxieties regarding what could happen to them during hospital visits. When taking into consideration the age group in question, participants' concerns appear reasonable, as young children would often associate a hospital environment with ill-health and pain.

On the other hand, many of the participants gestured towards their personal bravery during hospital visits. Perceived resilience was recognisable throughout, as many of the girls suggested that injections were an unavoidable necessity to their lives. In opposition, an alternative issue concerning hospital attendance was often shared: boredom. The majority

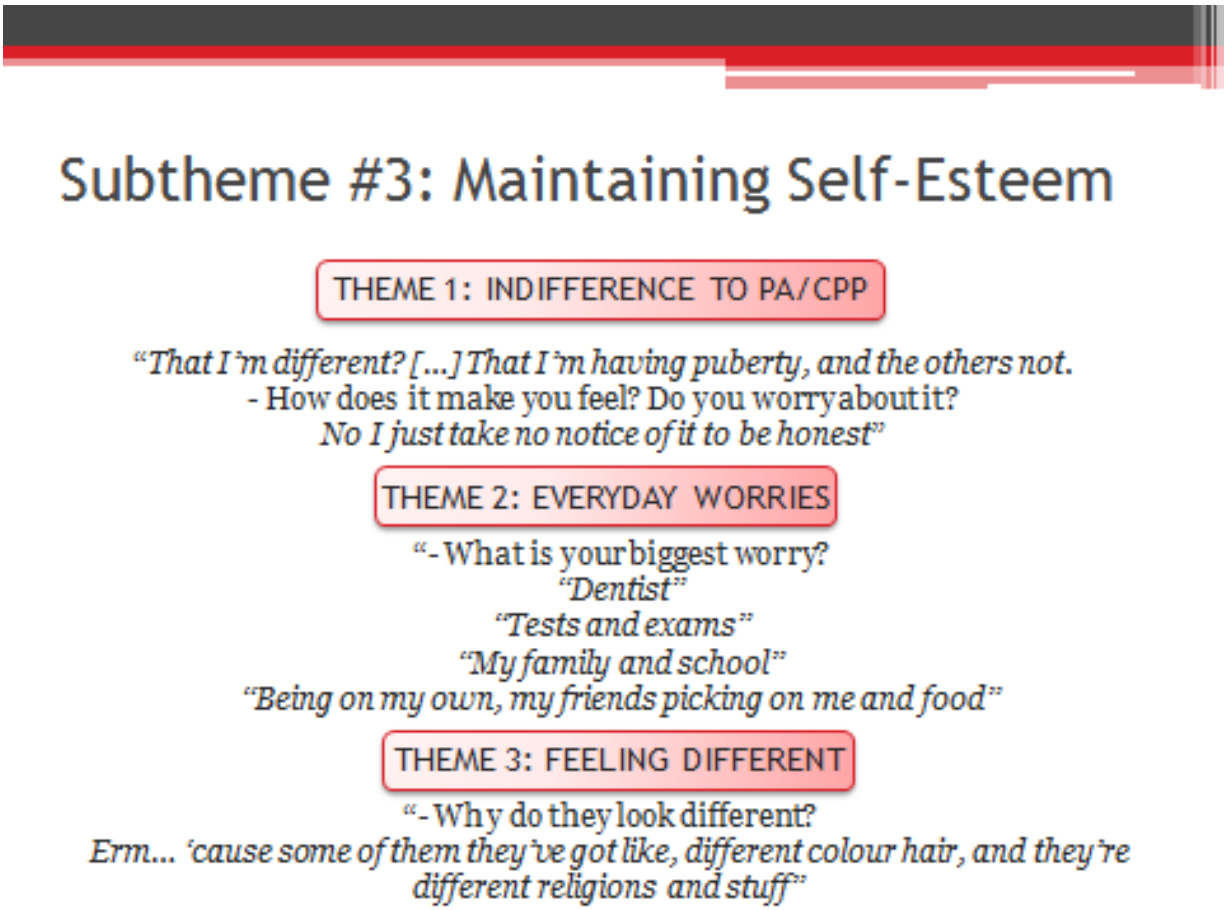
of the girls discussed the continued, reliable inconvenience posed by appointments to which they played a largely passive role, as opposed to their parents who were regularly reported as leading key discussions with medical professionals.



One frequently discussed repercussion of precocious development was the continued efforts to control hormonal outbursts. The girls provided an insight into the unpredictability of their emotions and the social consequences of mood swings. In addition to this, a number of individuals discussed the practical strategies they implemented to reduce the negative impact of their outbursts, which included largely independent tasks such as reading or watching TV.

In spite of the physical characteristics of their diagnoses, when asked, many of the girls reported feeling no different to their peers. However, some participants described situations that were unavoidably influenced by their condition, which included participation in sport, changing in front of others and requiring flexible access to toilets during their menstrual cycle.

Despite the explicitly negative consequences of PA and CPP, a number of the girls put forward positive aspects of their condition. Whilst some reported taking pleasure from experiencing aspects of "growing up" before their peers, others were comforted by the knowledge that particular aspects of puberty would be "out of the way" (e.g. managing spots).



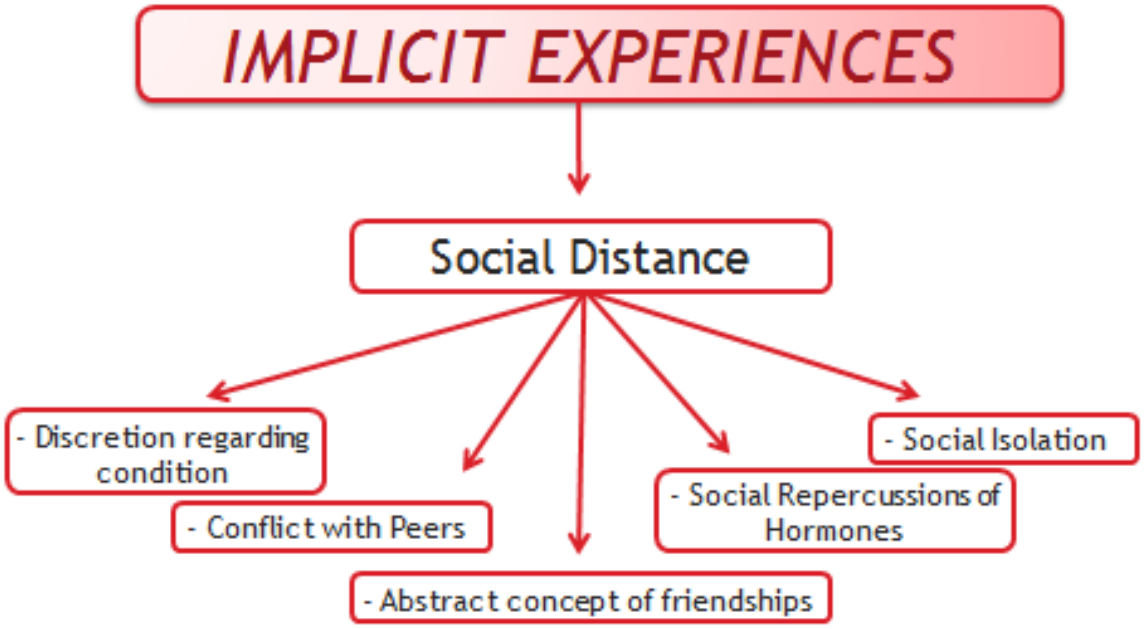
The final explicit subtheme concerned participants' self-esteem. Despite the physical and emotional consequences of PA/CPP, none of the girls indicated that their condition severely impacted on their lives. The data showed an overall indifference, where phrases such as "take no notice of it", "just get on with it" were regularly used to describe participants' diagnosis.

In addition to their indifference, when asked about general concerns, almost all of the girls raised issues that were unrelated to their conditions. Aside from two girls who reported anxieties regarding injections, many gave the impression that everyday worries (such as the dentist and pressures of school life) were at the forefront of their daily lives.

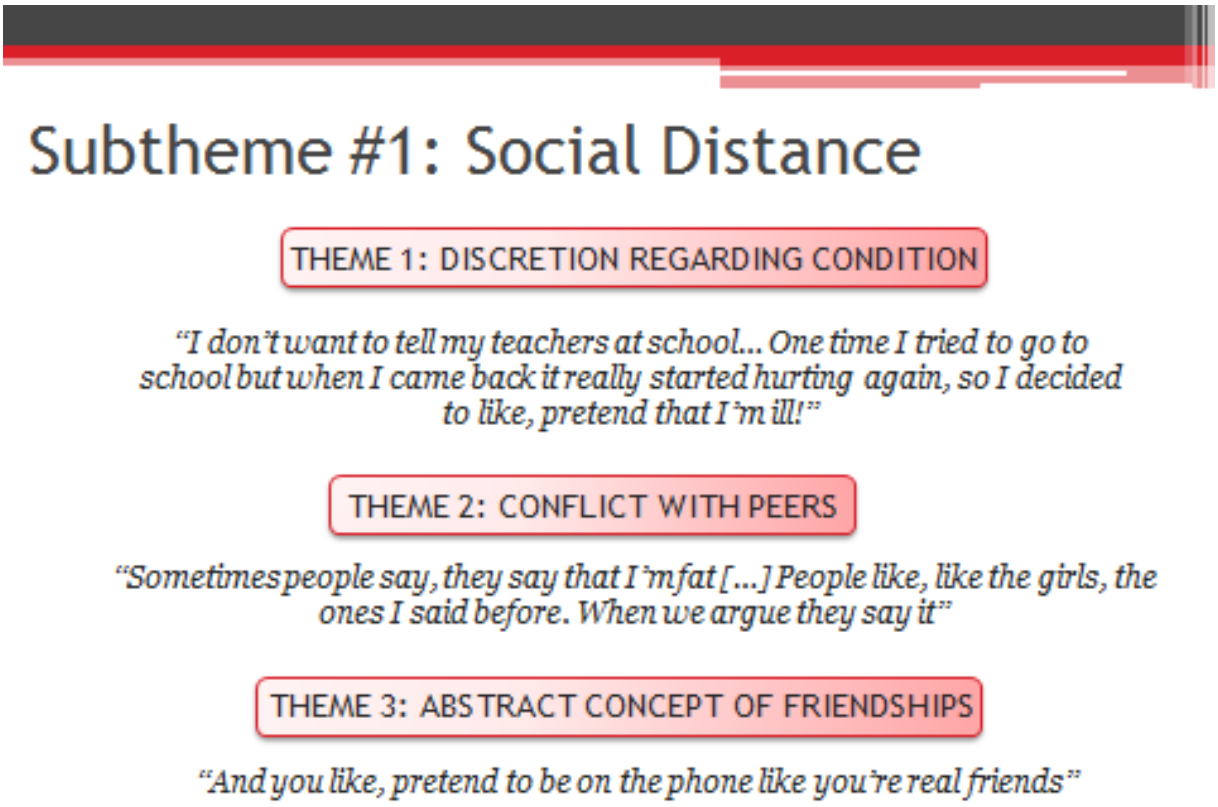
Finally, the subject of 'appearing different' was discussed at length during interviews. All participants were questioned about their appearance, to which many confirmed feeling different to their peers. However, when asked about exact physical dissimilarities, individuals focused on characteristics such as ethnicity, religion and hair colour, as opposed to explicit characteristics of PA/CPP.

When considering the aforementioned explicit factors of the PA/CPP diagnosis, it is difficult to identify aspects of participants' self-confidence that is profoundly impacted upon by their condition.

Superordinate Theme #2



The second superordinate theme concerned the implicit repercussions of having PA or CPP, as inferred by the dataset. Following my analysis, I chose against separating each subject topic into separate subthemes, opting instead to group all five of the emerging themes under the broader concept of 'Social Distance'. As before, all topics were discussed by multiple participants.

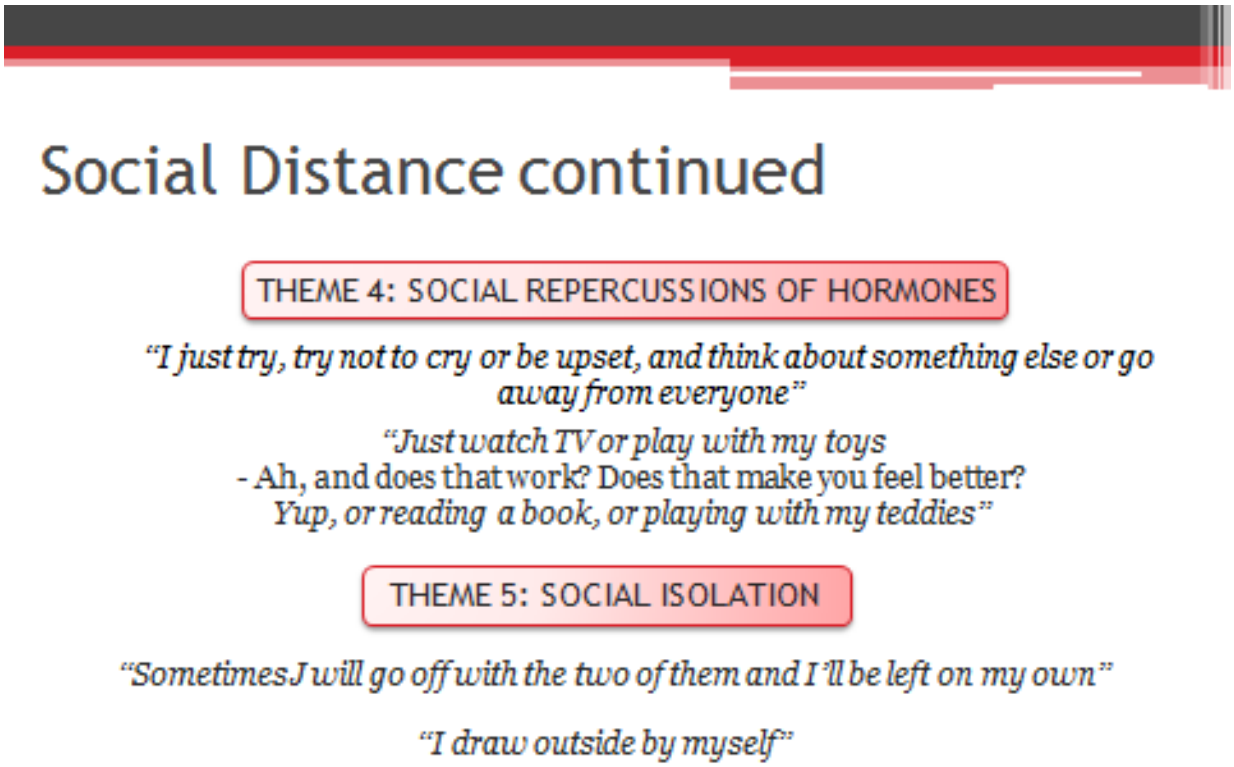


Some of the participants chose to discuss their condition with friends and teachers; others preferred to maintain their privacy. These children disclosed numerous situations where they deceived others in order to conceal their diagnosis.

Many participants divulged information regarding ongoing conflicts with their peers. Whilst mild conflict is an everyday part of school-life, many of the girls suggested that their feuds involved aspects of bullying. Despite reference to frequent verbal disagreements with other children, not one participant alluded to comments regarding the physical characteristics of precocious puberty during arguments.

In addition to conflict with others, the data highlighted dysfunction within participants' existing friendship groups. Some individuals generated relatively abstract ideas regarding

the role of friends, whilst others seemed to understand the concept of friendships, despite actively separating themselves from meaningful connections with others.

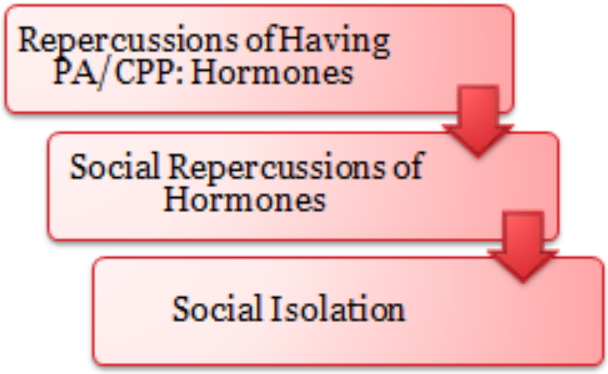


The data revealed a number of social consequences that appeared to result from hormonal outbursts. When asked about managing their emotions, almost all of the children referenced activities which they would complete in isolation. The girls implied that social withdrawal was used frequently as a coping mechanism. Thus, despite being unable to identify explicit repercussions of PA/CPP, it would appear that factors embedded within the girls' conditions impacted negatively upon their social world.

Finally, anxieties regarding social isolation were at large throughout all six interviews. Many children discussed experiences of seclusion within their school environment; abandonment was a key concern for a number of participants. Upon consideration of this concern, in addition to the four previously discussed themes, an issue regarding social dysfunction becomes apparent throughout the sample.

Relationships Between Themes

Despite themes being either explicitly discussed or interpreted implicitly through analysis, the most accurate representation of the data is observed through recognition of the underlying connections between themes:

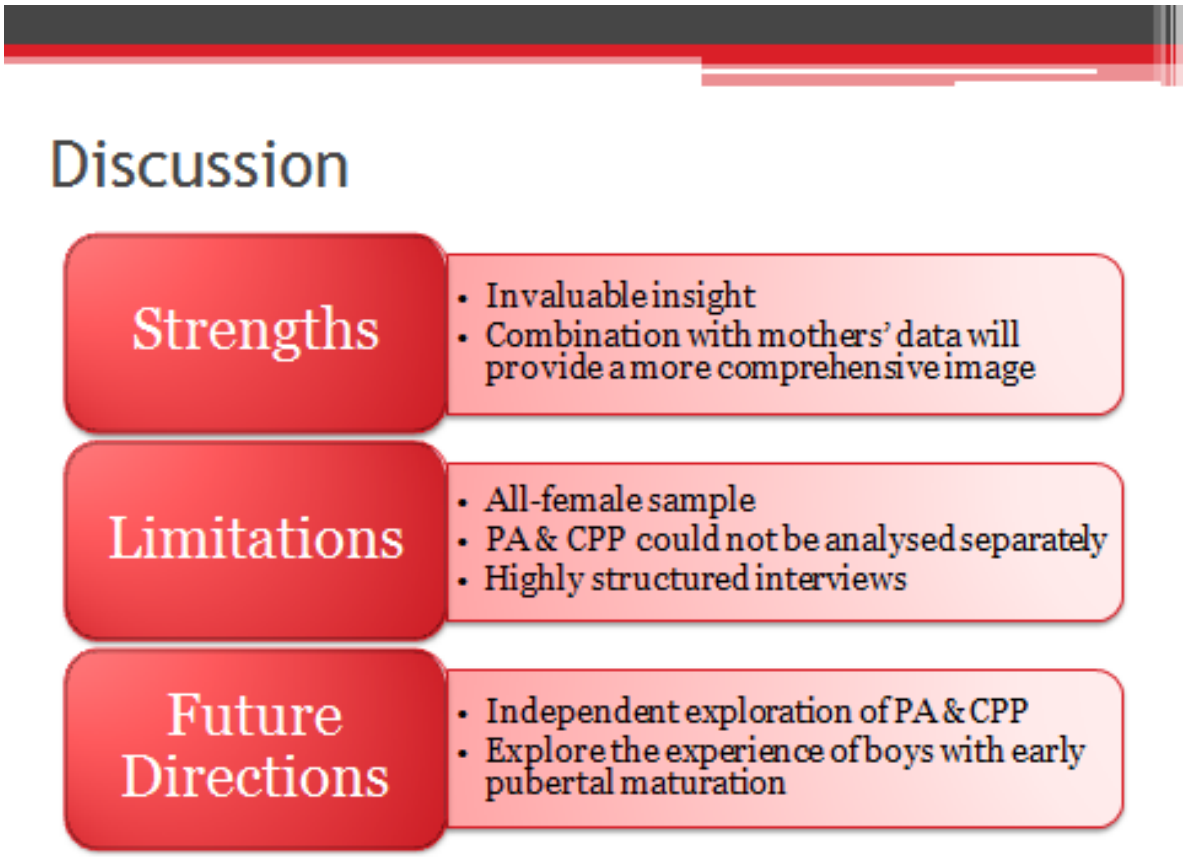


Although IPA identified two largely contrasting sets of superordinate themes, it is important to acknowledge the underlying relationships between explicit and implicit factors. Throughout this analysis, I have attempted to arrange the data into a coherent, yet accurate representation of lived experiences. However, only when considering the dataset as a whole, which is comprised of a number of complex connections, are we able to gain the most comprehensive account of the participants' life-world.

Summary of results

To summarise, on one hand, a large amount of the data implied that a diagnosis of PA or CPP was not a primary concern for these young girls. This image was captured from participants' passivity toward the healthcare experience that was framed as being an inconvenience that they simply *"get on with".*

However, all six children described insecurities within their social interactions, which raised questions regarding their ability to function socially whilst managing the physical and emotional components of their conditions.



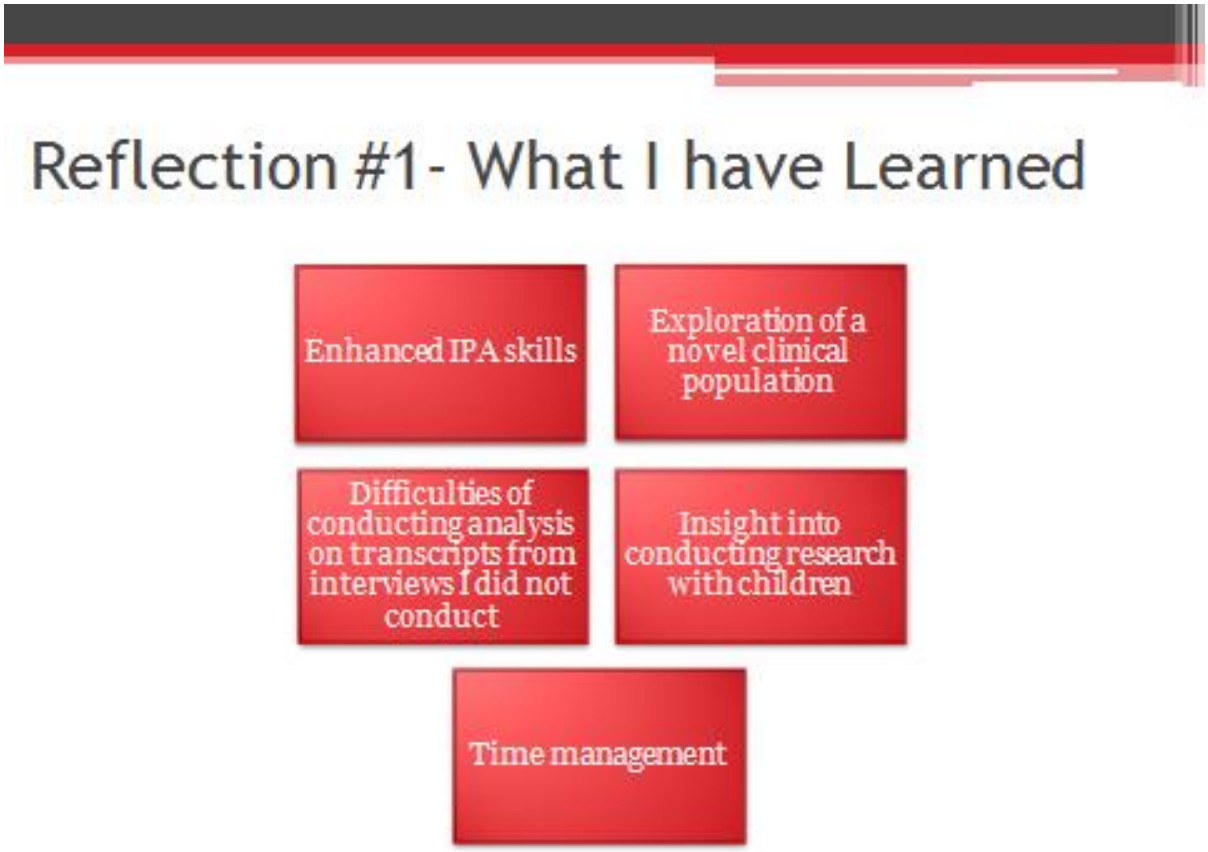
This analysis provides an invaluable qualitative insight into the experiences of children with PA or CPP. It is particularly useful considering the ethical restrictions associated with the current sample, and provides essential comparative data that will offer a much more comprehensive insight when combined with the mothers' interview data.

In spite of these advantages, a number of limitations must be acknowledged. A female-centric sample is restrictive to the extent that results are not generalisable to boys experiencing precocious puberty. Furthermore, the inclusion of children with both PA and CPP is flawed. As PA is limited to Adrenarche alone, girls with this condition are likely to have alternative experiences altogether. An example of this is the absence of menstrual bleeding. In addition to sampling issues, there were a number of limitations surrounding the interview procedure. Due to ethical constraints, each interview was highly structured and

contained extensive input from the researcher. IPA encourages the exploration of experience through participants' own words, where the interviewer is active insofar as guiding the discussion. However, the current project demanded a much more dynamic role for the researcher. As a result, there were numerous occasions where participants' responses may have been unintentionally guided by asking closed questions. Also, the presence of parents may have further influenced the data, as some mothers interrupted interviews despite being advised against doing so.

The use of indirect questioning and play-based props during interviews may be considered a flaw of the current procedure, which could have impacted upon the validity of the analysis. However, despite the absence of direct questioning, all six of the participants initiated conversation regarding their diagnoses, and appeared happy to actively discuss their experiences of having PA/CPP. Furthermore, the dataset would suggest that adequate information was collected regarding the girls' experiences of being diagnosed with PA/CPP without them needing to be directly questioned on their conditions. Thus, in this instance, the props used during interviews served as age-appropriate cues to facilitate conversation whilst simultaneously allowing the researcher to quickly build rapport with participants.

Future research should aim to rectify some of the limitations mentioned. For example, researchers should strive to recruit mixed-sex samples, where PA and CPP should be explored as separate conditions.

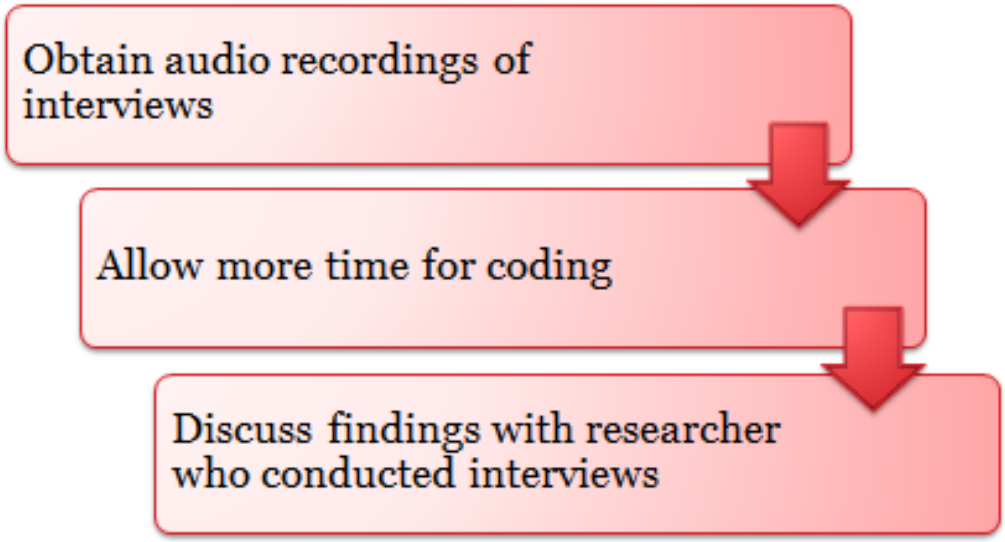


After having conducted IPA during Undergraduate study, I believe I possessed a sound knowledge of the analytical process as a whole prior to the commencement of this placement. Thus, having the chance to conduct IPA again has provided me with the opportunity to considerably enhance my basic skillset. In addition to this, I held no previous knowledge of precocious sexual development and so conducting this analysis has provided me with the opportunity to explore a novel clinical population.

Aside from factors related to IPA, this placement has allowed me to acknowledge a number of complications within clinical research. For example, throughout my analysis I was able to identify with the difficulties associated with analysing transcripts from interviews conducted by a separate researcher. As a result of this, I held no initial impressions of the dataset and I was unable to judge the verbal components (such as tone, hesitation, confidence) that are

essential throughout social interaction. In addition to this, I am now much more aware of the multifaceted difficulties associated with conducting research with children, especially in terms of ethical restrictions.

Reflection #2- What I Would do Differently



Upon reflection, there are a number of factors that I would have changed during the placement. In order to fully comprehend each interaction, I believe it would have been beneficial for me to have obtained audio recordings from the original interviews. Further to this, I would have allowed for additional time during the early stages of IPA, which would have provided me with an opportunity to conduct more comprehensive line-by-line coding. Finally, I feel it would have been beneficial for a discussion to have taken place between myself and the original researcher in order to share my findings. I will endeavour to arrange this before the analysis is written up for publication.

Thank You for listening!
Any questions?

CHAPTER THREE:

VALIDATION OF THE NEUROPSYCHOLOGICAL ASSESSMENT BATTERY SCREENING TOOL (S-NAB) IN PARTICIPANTS WITH TRAUMATIC BRAIN INJURY IN THE UK

Abstract

Aim: Sustaining a Traumatic Brain Injury (TBI) can have a profound impact upon an individual's cognitive functioning (Iverson, Holdnack & Lange, 2013). The ability to accurately recognise cognitive impairment following a TBI is imperative to rehabilitation planning and has been shown to predict recovery outcomes (Lau, Collins & Lorrell, 2012). Neuropsychological assessments are often conducted in conjunction with traditional clinical indicators in order to identify impairment. However, a full neuropsychological evaluation is resource intensive and can be frustrating for patients experiencing fatigue and low tolerance following a TBI. Thus, a brief screening tool to assess for cognitive strengths and weaknesses would prove clinically useful in the immediate post-injury stage (Allen et al., 2013). At present, no cognitive screening tools have been validated for use within the TBI population. The Neuropsychological Assessment Battery Screening Tool (S-NAB) has been put forward as a candidate measure for brief cognitive assessment. However, only one study has investigated the construct validity of the S-NAB in a TBI population to date (Zgaljardic & Temple, 2010). The current study aims to provide additional preliminary data on the construct validity of the S-NAB in persons with TBI.

Method: 22 individuals with a mild-complicated to severe TBI completed the S-NAB and a battery of well-established neuropsychological assessments (WAIS-IV, WMS-IV and D-KEFS) as part of their routine post-injury clinical care.

Results: The S-NAB Total Index score evidenced strong and significant correlations with all but one domain of the WAIS-IV and WMS-IV. Significant correlations were also reported between the S-NAB Total Index score and many aspects of the D-KEFS. In addition to this, almost all of the S-NAB cognitive module index scores (Attention, Language, Spatial and

Executive Functioning) evidenced significant correlations with domains of the neuropsychological battery that measure similar cognitive functioning. Further research is required to investigate the S-NAB Memory module.

Discussion: This research study provides preliminary data which supports S-NAB construct validity in persons with a TBI. Due to the limited sample size, the current results should only be used to guide further study to establish construct validity in the S-NAB.

Introduction

TBI occurs as a result of damage to the brain via an external force and is a leading cause of disability worldwide (Allen et al., 2013). Sustaining a TBI can have a significant impact upon an individual's physical, cognitive, emotional and social functioning (Iverson, Holdnack & Lange, 2013). Cognitive repercussions of brain injury are imperative to an individual's prognosis in terms of level of disability, functioning in daily living and quality of life (Hofgren, 2009). However, the impact of a TBI on cognitive functioning is highly individualised and varies between cases, which makes long-term impairment extremely difficult to predict (Iverson, Holdnack & Lange, 2013). Level of cognitive impairment post-injury is typically associated with TBI severity; profound global deficit is usually observed following the most critical head injuries (Allen et al., 2013).

TBI severity is classified into mild-uncomplicated, mild-complicated, moderate and severe in the acute post-injury stage. Traditionally, classification is provided as a result of the individual's Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) score, their duration of unconsciousness at the time of injury, their duration of Post-Traumatic Amnesia (PTA), and the results from neuroimaging. An individual's GCS score is the clinical indicator most widely used by professionals whilst classifying TBI severity (Allen et al., 2013). Comprised of a 15-point scale ranging from 0-8 (severe injury), 9-12 (moderate injury), and 13-15 (mild injury), the GCS score reflects the depth of coma experienced (Teasdale & Jennett, 1974). When used in conjunction with the other clinical indicators mentioned previously, GCS scores have proven useful for predicting level of recovery following a TBI (Ghosh et al., 2009). However, there are a number of limitations to utilising these methods alone to predict the heterogeneous nature of cognitive impairment following TBI (Saatman et al., 2008).

Ultimately, some individuals demonstrate minimal long-term cognitive deficiency despite receiving an initial classification of severe TBI from clinical indicators (Wells, Minnes, & Phillips, 2009). As a result of this, Saatman and colleagues (2008) propose that a multidimensional classification system, which incorporates clinical indicators and neuropsychological assessment, would be most useful following a TBI. They suggest that the results of clinical indicators from the acute stage of injury should be combined with ongoing neuropsychological assessment during rehabilitation, in order to most accurately classify injury severity and thus predict functional outcome.

Neuropsychological assessments are regularly conducted in conjunction with standard neurodiagnostic procedures (such as clinical indicators and neuroimaging) following a TBI (Hanks et al., 2008). The scores obtained through neuropsychological testing have been shown to accurately predict level of recovery over time (Lau, Collins & Lorrell, 2012), functional outcome (Hanks et al., 2008) and return to work (Cifu et al., 1997). As discussed in Chapter One of this thesis, brief screening measures are perhaps more pragmatic during the immediate post-injury stage where clinical presentation is subject to rapid change (Allen & Goldstein, 2013), particularly as full neuropsychological evaluation is extremely resource intensive (Allen et al., 2013). In order to conduct a thorough cognitive exploration in the post-acute setting patients are required to complete numerous lengthy neuropsychological assessments during a time where individuals often demonstrate low tolerance and heightened fatigue (Zgaljardic & Temple, 2010). Thus, screening for cognitive impairment at this stage of rehabilitation allows for the identification of cognitive strengths and weaknesses, which can be used to gauge initial concerns and guide the ongoing assessment

of cognitive functioning that takes place in the months post-injury (Zgaljardic & Temple, 2010).

The validation of neuropsychological assessment measures within individual clinical populations is imperative; a clinically useful screening tool must have adequate sensitivity to detect post-TBI impairment and specificity to distinguish those with impairment as a result of TBI from matched control groups that may naturally demonstrate low cognitive functioning (Donders & Levitt, 2012). To date, no cognitive screening tool has been specifically validated within the TBI population (Zgaljardic & Temple, 2010). A comprehensive summary of the screening tools that have been previously administered on persons with a TBI is provided in Chapter One of this thesis. Of the screening measures discussed, the Neuropsychological Assessment Battery Screening Tool (S-NAB) was recognised as a potentially useful measure of global cognitive functioning following TBI.

The S-NAB is one of six modules that comprise The Neuropsychological Assessment Battery (NAB; Stern & White, 2003). The NAB was designed to assess the cognitive functioning of individuals with neurological deficit and has previously demonstrated good sensitivity when administered to persons with a TBI (Donders & Levitt, 2012; Zgaljardic & Temple, 2010). The NAB includes five cognitive domain modules (Attention, Language, Spatial, Executive Functioning [EF], and Memory), as well as the S-NAB; a condensed version of the full NAB that functions as a screening tool for brief neuropsychological evaluation (Stern & White, 2003). The S-NAB is also comprised of five index domains, identical to the assessment items on the NAB. Administration of the S-NAB provides a global index score, as well as five modular index scores, which reflect the level of functioning within each cognitive domain respectively. As proposed by White and Stern (2003) in the S-NAB administration manual,

adhering to the screening tool recommendations should "maximise the hit rate and minimise the false-negative rate" during neuropsychological assessment. Thus, should an individual perform well on any of the five index domains of the S-NAB, it is assumed that their functioning within that particular cognitive domain is adequate and so further assessment is not required. However, if an individual's test results on an S-NAB domain falls within a certain range of scores that indicate potential impairment (as defined in the S-NAB manual), administration of the corresponding NAB module is warranted (White & Stern, 2003). Results from the S-NAB can be used to direct further, more comprehensive neuropsychological investigation.

At present, there are only four studies that have administered the S-NAB on persons with TBI (Iverson, Williamson, Ropacki & Reilly, 2007; Temple et al., 2009; Zgaljardic & Temple, 2010; Zgaljardic, Yancy, Temple, Watford & Miller, 2011). Of these studies, Iverson and colleagues (2007) reported preliminary data on the sensitivity of the S-NAB to impairment following brain injury and compared their results to the clinical sample data provided in the S-NAB manual. Temple and colleagues (2009) and Zgaljardic and colleagues (2011) reported significant association between the S-NAB and the Functional Independence Measure (FIM; Rankin, 1993), which supported evidence for the ecological validity of the S-NAB with regards to functional ability following brain injury. Finally, Zgaljardic and Temple (2010) correlated individuals' scores from the S-NAB with their results from a battery of previously well-established neuropsychological assessments in order to determine construct validity.

Construct validity is traditionally thought of as the degree to which a tool is able to measure its desired psychological construct (Cronbach & Meehl, 1955). Thus, in this instance, construct validity refers to how well each of the S-NAB modules measure the respective

cognitive domains in which they purport to examine. As stated previously, only Temple and Zgaljardic (2010) have explored S-NAB construct validity. Typically, in order to validate a neuropsychological assessment tool within a specific clinical population, researchers examine the relationship between components of the instrument in question with some form of established "gold standard" measure (Pawlowski, Segabinazi, Wagner & Bandeira, 2013). Zgaljardic and Temple (2010) implemented this method to examine S-NAB construct validity by correlating individual modular index scores with well-established tests of Attention, Language, Spatial, EF, and Memory. Apart from the EF module, all S-NAB modular index scores yielded strong and significant correlations with the "gold standard" neuropsychological tests selected. Alternatively, a weak and non-significant association was reported between the S-NAB EF index score and its matched test (Controlled Oral Word Association Test; Benton, Hamsher & Sivan, 1994).

Despite their promising results, Zgaljardic and Temple (2010) identified a number of limitations with their research study. Firstly, the exploration of additional established EF tests was recommended due to their selection of a singular matched test. In addition to this, their sample of participants was comprised of persons with Acquired Brain Injury (ABI) which included individuals with acute ischemic cerebrovascular accident (CVA) as well as persons who had sustained a TBI. Further to this, weak internal consistency was reported for subtest scores that comprised each of the cognitive domains. As a result of this, the authors suggested that the S-NAB cognitive index scores may not reliably reflect the performance of participants on individual subtests. As a result of these factors, Zgaljardic and Temple (2010) highlighted the need for additional research to examine S-NAB construct validity further within individual clinical populations.

In sum, the S-NAB boasts a number of features to support its use within an acute rehabilitation setting (Temple et al., 2009; Zgaljardic & Temple, 2010). In terms of practicability, the test is brief in administration (approximately 45-minutes) and has two parallel forms which allows for repeat testing (i.e. upon hospital admission and prior to discharge from clinical services). Additionally, all raw index scores (including total index score and individual modular index scores) are standardised and reported in the form of T-scores to allow for comparisons with a predetermined range of cut-off scores. The NAB manual (White & Stern, 2003) also contains extensive normative data that allows for the generation of a range of scores for each individual covering all five cognitive domains, as opposed to a singular global index score of functioning, which is found when utilising alternative cognitive screening tools (e.g. the MMSE). In addition to this, the normative data provided controls for age (18-97 years), gender, and previous education attainment, which are factors known to influence cognitive performance (Zgaljardic & Temple, 2010). These key components, combined with the advantage of gaining a neurocognitive evaluation that incorporates all five main cognitive domains, distinguishes the S-NAB from alternative neuropsychological screening tools (See Chapter One for more detail). As summarised previously, initial administration of the S-NAB has produced promising results in the TBI population. However, research in this subject field is lacking considerably. This provides an ideal platform on which to build the current research question.

The aim of the current pilot study is to produce preliminary data on the construct validity of the S-NAB in persons with a mild-complicated to severe TBI. The results obtained from this research paper are intended to be used to guide a larger research study that will investigate the validity of the S-NAB in TBI. Similar to the study by Zgaljardic and Temple (2010), the

current study aims to correlate the S-NAB Total Index score, individual Modular Index scores, and modular subtest scores, with a battery of well-established neuropsychological tests.

Thus, the aim of the current study is to: (a) examine the association between the S-NAB Total Index score and the Neuropsychological (NP) battery; (b) examine the associations between the S-NAB Modular Index scores and the NP tests matched by cognitive domain; and (c) examine the associations between the S-NAB modular subtests and the NP tests matched by cognitive domain. Finally, the data obtained is also to be used to produce a power analysis calculation which will guide the proposed future study.

Methods

Ethics

NHS ethical approval was granted by the South Birmingham ethics committee on 23rd July 2014 (Appendix 3A). The University Hospitals Birmingham (UHB) Research and Development trust granted approval for testing to take place at the Queen Elizabeth Hospital, Birmingham (Appendix 3B).

Participants

Participants were recruited through an outpatient service provided by the Queen Elizabeth Hospital Neuropsychology unit. Participants were considered for selection if they:

(a) were ≥18 or ≤69 years of age,

(b) received a diagnosis of mild complicated, moderate or severe TBI (as judged by a Glasgow Coma Score between 3 and 15, loss of consciousness for ≥30 minutes, PTA duration of ≥24 hours, or evidence of neuroimaging abnormalities),

(c) sustained their head injury within the last 3 years,

(d) were able to provide informed written consent.

Further to this, an exclusion criterion was applied and individuals were not selected to participate if:

(a) they were not sufficiently fluent in English, as judged by the Consultant Neuropsychologist,

(b) they had experienced previous head trauma,

(c) they were still in PTA,

(d) they demonstrated motor or sensory deficits which may have impeded practical task completion,

(e) a severe and enduring mental health condition was present,

(f) a learning disability was present,

(g) a history of pre-existing dyslexia was present, or

(h) an organic illness (e.g. dementia) was present.

30 participants were originally identified for the study and provided informed written consent (100%). Of these individuals, the results from 8 participants were excluded prior to analysis (26.67%) due to confounding variables (significant failure of performance validity tests, consumption of illicit drugs or alcohol during testing period). Therefore, 22 participants took part in the study (8 females, 14 males) with a mean age of 37.3 years (SD=

15, range= 18-66) and mean educational attainment of 12.8 years (SD= 1.9, range= 10-16). All inclusion and exclusion criterion was adhered to by all 22 participants.

Measures

The S-NAB is comprised of 14 individual tests, which are separated into five index domains: Attention, Language, Spatial, EF, and Memory. Total index scores for each module are presented as standardised (mean = 100, SD = 15), and individual subtest scores are presented as T-scores (mean = 50, SD = 10). Of the two parallel test versions, Form One was used throughout this study. Full description of administration, scoring and interpretation can be found in the S-NAB Administration Manual (Stern & White, 2003). See Table 1 for breakdown of S-NAB index subtests.

Table 1:
S-NAB index modules, corresponding subtests and descriptive statistics

S-NAB Index Domains	Subtests	Mean	SD	Range
S-NAB Total Score		98.73	19.68	51-141
S-NAB Attention		87.05	19.55	52-123
	Digits Forwards	49.09	11.14	25-67
	Digits Backwards	51.00	10.54	26-66
	Numbers & Letters- Part A	36.82	12.42	19-57
	Numbers & Letters- Part B	38.23	9.22	25-60
S-NAB Language		106.82	20.31	45-127
	Auditory Comprehension	50.27	10.24	19-55
	Naming	53.32	13.14	19-65
S-NAB Memory		103.23	17.00	66-142
	Shape Learning- Immediate Recognition	54.55	9.39	34-68
	Shape Learning- Delayed Recognition	53.68	10.73	35-79
	Story Learning- Immediate Recall	52.41	9.28	35-67
	Story Learning- Delayed Recall	46.55	13.93	19.73
S-NAB Spatial		104.91	17.31	77-135
	Visual Discrimination	50.91	11.80	24-62
	Design Construction	53.41	10.88	27-68

S-NAB EF		92.55	19.68	51-141
	Mazes	42.77	12.30	19.64
	Word Generation	49.14	11.38	26-75

The Test of Memory Malingering (TOMM; Tombaugh, 1996) and the Word Memory Test (WMT; Green, Allen & Astner, 1996) were administered to assess performance validity (participants engagement with the testing process) in order to ascertain reliability of the results obtained for each individual (BPS, 2009). See Chapter One for rationale for the use of performance validity tests. The computerised version of the WMT was used in this study. Full description of administration, scoring and interpretation can be found in the Administration Manual for both tests (Tombaugh, 1996; Green, Allen & Astner, 1996).

The battery of well-established NP tests was comprised of selected subtests from: the Wechsler Adult Intelligence Scale- Fourth Edition (WAIS-IV; Wechsler, 2008), the Wechsler Memory Scale-Fourth Edition (WMS-IV; Wechsler, 2009) and the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan & Kramer, 2001). See Table 2, 3 and 4 for breakdown of WAIS-IV, WMS-IV and D-KEFS subtests and corresponding cognitive domains. Full description of administration, scoring and interpretation can be found in the corresponding Administration Manuals (Wechsler, 2008; Wechsler, 2009; Delis, Kaplan & Kramer, 2001).

Table 2:
Breakdown of WAIS-IV domains, subtests, descriptive statistics (scaled scores for WAIS-IV subtests) and corresponding cognitive abilities

WAIS-IV Index Domains	Subtests	Mean	SD	Range	Proposed Cognitive Abilities
FSIQ: Full-scale IQ		97.67	14.57	70-126	
VCI: Verbal Comprehension Index	 Vocabulary Information	99.67 9.77 10.14	14.57 2.64 3.15	70-126 3-14 4-18	Verbal reasoning, verbal comprehension, general knowledge
PRI: Perceptual Reasoning Index (PRI)	 Block Design Matrix Reasoning	101.05 9.71 10.72	16.97 3.08 3.47	71-133 5-15 4-16	Spatial perception, spatial reasoning, problem solving
WMI: Working Memory Index	 Digit Span Arithmetic	101.09 9.86 10.30	13.31 2.44 3.18	77-125 5-14 5-15	Attention, concentration
PSI: Processing Speed Index	 Symbol Search Coding	88.41 8.14 7.59	12.30 2.62 2.32	62-108 3-12 2-11	Visual perception, motor speed, visual working memory

Table 3:
Breakdown of WMS-IV subtests, descriptive statistics (WMS-IV and corresponding cognitive abilities

Subtests	Mean	SD	Range	Proposed Cognitive Abilities
Visual Reproduction Immediate	9.52	3.17	3-14	Immediate memory, visual memory
Visual Reproduction Delayed	10.00	2.93	4-17	Delayed memory, visual memory
Logical Memory Immediate	10.73	3.39	1-15	Immediate memory, auditory memory
Logical Memory Delayed	10.41	3.35	1-16	Delayed memory, auditory memory

Table 4:
Breakdown of D-KEFS tasks, subtests, descriptive statistics (scaled scores for D-KEFS subtests) and corresponding cognitive abilities

D-KEFS Tasks	Subtests	Mean	SD	Range	Proposed Cognitive Abilities
Trail Making Test	Motor Speed	9.71	2.54	5-13	Executive functioning, visual attention, task switching
	Number Sequencing	7.86	3.48	1-13	
	Letter Sequencing	8.00	4.07	1-12	
	Number-Letter Switching	8.73	3.45	1-13	
Verbal Fluency	Letter Fluency	9.14	3.48	4-19	Executive functioning, semantic memory
	Category Fluency	10.27	4.01	3-17	
Colour Word Interference	Colour Naming	7.23	3.37	1-13	Executive functioning, processing speed, working memory
	Word Reading	8.31	3.61	1-14	
	Inhibition	8.95	4.11	1-18	
Towers	N/A	10.91	2.22	6-15	Executive functioning, planning, problem-solving

Procedure

Prior to recruitment, all participants completed a clinical assessment interview with a Consultant Clinical Neuropsychologist at UHB where information regarding current presenting problem, history of injury and severity of TBI was obtained. Participants who met the inclusion criterion were approached by a member of the clinical team at UHB and asked if they would like to take part in the research project. An information sheet (Appendix 3C) was provided and any queries were answered by the researcher prior to individuals' scheduled appointment. Informed consent (Appendix 3D) was obtained before testing commencement. Testing took place at UHB over two sessions in order to reduce fatigue. Each testing session lasted approximately 3 hours; the full battery was administered in less than 5 hours for all participants. All tests were completed orally or by using a pencil and paper, aside from the WMT which was computer administered. The order of tests was in

line with routine clinical practise and so identical for each participant. All tests were administered as part of routine clinical practice. As a result of this, debriefing and feedback of assessment scores took place as part of routine procedure at UHB.

Analysis

In order to explore the first aim of this research study, a Pearson product-moment correlation was carried out using SPSS in order to examine the association between participants' S-NAB Total Index score and their results from the battery of well-established NP tests.

Next, to investigate the second aim a further Pearson product-moment correlation was conducted in SPSS between each S-NAB module index score (Attention Index, Language Index, Memory Index, Spatial Index, EF Index) and the participants' results from the NP battery.

Finally, to explore the final aim of the current research project, each of the S-NAB modules and their corresponding subtests were examined individually by cognitive domain. Thus, five Pearson product-moment correlations were carried out to examine the associations between scores obtained from each S-NAB modular subtest and scores from the NP battery.

In addition to the correlation statistics, a power analysis was carried out to ascertain the sample size required to provide sufficient power to discriminate between medium and large effect sizes in the larger prospective study.

Results

Association between S-NAB Total Index and NP battery

Table 5 reports the correlations between the Total S-NAB Index score and the NP battery comprised of tests from the WAIS-IV, WMS-IV and D-KEFS. The S-NAB Total Index score evidenced strong and significant correlations with all WAIS-IV domains. Significant correlations were also reported between the S-NAB and the Immediate Memory Index, Delayed Memory Index and Visual Memory Index from the WMS-IV. Three significant correlations were observed between the S-NAB and subtests from the D-KEFS Trail Making Test, two significant correlations with subtests from the Colour Word Interference task, and the S-NAB Total Index reached significance with the Towers test. However, there were no significant correlations reported between the S-NAB Total Index score and any subtests from the D-KEFS Verbal Fluency task.

Associations between S-NAB Modular Index scores and NP battery

Table 6 reports the correlations between the S-NAB Modular Index scores and the NP battery comprised of tests from the WAIS-IV, WMS-IV and D-KEFS.

The S-NAB Attention Index evidenced strong and significant correlations with all but one WAIS-IV domains. Significant correlations were also reported between the S-NAB Attention Index and domains from the D-KEFS Trail Making test and D-KEFS Colour Word Interference test.

The S-NAB Language domain evidenced two significant correlations with domains of the WAIS-IV. Aside from this, only two further significant correlations were observed between the S-NAB Language Index and the D-KEFS Colour Word Interference test.

The S-NAB Memory Index evidenced a number of significant correlations with the NP battery, including three significant WAIS-IV associations and two significant WMS-IV correlations. Further significant correlations were between the S-NAB Memory Index and the D-KEFS Trail Making task, the D-KEFS Colour Word Interference task and the Towers task.

The S-NAB Spatial domain also reported three significant correlations with the WAIS-IV and two significant correlations with the WMS-IV. Further significant correlations were observed between the S-NAB Spatial Index and the D-KEFS Trail Making test, and the D-KEFS Verbal Fluency task. Finally, the S-NAB EF Index evidenced significant correlations with three WAIS-IV domains and one WMS-IV domain.

The S-NAB EF Index also reported one significant correlation with the D-KEFS Trail Making test, the D-KEFS Verbal Fluency task and the Towers task. Further to this, there were two significant correlations between the S-NAB EF Index and the Colour Word Interference task from the D-KEFS.

Associations between S-NAB Modular subtest scores and NP battery

S-NAB Attention subtests

Table 7 reports the correlations between the S-NAB Attention subtest scores and the NP battery. All subtests in the attention domain evidenced significant correlations with NP tests that are routinely used to assess for attentional functioning.

Of the S-NAB attention subtests, particularly strong associations were observed between Digits Forward and WAIS-IV working memory index (WMI) (r= .584, p= ≤.001, n=22), Digits Backwards and the Letter Sequencing (r= .540, p= ≤.001, n=22) and Number-Letter

Switching ((*r*= .612, *p*= ≤.001, *n*=22) subtests from the D-KEFS Trail Making Task (TMT). In addition to this, both Part A and Part B of the Numbers and Letters task evidenced significant correlations with subtests from the TMT. In particular, Part B: Efficacy obtained significant correlations with both the WAIS-IV and the D-KEFS TMT. All of the aforementioned tests in the NP battery are associated with the assessment of attention.

S-NAB Language subtests

Table 8 reports the correlations between the S-NAB Language subtest scores and the NP battery. Both subtests that comprise the S-NAB Language domain evidenced significant correlations with NP tests that are routinely used to assess language functioning.

Specifically, the Auditory Comprehension task reached significance with the WAIS-IV Verbal Comprehension Index (VCI) (*r*= .508, *p*= .0.16, *n*= 22). Moreover, the Naming task evidenced a significant correlation exclusively with the WAIS-IV VCI (*r*= .533, *p*= .011, *n*= 22).

S-NAB Memory subtests

Table 9 reports the correlations between the S-NAB Memory subtest scores and the NP battery. Of the two subtests in the memory domain of the S-NAB, only the Logical Memory task evidenced significant correlations with tasks from the NP battery that are routinely used to assess memory.

In particular, the delayed recall trial of the Logical Memory task reached significance with all subtests from the WMS-IV: Immediate Memory Index (*r*= .558, *p*= ≤.001, *n*=21), and Delayed Memory Index (*r*= .502, *p*= .020, *n*=21), Auditory Memory Index (*r*= .561, *p*= ≤.001, *n*=21), and Visual Memory Index (*r*= .454, *p*= .044, *n*=20). There were no significant relationships between the delayed recall trial of the Logical Memory task and the WMS-IV,

however; the task did reach significance with the Category Fluency trial of the D-KEFS Verbal Fluency task (r= .482, p= .023, n=22), which assesses semantic memory functioning.

Both trials of the Shape Learning task did not evidence significant correlations with any gold standard memory tests.

S-NAB Spatial subtests

Table 10 reports the correlations between the S-NAB Spatial subtest scores and the NP battery. Both subtests that comprise the S-NAB spatial domain evidenced significant correlations with the WAIS-IV Perceptual Reasoning Index (PRI), which is routinely utilised to measure spatial functioning: Visual Discrimination (r= .503, p= .020, n=21) and Design Construction (r= .543, p= .011, n=21).

S-NAB EF subtests

Table 11 reports the correlations between the S-NAB EF subtest scores and the NP battery. Both S-NAB EF subtests reached significance with tests from the D-KEFS, which is used regularly as a gold standard measure of EF.

The Word Generation task evidenced significant correlations exclusively with domains from the D-KEFS Verbal Fluency task: Letter Fluency: Total Correct (r= .610, p= ≤.001, n= 22), and Category Fluency: Total Correct (r= .473, p= .026, n= 22). Further to this, the Mazes task reported significant associations with two of the D-KEFS Trail Making task domains: Number Sequencing (r= .447, p= .037, n= 22), and Number-Letter Switching (r= .467, p= .028, n= 22), two of the D-KEFS Colour Word Interference domains: Inhibition VS. Colour Naming (r= -.528, p= .012, n= 22), and Colour Naming (r= .518, p= .014, n= 22), and with the D-KEFS Towers test (r= .489, p= .021, n=22).

Power Calculation

In order to calculate an a-priori power analysis, the averaged z-score for the NP battery was correlated with the NAB screening index and each of the sub-indices of the screen. The correlations between the NP battery was correlated with the NAB screening indices ranged from 0.36 (average NP by S-NAB Language) to 0.68 (average NP by S-NAB Total Index score). Therefore, if these analyses were to be replicated in a larger study, a sample size of between 15 and 58 participants would be required in order to active a power of 0.80 (Pearson's Product Moment Correlation, alpha = 0.05, two-tailed).

For the future prospective study, it is proposed that data will be collected from a further 38 participants, which will provide a sample size of 60. It is suggested that analysis of 60 individuals' NP assessment scores will secure a dataset that is large enough to active a power of 0.08, whilst ensuring that clinically relevant information is written up for publication and made available to clinicians as soon as possible.

Table 5:
Pearson's Product Moment Correlation between S-NAB Total Index and NP battery

NP Battery Test		S-NAB Total Index Score (n=22)	
		r	*p* value
WAIS-IV	Full-Scale IQ	0.751	≤.001**
	Verbal Comprehension Index	0.538	≤.001**
	Perceptual Reasoning Index	0.726	≤.001**
	Working Memory Index	0.608	≤.001**
	Processing Speed Index	0.523	0.012*
WMS-IV	Immediate Memory Index	0.594	≤.001**
	Delayed Memory Index	0.592	≤.001**
	Auditory Memory Index	0.328	0.147
	Visual Memory Index	0.471	0.036*
D-KEFS: Trail Making test	Switching vs Combined Number + Letter Sequencing	0.015	0.946
	Number Sequencing	0.482	0.023*
	Letter Sequencing	0.517	0.014*
	Switching vs Motor Speed	0.303	0.238
	Number-Letter Switching	0.592	≤.001**
D-KEFS: Verbal Fluency	Letter Fluency vs. Category Fluency	-0.103	0.648
	Letter Fluency: Total Correct	0.389	0.073
	Category Fluency: Total Correct	0.415	0.055
D-KEFS: Colour Word Interference	Inhibition vs. Colour Naming	-0.163	0.470
	Condition 1: Colour Naming	0.609	≤.001**
	Condition 2: Word Reading	0.584	0.017*
	Condition 3: Inhibition	0.311	0.159
D-KEFS: Towers	Towers	0.436	0.043*

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 6:
Pearson's Product Moment Correlation between S-NAB Modular Index scores and NP battery

NP Battery Test		S-NAB Attention Index Score (n=22)		S-NAB Language Index Score (n=22)		S-NAB Memory Index Score (n=22)		S-NAB Spatial Index Score (n=22)		S-NAB EF Index Score (n=22)	
		r	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value	*r*	*p* value
WAIS-IV	Full-Scale IQ	0.616	≤.001**	0.500	0.210	0.470	0.031*	0.641	≤.001**	0.526	0.014*
	Verbal Comprehension Index	0.367	0.093	0.624	≤.001**	0.229	0.306	0.418	0.053	0.319	0.148
	Perceptual Reasoning Index	0.584	≤.001**	0.416	0.610	0.521	0.015*	0.673	≤.001**	0.510	0.018*
	Working Memory Index	0.547	≤.001**	0.208	0.353	0.278	0.209	0.588	≤.001**	0.556	≤.001**
	Processing Speed Index	0.512	0.015*	0.234	0.294	0.459	0.032*	0.331	0.133	0.343	0.119
WMS-IV	Immediate Memory Index	0.283	0.214	0.398	0.074	0.557	≤.001**	0.568	≤.001**	0.471	0.031*
	Delayed Memory Index	0.334	0.139	0.394	0.077	0.438	0.047*	0.587	≤.001**	0.473	0.030
	Auditory Memory Index	0.108	0.642	0.169	0.465	0.350	0.120	0.210	0.361	0.360	0.109
	Verbal Memory Index	0.206	0.382	0.341	0.141	0.390	0.089	0.439	0.053	0.333	0.152
D-KEFS:	Switching vs Combined Number + Letter Sequencing	0.086	0.703	-0.296	0.182	-0.003	0.991	0.417	0.053	-0.071	0.752
Trail Making	Number Sequencing	0.422	0.050	0.229	0.305	0.464	0.030*	0.209	0.350	0.423	0.050*
test	Letter Sequencing	0.530	0.011*	0.396	0.068	0.437	0.042*	0.193	0.389	0.363	0.097
	Switching vs Motor Speed	0.331	0.194	-0.042	0.873	0.358	0.158	0.296	0.248	0.135	0.605
	Number-Letter Switching	0.619	≤.001**	0.208	0.354	0.501	0.018*	0.491	0.020*	0.401	0.065
D-KEFS:	Letter Fluency vs. Category Fluency	-0.154	0.493	-0.119	0.598	-0.326	0.139	0.284	0.200	-0.013	0.955
Verbal	Letter Fluency: Total Correct	0.215	0.336	0.216	0.335	0.143	0.526	0.507	0.016*	0.438	0.042*
Fluency	Category Fluency: Total Correct	0.303	0.170	0.277	0.212	0.370	0.090	0.225	0.314	0.389	0.073
D-KEFS:	Inhibition vs. Colour Naming	-0.343	0.119	0.204	0.363	-0.316	0.152	0.245	0.272	-0.390	0.073
Colour Word	Condition 1: Colour Naming	0.626	≤.001**	0.330	0.133	0.491	0.020*	0.143	0.527	0.613	≤.001**
Interference	Condition 2: Word Reading	0.577	0.019*	0.531	0.035*	0.329	0.214	0.121	0.656	0.594	0.015*
	Condition 3: Inhibition	0.167	0.457	0.433	0.044*	0.091	0.688	0.334	0.129	0.091	0.686
D-KEFS: Towers	Towers	0.315	0.154	-0.058	0.796	0.458	0.032*	0.392	0.071	0.501	0.018*

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 7:
Pearson's Product Moment Correlation between S-NAB Attention Index and subtests and NP battery

NP battery test		S-NAB Attention Index Score (n=22)	Digits Forwards (n=22)	Digits Backwards (n=22)	Numbers & Letters (A) Speed (n=22)	Numbers & Letters (A) Errors (n=22)	Numbers & Letters (A) Efficiency (n=22)	Numbers & Letters (B) Efficiency (n=22)
WAIS-IV	FSIQ	0.616**	0.437*	0.573**	0.625**	0.351	0.622**	0.482*
	VCI	0.367	0.282	0.279	0.486*	-0.062	0.472*	0.172
	PRI	0.584**	0.355	0.620**	0.593**	0.451*	0.595**	0.432
	WMI	0.547**	0.584**	0.412	0.388	0.356	0.383	0.514*
	PSI	0.512*	0.212	0.549**	0.510*	0.531*	0.522*	0.530*
WMS-IV	IMI	0.283	0.132	0.416	0.374	0.108	0.373	0.126
	DMI	0.334	0.165	0.399	0.423	0.024	0.420	0.209
	AMI	0.108	-0.023	0.242	0.231	-0.136	0.230	0.138
	VMI	0.206	0.069	0.381	0.362	0.008	0.357	0.108
D-KEFS: Trail Making test	Switching vs Combined Number + Letter Sequencing	0.086	0.289	0.176	-0.077	0.240	-0.093	-0.036
	Number Sequencing	0.422	0.146	0.287	0.537**	0.260	0.541**	0.422
	Letter Sequencing	0.530*	0.138	0.540**	0.566**	0.476*	0.581**	0.529*
	Switching vs Motor Speed	0.331	0.025	0.321	0.362	0.407	0.381	0.348
	Number-Letter Switching	0.619**	0.334	0.612**	0.614**	0.597**	0.615**	0.551**
D-KEFS: Verbal Fluency	Letter Fluency vs. Category Fluency	-0.154	0.167	-0.333	-0.133	-0.152	-0.164	-0.209
	Letter Fluency: Total Correct	0.215	0.543**	0.153	-0.011	-0.133	-0.007	0.073
	Category Fluency: Total Correct	0.303	0.345	0.384	0.091	-0.001	0.118	0.221
D-KEFS: Colour Word Interference	Inhibition vs. Colour Naming	-0.343	-0.194	-0.209	-0.387	-0.069	-0.383	-0.418
	Condition 1: Colour Naming	0.626**	0.518*	0.515*	0.570**	0.160	0.573**	0.577**
	Condition 2: Word Reading	0.577*	0.231	0.429	0.681**	0.229	0.697**	0.535*
	Condition 3: Inhibition	0.167	0.196	0.225	0.108	0.057	0.116	0.056
D-KEFS: Towers	Towers	0.315	0.418	0.325	0.118	-0.101	0.115	0.189

Note. All values in table are Pearson's r

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 8:
Pearson's Product Moment Correlation between S-NAB Language Index and subtests and NP battery

NP battery test		S-NAB Language Index Score (n=22)	Auditory Comprehension (n=22)	Naming (n=22)
WAIS-IV	FSIQ	0.500*	0.610**	0.319
	VCI	0.624**	0.508*	0.533*
	PRI	0.416	0.592**	0.218
	WMI	0.208	0.364	0.159
	PSI	0.234	0.502*	-0.015
WMS-IV	IMI	0.398	0.523*	0.311
	DMI	0.394	0.478*	0.297
	AMI	0.169	0.216	0.109
	VMI	0.341	0.387	0.280
D-KEFS: Trail Making test	Switching vs Combined Number + Letter Sequencing	-0.296	-0.110	-0.184
	Number Sequencing	0.229	0.513*	-0.054
	Letter Sequencing	0.396	0.583**	0.148
	Switching vs Motor Speed	-0.042	0.174	-0.141
	Number-Letter Switching	0.208	0.599**	-0.055
D-KEFS: Verbal Fluency	Letter Fluency vs. Category Fluency	-0.119	-0.094	-0.153
	Letter Fluency: Total Correct	0.216	0.110	0.326
	Category Fluency: Total Correct	0.277	0.166	0.398
D-KEFS: Colour Word Interference	Inhibition vs. Colour Naming	0.204	0.107	0.288
	Condition 1: Colour Naming	0.330	0.349	0.206
	Condition 2: Word Reading	0.531*	0.607*	0.303
	Condition 3: Inhibition	0.433*	0.385	0.376
D-KEFS: Towers	Towers	-0.058	-0.191	0.122

Note. All values in table are Pearson's r

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 9:
Pearson's Product Moment Correlation between S-NAB Memory Index and subtests and NP battery

NP test battery		S-NAB Memory Index Score (n=22)	Shape Learning-Immediate Recognition (n=22)	Shape Learning-Delayed Recognition (n=22)	Story Learning-Immediate Recall (n=22)	Story Learning-Delayed Recall (n=22)
WAIS-IV	FSIQ	0.470*	0.414	0.423	0.144	0.437*
	VCI	0.229	0.173	0.211	0.078	0.249
	PRI	0.521*	0.493*	0.434*	0.098	0.458*
	WMI	0.278	0.215	0.475*	0.080	0.246
	PSI	0.459*	0.448*	0.242	0.224	0.453*
WMS-IV	IMI	0.557**	0.406	0.334	0.229	0.558**
	DMI	0.438*	0.303	0.250	0.120	0.502*
	AMI	0.350	0.026	0.027	0.316	0.561**
	VMI	0.390	0.240	0.165	0.188	0.454*
D-KEFS: Trail Making test	Switching vs Combined Number + Letter Sequencing	-0.003	0.193	0.215	-0.088	-0.169
	Number Sequencing	0.464*	0.391	0.348	0.108	0.454*
	Letter Sequencing	0.437*	0.376	0.328	0.177	0.445*
	Switching vs Motor Speed	0.358	0.083	0.298	0.010	0.527*
	Number-Letter Switching	0.501*	0.566**	0.512*	0.096	0.405
D-KEFS: Verbal Fluency	Letter Fluency vs. Category Fluency	-0.326	-0.011	-0.012	-0.386	-0.391
	Letter Fluency: Total Correct	0.143	0.123	0.175	0.219	0.101
	Category Fluency: Total Correct	0.370	0.115	0.160	0.482*	0.383
D-KEFS: Colour Word Interference	Inhibition vs. Colour Naming	-0.316	-0.071	-0.101	-0.360	-0.373
	Condition 1: Colour Naming	0.491*	0.347	0.181	0.421	0.486*
	Condition 2: Word Reading	0.329	0.187	0.258	0.113	0.393
	Condition 3: Inhibition	0.091	0.218	0.102	-0.061	0.018
D-KEFS: Towers	Towers	0.458*	0.137	0.324	0.316	0.403

Note. All values in table are Pearson's r

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 10:
Pearson's Product Moment Correlation between S-NAB Spatial Index and subtests and NP battery

NP test battery		S-NAB Spatial Index Score (n=22)	Visual Discrimination (n=22)	Design Construction (n=22)
WAIS-IV	FSIQ	0.641**	0.512*	0.494*
	VCI	0.418	0.342	0.285
	PRI	0.673**	0.503*	0.543*
	WMI	0.588*	0.583**	0.364
	PSI	0.331	0.183	0.347
WMS-IV	IMI	0.568**	0.295	0.621**
	DMI	0.587**	0.316	0.631**
	AMI	0.210	0.019	0.349
	VMI	0.439	0.263	0.462*
D-KEFS: Trail Making test	Switching vs Combined Number + Letter Sequencing	0.417	0.561**	0.065
	Number Sequencing	0.209	0.088	0.257
	Letter Sequencing	0.193	0.058	0.289
	Switching vs Motor Speed	0.296	0.026	0.573*
	Number-Letter Switching	0.491*	0.446*	0.342
D-KEFS: Verbal Fluency	Letter Fluency vs. Category Fluency	0.284	0.321	0.080
	Letter Fluency: Total Correct	0.507*	0.426*	0.363
	Category Fluency: Total Correct	0.225	0.127	0.255
D-KEFS: Colour Word Interference	Inhibition vs. Colour Naming	0.245	0.222	0.141
	Condition 1: Colour Naming	0.143	0.043	0.213
	Condition 2: Word Reading	0.121	0.159	0.061
	Condition 3: Inhibition	0.334	0.262	0.274
D:-KEFS: Towers	Towers	0.392	0.185	0.445*

Note. All values in table are Pearson's r

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 11:
Pearson's Product Moment Correlation between S-NAB EF Index and subtests and NP battery

NP test battery		S-NAB Executive Functioning Index Score (n=22)	Mazes (n=22)	Word Generation (n=22)
WAIS-IV	FSIQ	0.526*	0.372	0.424
	VCI	0.319	0.113	0.378
	PRI	0.510*	0.413	0.359
	WMI	0.556**	0.429*	0.393
	PSI	0.343	0.300	0.216
WMS-IV	IMI	0.471*	0.347	0.397
	DMI	0.473*	0.359	0.389
	AMI	0.360	0.316	0.221
	VMI	0.333	0.318	0.201
D-KEFS: Trail Making test	Switching vs Combined Number + Letter Sequencing	-0.071	-0.015	-0.082
	Number Sequencing	0.423*	0.447*	0.176
	Letter Sequencing	0.363	0.381	0.168
	Switching vs Motor Speed	0.135	0.405	-0.185
	Number-Letter Switching	0.401	0.467*	0.139
D-KEFS: Verbal Fluency	Letter Fluency vs. Category Fluency	-0.013	-0.095	0.075
	Letter Fluency: Total Correct	0.438*	0.054	0.610**
	Category Fluency: Total Correct	0.389	0.119	0.473*
D-KEFS: Colour Word Interference	Inhibition vs. Colour Naming	-0.390	-0.528*	-0.046
	Condition 1: Colour Naming	0.613**	0.518*	0.380
	Condition 2: Word Reading	0.594*	0.461	0.417
	Condition 3: Inhibition	0.091	-0.056	0.179
D-KEFS: Towers	Towers	0.501*	0.489*	0.240

Note. All values in table are Pearson's r

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Discussion

Conducting Pearson Product Moment Correlations revealed the associations between the S-NAB and a battery of well-established NP tests. In turn, this provides detail regarding the construct validity of the S-NAB and its five cognitive modules.

The results largely indicate good construct validity between aspects of the S-NAB and the current battery of well-established NP tests. Overall, this dataset provides preliminary support for the S-NAB as a clinically useful screening tool for persons with a TBI. The S-NAB Total Index score and each S-NAB modular Index and subtest scores are discussed in turn.

S-NAB Total Index Score

Overall, the S-NAB Total Index Score evidenced significant correlations with a large proportion of the battery of NP tests. Notably, strong, significant correlations were reported between the S-NAB Total Index and all WAIS-IV domains. In addition to this, strong and significant correlations were also observed between the S-NAB Total Index and all but one of the WMS-IV domains. Thus, aside from the Auditory Memory domain of the WMS-IV, all correlations between the S-NAB Total Index and the WAIS-IV and WMS-IV reached significance. In terms of EF, the S-NAB Total Index evidenced a number of significant correlations with components of the D-KEFS. In particular, significant correlations were observed between the S-NAB and domains of the Trail Making task, the Colour Word Interference task and Towers.

In general, the associations between the S-NAB Total Index score and the NP battery are encouraging. The observation of a strong association between the S-NAB Index score and both the WAIS-IV and WMS-IV is particularly promising, as the administration of these NP tests is proposed to cover all domains of attention, language, memory and spatial functioning

(Wechsler, 2008; Wechsler, 2009). Thus, the current results provide initial support that administration of the S-NAB tool on persons with TBI would produce a Total Index score of similar accuracy to these well-established routine NP tests.

Further to this, although not all associations between the S-NAB Total index and D-KEFS measures reaching significance, the current results provide preliminary support to suggest that some level of EF exploration is present. This is in contrast to the study of construct validity by Zgaljardic and Temple (2010) who reported no significant correlations between the S-NAB Total Index score and EF in individuals with a TBI. In addition to this, basic examination of EF would indicate that the S-NAB is somewhat superior to alternative available screening tools (e.g. RBANS) which are not able to provide coverage of all five core cognitive domains (McKay et al., 2007).

S-NAB Attention Index score and subtests

The S-NAB Attention Index score evidenced significant correlations with the battery of NP tests where expected. For example, strong and significant correlations were reported with all domains of the WAIS-IV aside from the Verbal Comprehension Index. As seen in the results, these significant results were largely uniform across all S-NAB Attention subtests. This pattern of results implies consistency across the cognitive domains examined by the S-NAB Attention module as a whole. A select number of strong and significant correlations between the S-NAB Attention Index (and subtest scores) and aspects of the D-KEFS Trail Making test and Colour Word Interference task were recorded. As before, these results were consistent across all subtests in the S-NAB Attention module.

The associations observed between the S-NAB Attention module and the NP battery are extremely encouraging. All significant correlations were observed with tests from the NP battery that are routinely administered to explore attention (WMI from the WAIS-IV, Trail Making test from the D-KEFS). Further to this, the consistency observed across all attention subtests is promising. These results mirror those of Zgaljardic and Temple (2010) who also observed significant associations between the S-NAB Attention module and matched NP tests. In sum, the current results provide preliminary support for good construct validity in the S-NAB Attention module.

S-NAB Language Index score and subtests

The S-NAB Language Index score evidenced strong and significant correlations with the Full-Scale IQ and Verbal Comprehension Index domains of the WAIS-IV. This was largely consistent across both Language subtests. Most notably, all components of the S-NAB Language module reported significant correlations with the Verbal Comprehension Index of the WAIS-IV, which is traditionally used to examine language abilities. Further significant correlations were observed between the Auditory Comprehension S-NAB subtest and the Immediate Memory Index and Delayed Memory Index domains of the WMS-IV. In addition to this, the few significant correlations reported between the elements of the S-NAB Language module and the D-KEFS measure were found in the Trail Making Task and the Colour Word Interference task, which both include components of language to complete.

As before, the presence of strong and significant correlations between all elements of the S-NAB Language module and the Verbal Comprehension Index of the WAIS-IV is extremely encouraging. Furthermore, any additional significant correlations were observed between the S-NAB Language module and tasks that require an individual to utilise language (e.g. to

complete the D-KEFS Colour Word Interference task). Again, these results mirror the findings of Zgaljardic and Temple (2010), who also reported significant associations between the S-NAB Language module and matched NP tests. Therefore, the current results provide preliminary data to support the notion of construct validity between the S-NAB Language module and the NP battery.

S-NAB Memory Index score and subtests

The S-NAB Memory Index score evidenced strong and significant correlations with the Full-Scale IQ, Perceptual Reasoning Index and Processing Speed Index of the WAIS-IV. These associations were relatively consistent across Memory subtests. Perhaps most notably, the S-NAB Memory Index score reported further strong and significant correlations with the Immediate Memory Index and Delayed Memory Index domains of the WMS-IV. However, correlations between the Auditory Memory Index and Visual Memory Index domains of the WMS-IV and the S-NAB Memory Index did not reach significance. Furthermore, the Memory Index score also evidenced significant correlations with elements of the Trail Making test, the Colour Word Interference task and the Towers test from the D-KEFS. However, these results were not consistent across Memory subtests. In fact, most of the associations between S-NAB Memory subtests and the NP battery were largely inconsistent. Most notably, only the Story Learning- Delayed Recall task evidenced significant correlations with WMS-IV domains, where all associations between this subtest and the WMS-IV domains were significant.

Despite the observation of significant correlations between the S-NAB Memory Index score and the Immediate Memory Index and Delayed Memory Index domains of the WMS-IV, the S-NAB Memory module did not evidence consistent significant correlations across subtests. This is especially notable with the WMS-IV, which is one of the most widely used tests of memory

functioning in routine clinical practice (Wechsler, 2009). Whilst there was some evidence of association between the S-NAB Memory Index and the WMS-IV domains, the current results are not in line with conclusions made by Zgaljardic and Temple (2010), who reported significant associations between the S-NAB Memory module and matched memory NP tests. These observed differences may be due to a number of factors. Firstly, Zgaljardic and Temple recruited patients that had experienced ABI (which included a number of patients with CVA), as well as individuals who had sustained a TBI. Moreover, their participants had a history of moderate-to-severe ABI, which excluded individuals with a mild-complicated diagnosis. In light of this, further research is required to clarify these inconsistencies. Indeed, the current study utilised a small sample and so should only be interpreted as preliminary data to guide further investigation. As many of the non-significant results were approaching significance and reported moderate correlations, the addition of more participant data may be of benefit.

S-NAB Spatial Index score and subtests

The S-NAB Spatial Index score evidenced strong and significant correlations with the Full-Scale IQ, Perceptual Reasoning Index and Working Memory Index domains of the WAIS-IV. Notably, the most strong and significant correlations was observed between the S-NAB Spatial Total Index and the WAIS-IV Perceptual Reasoning Index, which is often administered in order to examine spatial reasoning abilities. These significant correlations were largely consistent across both spatial subtests. Further significant correlations were reported between the S-NAB Spatial Index score and the Immediate Memory Index and Delayed Memory Index of the WMS-IV. This was also true for the Design Construction subtest. Finally, very few significant correlations were evidenced between all elements of the S-NAB Spatial module and the four D-KEFS tasks.

The few significant correlations were spread across the Trail Making test, the Verbal Fluency task and the Towers test.

As with the S-NAB Attention and Language modules, the presence of consistently strong and significant correlations between all elements of the S-NAB Spatial module and the WAIS-IV Perceptual Reasoning Index is encouraging. Further to this, the few significant correlations found between components of the S-NAB Spatial module and the D-KEFS measures were found in tasks that would require an aspect of spatial reasoning (e.g. as in the D-KEFS Towers task). Again, these findings mirror the conclusions made by Zgaljardic and Temple (2010). Thus, the current results would therefore provide preliminary support for good construct validity in the S-NAB Spatial module.

S-NAB EF Index score and subtests

The S-NAB EF Index score evidenced significant correlations with the Full-Scale IQ, Perceptual Reasoning Index and Working Memory Index domains of the WAIS-IV. However, these significant correlations were limited to the Index score alone and not observed in the EF subtests. Further significant correlations were reported between the S-NAB EF Index score and the Immediate Memory Index and Delayed Memory Index domains of the WMS-IV. Most notably, there were significant correlations observed between all components of the S-NAB EF module and measures from the D-KEFS. The S-NAB EF Index score evidenced significant correlations with aspects of all four D-KEFS tasks. In addition to this, the S-NAB Mazes subtest also reported significant correlations with elements from all D-KEFS tests aside from the Verbal Fluency task. Conversely, the S-NAB Word Generation subtest evidenced only two significant correlations, which were with components of the D-KEFS Verbal Fluency task. However, despite the presence of significant correlations, results were not consistent across Index score

and EF subtests. In addition to this, there were a higher number of non-significant correlations reported than significant associations between the S-NAB EF module and the NP battery.

Despite inconsistencies in the associations evidenced between the S-NAB EF module and NP battery, some promise is evident from the current observations. Firstly, the most significant correlations were reported between elements of the D-KEFS measures and the S-NAB EF module. In addition to this, and as discussed previously, the current results provide novel data which suggests that examination of EF is present when administering the S-NAB tool. The results from this research study dispute the conclusions made by Zgaljardic and Temple (2010) who reported no association between the S-NAB EF module and matched NP tests of EF. Thus, although construct validity cannot be confirmed by this preliminary dataset, the current results are encouraging and warrant further investigation in future study.

Study Limitations

Despite the encouraging results observed in the current research study, there are a number of methodological limitations that warrant further discussion. As mentioned previously throughout the chapter, a sample size of only 22 participants was utilised. As a consequence of this, the current results should only be used as preliminary data to guide further study. In sum, a larger sample size would ensure that statistical calculations are more reliable for accurately reporting construct validity. Hence, it is proposed that a further 38 participants will be recruited for the prospective larger study at UHB.

A further limitation of the current study is the NP tests selected for use within the NP battery. Despite the routine administration of the WAIS-IV, WMS-IV and D-KEFS in clinical practice throughout the UK, associations with the S-NAB cannot be generalised to alternative NP tests

which measure cognitive functioning. Whilst it would be impossible to test for statistical associations between the S-NAB and all other NP tests used worldwide, this factor should not be overlooked.

In addition to this, the use of multiple correlations warrants consideration of the risk of obtaining Type I error. On this occasion, and due to aims of the current study regarding collection of preliminary data alone, a Bonferroni correction was not utilised. However, it is intended that this risk will be examined further during data analysis in the prospective study.

Finally, and as a result of the restricted amount of participant data available, two participants were included in the analysis who marginally failed performance validity testing. Whilst a failure on such measures does not necessarily warrant the removal of an individual's test results, the omission of this data would have been preferred in order to rule out the inclusion of potentially unreliable results.

Conclusions

The current research study provides preliminary data to partially support S-NAB construct validity and provides initial data on its clinical use within a TBI population. By completing the first aim of this study, a number of significant associations were observed between the S-NAB Total Index score and the battery of NP tests that are used within routine clinical practice to examine attention, language, memory, spatial and EF abilities. These results suggest an initial level of accuracy demonstrated by the S-NAB Total Index score. Further to this, and in line with the current literature available (Zgaljardic & Temple, 2010), completion of the second and third research aims revealed that the S-NAB Attention, Language and Spatial modules (which is inclusive of corresponding subtests) demonstrated good construct validity with the battery of

NP tests. Further to this, the S-NAB EF module reported some association with the NP battery, which is in opposition to previous research findings from Zgaljardic and Temple (2010). However, evidence of construct validity was not found in the S-NAB Memory module, which is in opposition to previous findings of good construct validity (Zgaljardic & Temple, 2010).

Further to this, the current dataset provides initial data on the validity and clinical utility of the S-NAB on a sample of participants comprised solely of individuals who had previously sustained a TBI. As a result, this data should not be interpreted within the context of any additional brain injury population. To our knowledge, this is the first study to obtain data from an independently TBI sample.

In general, the option for clinicians to administer a brief NP assessment to gauge cognitive functioning in the acute stage of rehabilitation is extremely resource effective during a period of time where patients typically experience low levels of tolerance and high fatigue following a TBI (Allen et al., 2013). The S-NAB tool boasts a number of advantageous characteristics which imply that it would serve as an ideal candidate screening tool for administration on persons with a TBI (Zgaljardic & Temple, 2010). Prior to routine use within clinical care, it is imperative to ascertain S-NAB construct validity with well-established NP tests that are used currently. Thus, the current research study provides preliminary data to support this notion. Due to the limited sample size in this study, the results obtained are intended to guide a larger project that is proposed to take place at UHB over the next few years.

Appendices: Chapter One

1A: Reflection on Research Placement One

Prior to the commencement of this project, the subject field was a particularly daunting aspect. As the majority of my previous research experience included qualitative methodology, I was somewhat intimidated by the Neuropsychological focus of the project. Therefore, whilst conducting the literature search for the cognitive screening tools detailed in part one of this chapter, I had to systematically read, comprehend and make notes from a substantial number of research papers. Without completing this exhaustive process I would not have been able to produce a satisfactory NHS ethics application.

In order to complete sections of the ethics application such as "What is the scientific justification for the research?" I was required to conduct a mini literature review. This summary outlined the existing literature that described cognitive screening in TBI, the current clinical utility of the S-NAB and how the proposed research project could contribute towards establishing the validity of the S-NAB in persons with a TBI. To assist with this task, I was given a number of references that provided brief insight into screening for cognitive impairment in a TBI setting. From this, I read every published paper detailing the clinical application of the S-NAB, which allowed me to build an initial knowledge base. In this situation I believe I worked efficiently during independent study, where I enhanced my personal understanding of the topic so that I was able to complete the majority of the ethics application without assistance. In the instance that I was unable to answer particular questions, I called upon the expertise of others and utilised my time during supervision to gain further knowledge.

Writing each section of the ethics application in lay terminology was particularly difficult as much of the content was highly complex and comprised of advanced terminology. Thankfully, I

received great support from the research team where ultimately, almost every member contributed towards the application before it was prepared for submission. From this, I have learned to appreciate the small, individual efforts of others that can combine in order to form a complete article.

One of the biggest issues I faced throughout the placement was maintaining regular contact with every person involved in the study. The research team was comprised of six professionals, as well as myself, over four different NHS sites. Almost all of those involved were consultant clinical psychologists who lead demanding professional lives. As a result of this, it was extremely difficult to obtain all of the necessary information from each member of the research team within particular timeframes. This made sticking to my own personal deadlines extremely challenging. However, despite these problems, I have now learned to be much more proactive with communication rather than waiting for a reply.

In terms of completing my placement report, firstly, it was quite difficult to determine how I would transfer information from the NHS ethics application into a coherent, written document. Initially, I began by researching the cognitive screening tools that are currently used on patients with TBI. However, due to the literature on this topic lacking somewhat, it was unrealistic to base my entire report on this concept alone. My supervisor and I then decided that I would discuss each of the key decisions that we made as a research team throughout the ethics application process, which I believe captures a much more comprehensive overview of my time on placement. Thus, I have thoroughly enjoyed completing the first chapter of my thesis and I will now enter into my summer placement with confidence that I have a sound knowledge of the research area as a whole.

In sum, I feel this placement provided me with invaluable experience and I consider myself extremely fortunate to have had the opportunity to take on the responsibility of such an active role within a highly specialised research team. As the weeks progressed, I felt as though I developed in a professional capacity, where I now possess the self-confidence to approach problem-solving independently.

On reflection, if I was given the opportunity to change any aspect of my placement then I would have been stricter with personal deadlines. I would have aimed to have completed the content of the ethics application sooner, which would have allowed for a more lenient deadline for each of the team members to review my draft. As a consequence of failing to anticipate delayed responses from each of the team, the application was not successfully submitted before Christmas. I hope that in my future placements, I am able to manage my time more successfully and make allowances in advance for unforeseen circumstances that may impinge on my personal schedule.

Appendices: Chapter Three

3A: Copy of NRES Favourable Opinion Letter for NHS Ethical Approval

23 July 2014

Dear Miss Williams

Study title: Validation of the Neuropsychological Assessment Battery (NAB) Screening Tool in participants with traumatic brain injury and orthopaedic controls in the UK

REC reference: 14/WM/1006

Protocol number: RG_13-324

IRAS project ID: 141356

Thank you for your letter 22nd July 2014, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact the REC Manager, Dr Ashley Totenhofer

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS sites

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Version Date Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Confirmation of Insurance] UMAL 15 July 2013 Letter from sponsor [ERN_13-1321] University of Birmingham 20 May 2014 Letter from sponsor University of Birmingham 20 May 2014 Participant consent form [TBI University Hospital Birmingham] 1.1 24 June 2014 Participant consent form [NAB-S University Hospital Birmingham Orthopaedic]

1.1 24 June 2014

Participant information sheet (PIS) [University Hospital Birmingham Orthopaedic Controls]

1.1 24 June 2014

Participant information sheet (PIS) [TBI Leamington] 1.1 24 June 2014 Participant information sheet (PIS) [TBI Walsall] 1.1 24 June 2014 Participant information sheet (PIS) [TBI Moseley] 1.1 24 June 2014 Participant information sheet (PIS) [TBI University Hospital Birmingham] 1.1

24 June 2014 REC Application Form [REC_Form_04062014] 03 June 2014 Research protocol or project proposal [NAB-S Research Protocol] 1.0 06 May 2014 Response to Request for Further Information Summary CV for Chief Investigator (CI) Theresa Powell 06 May 2014 Summary CV for student Elouise Williams 06 May 2014

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

14/WM/1006 Please quote this number on all correspondence

With the Committee's best wishes for the success of this project.

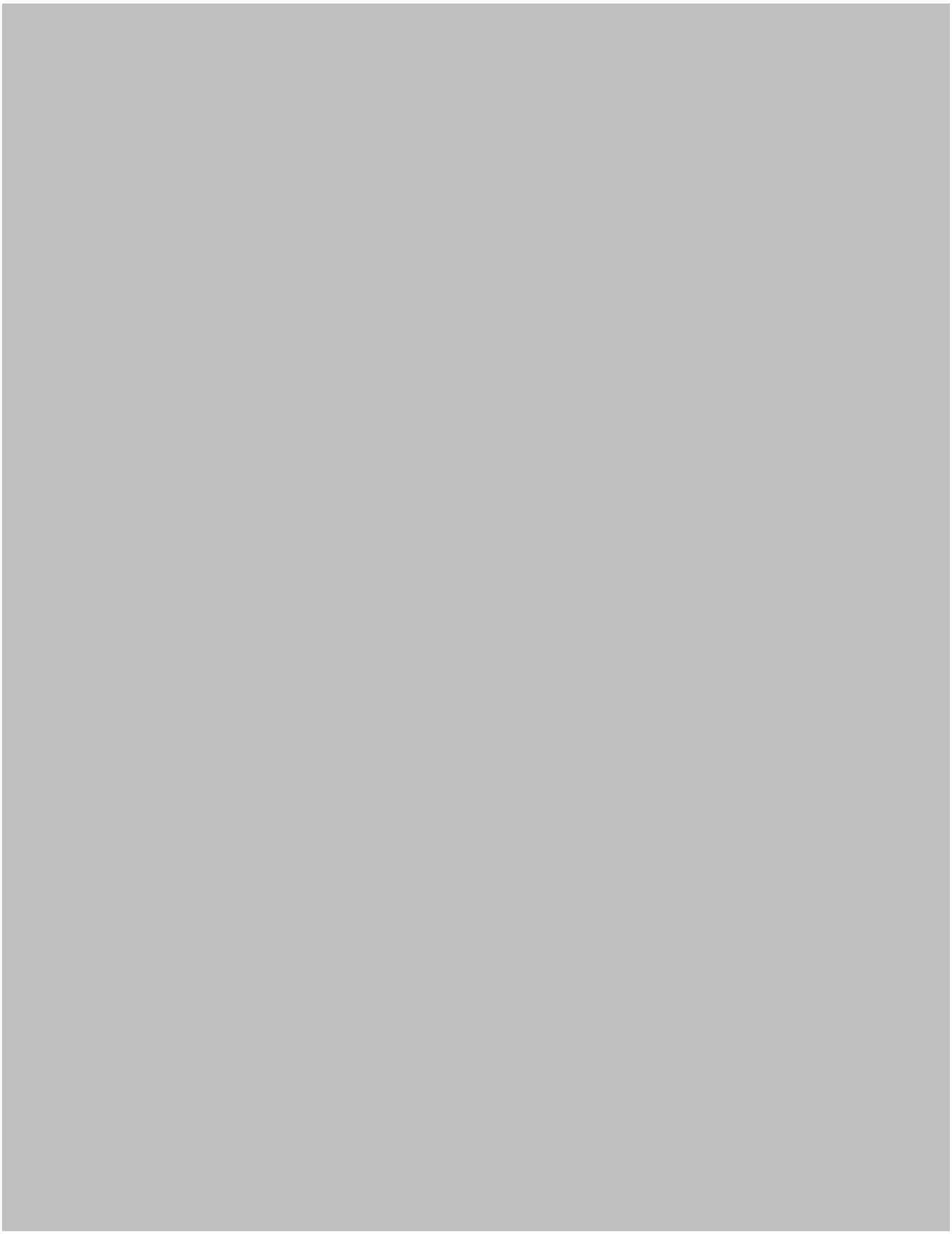
Yours sincerely

Signed on behalf of: Professor Simon Bowman Chair

Email: nrescommittee.westmidlands-southbirmingham@nhs.net

Enclosures: "After ethical review – guidance for researchers"

Appendix 3B: Research and Development Approval from UHB



Appendix 3C: UHB Participant Information Sheet

University Hospitals Birmingham NHS Foundation Trust

PARTICIPANT INFORMATION SHEET

Study Title: Validation of the Neuropsychological Assessment Battery Screening Tool (NAB-S)

You are being invited to take part in a research study. Before you decide whether or not you wish to take part, it is important for you to understand why the research is being carried out and what it will involve. Please take time to read the following information carefully and discuss any questions you may have with the researcher or the collaborator at your NHS site. Please ask if there is anything that is not clear to you or if you would like any further information.

The purpose of the study:
The following research study will be completed by students from the MRes Clinical Psychology course at the University of Birmingham. The primary aim of our research is to collect data from a particular assessment that is conducted on patients who have experienced a Traumatic Brain Injury (TBI). The Neuropsychological Assessment Battery Screening Tool (NAB-S) is routinely used as a brief assessment of cognitive functioning (including domains such as memory, attention, language) following TBI. Ultimately, we would like to ensure that this tool is valid (that it measures what it should) by testing it against other assessments that are commonly used to assess cognitive functioning.

Why have I been chosen?
We are inviting people who have experienced a Traumatic Brain Injury in the last 3 years between the ages of 18 and 69 to participate. You have been asked as your clinical team have judged you to fit these criteria and feel you would be able to contribute to this research study.

Do I have to take part?
No- your involvement in this study is voluntary. If you decide to take part, you are still free to withdraw at any time without needing to give reason for this. Any decision you make to withdraw, or a decision not to take part at all, will have no effect on the standard of healthcare you receive now or in the future.

What will happen to me if I take part?
The researcher will meet with you at the NHS site where you receive your current medical treatment to carry out some assessments with you. These will consist of 8 neuropsychological tests that are routinely used to assess cognitive functioning. All of the tests will be carried out either using a pen and paper or a laptop computer.
The tests will take around 3 hours to complete in total and you will be provided with breaks in between each assessment. We also encourage you to ask the researcher for breaks at your convenience. Alternatively, it is possible for testing to take place over 2 sessions; again this is at your convenience.
Your scores from the tests will be entered into a spread sheet for analysis where you will only be identified by a number. This means that your data will always remain anonymous. The informed consent form that you will sign will be stored in a locked cupboard at the University of Birmingham along with all other participants' consent forms. With your consent, your scores will also be fed

back to your current clinical team which could be useful to better inform your current treatment plan.

Are there any risks of taking part?
We do not expect that any part of this study will cause harm to anyone taking part. Some people may become tired during testing and in this case we encourage you to inform the researcher so that you are able to take a break. Other people may become frustrated whilst taking part in some of the assessments. We would like to emphasise that all of the tests you are going to complete have been designed to assess a wide range of functioning and there will be some aspects of these tests that are purposefully very difficult to complete.

If at any point during or after testing you experience distress and would like to discuss it with someone, the contact details of the researcher and the collaborator at your NHS site are provided below. Equally, your clinical team will be more than willing to discuss any issues that you may have.

Are there any benefits of taking part?
Your participation in this research will provide data that will be extremely beneficial in assisting to further research into the validity of the NAB-S in patients with TBI in the UK, which is an important area of research. This could lead to more frequent use of the NAB-S as a clinical tool which would be much more time efficient and financially effective.
On a personal level, should you give consent to allow for your data to be made available to your current clinical team, your assessment scores may provide them with additional information on your current cognitive functioning, which could prove useful for your treatment plan.

What will happen when the research study stops?
The data will be entered into a database and analysed together with data from other participants who took part in the study. The results will be published in journal articles, however, your identity or involvement in the study will never be revealed. It will be possible for you to see the results of the study when it is finished.

Will I remain anonymous?
All contributions you make towards this research study will be anonymous. Your data will be stored securely in a spread sheet that is only accessible by members of the research team. Your scores will be identified by an individual code and your name will not be used at any time other than on the written consent form, which will be stored in a locked cupboard at the University of Birmingham.

Who has reviewed the study?
All research in the NHS is examined by an independent group of people called a Research Ethics Committee. Their role is to protect your safety, rights, wellbeing and dignity.

Who do I contact for further information?
If you require any further information then please [redacted] the collaborator at your NHS site:

Queen Elizabeth Hospital Birmingham:
[redacted]

Alternatively, if you would prefer to seek advice from an individual who is independent of the research study please use the following contact information:

pals@uhb.nhs.uk; 01213713280 (Queen Elizabeth Hospital Birmingham; B15 2WB)

If you are unhappy at any point during your involvement in this research study then feel free to contact the Chief Investigator with any concerns:

If you would like to express your interest in participating in this study then a member of your clinical team will inform the research team and we will contact you from there.

Thank you for reading this.

Appendix 3D: UHB Participant Informed Consent Sheet

INFORMED CONSENT FORM

Study Title: Validation of the Neuropsychological Assessment Battery Screening Tool (NAB-S)
Principle Investigator: Dr Theresa Powell
Principle Research Site: University of Birmingham
Participant ID:

Thank you for reading the information about our research project. If you would like to take part, please read and sign this form.

PLEASE INITIAL THE BOXES IF YOU AGREE WITH EACH SECTION:

1. I confirm that I have read the information sheet version 1.1 dated 24/06/2014 for the above study and I have been given a copy to keep. I have had the opportunity to consider the information, ask questions and I am satisfied with the answers provided. ☐
2. I understand that my participation in this research is completely voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected. ☐
3. I understand that relevant sections of my medical notes and data collected during the study, may be looked at by individuals from the University of Birmingham, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐
4. I have been provided with sufficient information about the storage of my test scores and personal information. I understand and give permission for my data to be anonymously stored on the research database and this consent form to be stored in a locked cupboard at The University of Birmingham. ☐
5. I give permission for researchers to feed back my scores from this study to my current clinical team. ☐
6. I have been provided with adequate information about who to contact at my NHS site and how to do so if I need to. ☐
7. Overall, I agree to participate in this study. ☐

Name of Participant : _____Date : _____Signature : _____

Name of Researcher:_____ Date : _____ Signature : _____

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