ASSESSING COGNITIVE FUNCTIONS IN ARABIC AND ENGLISH SPEAKING POPULATIONS

by

BAZAH MAJED ALMUBARK

A thesis submitted to Plymouth University

in partial fulfilment of the degree of

DOCTOR OF PHILOSOPHY

School of Psychology

Faculty of Health and Human Sciences

March 2018

Acknowledgment

I would like to express my deepest appreciation and sincere gratitude to my director of studies Dr. Caroline Floccia, who supported me throughout my PhD study. She continually provided me with supervision and help required for my PhD study and related researches. I am extremely lucky to have her as my director of studies and mentor. Without her guidance and persistent help this thesis would not have been possible.

I would also like to thank Dr. Allegra Cattani for her valuable advice and help through my PhD study together with Prof. Tim Hollins for his help with the second study.

A thank you to Dr. Ahmed Megreya who helped with the stimuli used in the third study. In addition, a thank you to the participants who took part in all my PhD researches.

Finally, a special thank you to my mother and the love of my life 'Sultanah Al Saud' without her blessings and support I would not have achieved what I achieved today. Besides, a special thank you to my father 'Majed Almubark' who recently passed away. I wish he was still with me and celebrate the completion my PhD study. I love you dad and God bless your soul.

I dedicate all the efforts and thoughts in this thesis to my beloved parents.

Author’s declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Sub-Committee.

Work submitted for this research degree at the Plymouth University has not formed part of any other degree either at Plymouth University or at another establishment.

All the studies carried out in this thesis were conducted by myself, including literature review, developing tools, selecting of stimuli, designing of experiments, data collection, analysis, and discussion of results.

Publications:

Almubark, B., Cattani, A., Floccia, C., (submitted). Translation, cultural adaptation and validation of the Cognistat for its use in Arabic-speaking population with acquired brain injury.

Almubark, B., Cattani, A., Perfict, T., Floccia, C., (submitted). Development and validation of the Plymouth Saudi Memory Test (PSMT) for Arabic-speaking population with acquired brain injury.

Presentation and conference attended:

Almubark, B., Floccia, C., Cattani A., & Slade A. (2015). Assessment of cognitive function in Arabic speaking population. Poster presented at the 8th Saudi Student Conference, London, UK, February.

Almubark, B., Floccia, C., Cattani A., & Slade A. (2015). Assessment of cognitive function in Arabic speaking population. Poster presented at the Research in Rehabilitation Winter Meeting, Manchester, UK, February.

Almubark, B., Floccia, C., Cattani A., & Slade A. (2015). Assessment of cognitive function in Arabic speaking population with stroke: A pilot study. Poster presented at the 24th European Stroke Conference, Vienna, Austria, May.

Almubark, B., Floccia, C., Cattani A., & Slade A. (2015). Assessment of cognitive function in Arabic speaking population. Poster presented at the 9th World Congress of the International Society of Physical and Rehabilitation Medicine, Berlin, Germany, June.

Almubark, B., Cattani A., & Floccia C. (2017). Translation, cultural adaptation and validation of the Cognistat for its use with Arabic speaking population with Acquired Brain Injury. Official launching of the Arabic Cognistat at the Arab health exhibition and congress, Dubia, UAE, January.

Almubark, B., Cattani A., Hollins T., & Floccia C. (2017). Development and validation of the Long Term Memory Test (LTMT) for the Arabic speaking population with acquired brain injury. Poster presented at the 14th Congress of the European Forum for Research in Rehabilitation, Glasgow, UK, May.

Almubark, B., Cattani A., & Floccia C. (2017). Translation, cultural adaptation and validation of the Cognistat for its use with Arabic speaking population with Acquired Brain Injury. Poster presented at the 14th Congress of the European Forum for Research in Rehabilitation, Glasgow, UK, May.

Word count of main body of thesis: 41 779

Signed…………………………………….

Date………………………………………

Bazah Majed Almubark

Assessing cognitive functions in Arabic and English speaking populations

Abstract

The aims of this thesis are to assess cognitive functions in adult Arabic populations for clinical purposes, and to examine resulting cultural differences between Arabic and English speaking populations. In the first study, we translated, culturally adapted and validated an existing cognitive screening tool (Cognistat) for its use with Arabic adults with Acquired Brain Injury (ABI), and we examined the differences in cognitive performance between Arabic and English individuals. A total of 107 healthy Arabic speaking adults and 62 ABI patients (30 stroke and 32 traumatic brain injury; TBI) between 18-60 years were involved in the study. The results indicated that the translated/adapted tool is valid and reliable for its use with Arabic individuals with ABI. Cultural differences between Arabic and English individuals were found in orientation to time, memory, language (repetition and naming), construction, calculation and reasoning (similarities and judgment).

In the second study we developed and validated a memory test – the Plymouth Saudi Memory Test (PSMT) – that assesses a wide range of memory domains in Arabic adults with ABI; cultural variations in memory functioning between both Arabic and English individuals were also investigated. A total of 80 healthy Arabic speaking adults and 61 ABI patients (30 stroke and 31 TBI) between 18-60 years were tested. The results demonstrated that the PSMT is a valid and reliable test for detecting memory deficits among Arabic adults with ABI, and the comparison between the

Arabic and English individuals revealed variations in working memory, semantic memory, and prospective memory.

As a follow-up of cultural differences uncovered in the first two studies, the third and final study investigated the effect of length of stay in the UK on unfamiliar faces recognition, as well as cultural differences in unfamiliar faces recognition between Arabic and British individuals. A face recognition task that involved both Arabic and English faces was designed, and 35 participants (19 Arabs and 16 English) between 18-49 were tested. Typically, Westerners show an external feature advantage when processing unfamiliar faces, while participants from Arabic countries show a greater reliance on internal features. Results showed that the expected internal feature advantage in Arabic participants is more likely to be found for those Arabic immigrants who spend more time back in their home country, suggesting that visual processing biases can be modified with exposure in adulthood.

Altogether, these results provide the clinical and research community with new tools to evaluate cognitive skills in Arabic-speaking adults, and add to the body of evidence that some of these skills can be shaped by cultural experience. The findings of the cultural differences further our understanding of the potential variations in cognitive functions among people from different cultural backgrounds.

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General introduction

Culture is “a pattern of shared attitudes, beliefs, categorizations, self-definitions, norms, role definitions and values that is organized around a theme” (Triandis 1996, p.408). It is widely believed that culture provides individuals with particular modes of thinking, feeling and action (Ardila, 1995; Berry, 1979), which can lead to cultural variations in cognitive abilities. For instance, differences in attention, information processing, memory, construction, judgment ability, and decision making, have been documented in individuals from Western European and East Asia cultures (i.e. Conway et al., 2005; Fiske, Kitayama, Markus & Nisbett, 1998; Ji et al., 2000; Kastanakis & Voyer, 2014; Nisbett, 2003; Nisbett & Masuda, 2003; Nisbett, Peng, Choi & Norenzayan, 2001; Salmon, Jin, Zhang, Grant, & Yu 1995; Savani & Markus, 2012; Schmitt et al., 1994).

Cultural-related cognitive variations are important factors to consider when assessing cognitive function in clinical population, such as those with Acquired brain Injury (ABI). Although brain pathologies are suggested to present similar manifestations in terms of cognitive impairments across humans, cognitive abilities measured by neuropsychological tests are likely to be affected by cultural variations (Ardila, 1995).

There is a growing and urgent need to develop culturally-appropriate tools for the Arabic-speaking population, which represents as many as 420 million individuals scattered among 22 countries (Istizada, 2017). To date, there are very limited cognitive tools that have been adapted to examine cognitive process in the Arabic-speaking population with ABI, with the exception of the Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and the Montreal

Cognitive Assessment (MoCA; Abdel Rahman & El Gaafary, 2009). However, the sensitivity of both tests were criticised (Fountoulakis, 1998; Nelson et al., 1986; Moss & Albert, 1988), which called for the adaptation/development of alternative, more sensitive, cognitive tools. In parallel, the comparison between Arabic-speaking and English-speaking participants provides a unique opportunity to examine the impact of cultural differences on the assessment of cognitive skills, to shed light on the commonalities and differences across inviduals with vastly different experience, thinking processes and styles. Therefore, this thesis examines the cultural differences in cognitive functioning between the Arabic and English speaking populations, along the development of cognitive tools for the Arabic-speaking adults with ABI.

This thesis contains three separate yet complementary studies. In the first study, the Cognistat (a cognitive screening tool) was translated and culturally adapted for its use with Arabic adults with ABI, and its psychometric properties were examined. This study allowed us to generate a validated cognitive tool that can help assess numerous cognitive processes among Arabic patients, and allow the comparison of cognitive abilities between Arabic and English adults. This first study led to the development of a test that further examines one of the most commonly affected cognitive processes in adults with ABI, i.e. memory. Thus, the second study focused on the development and validation of the Plymouth Saudi Memory Test (PSMT) for the Arabic speaking population with acquired brain injury; it also focused on the investigation of cultural differences in memory processes between Arabic and English participants. The resulting memory test examines a wide range of memory processes involving working memory, episodic memory, semantic memory, prospective memory and recognition memory. To further examine cultural variations between Arabic and English populations, the third and final study focused on cultural differences in faces recognition among Arabic and British adults, and specifically tested whether length of stay in the UK would modify Arabic adults' reliance on internal features for unfamiliar face recognition.

Chapter 1: Translation, cultural adaptation and validation of the Cognistat

Introduction

All healthy adults on the planet share the same basic cognitive processes (Nisbett et al., 2001; Park et al., 1999). These cognitive processes involve perception, attention, (focusing, sustaining, shifting and dividing attention), visuospatial ability (drawing, construction and visual search), and expressive and receptive language (Cumming et al., 2012; 2013). Recall and recognition of verbal and visual memory are also parts of these cognitive processes. Human cognition is also characterised by planning, thoughts organisation and inhibition control which are all referred to as belonging to the umbrella term “executive functions”.

Categorisation, learning and reasoning as “basic” cognitive processes reveal no differences among human groups (Nisbett et al., 2001, page 291). However, it is argued that cultures modulate some of the cognitive processes (Conway et al., 2005; Kastanakis & Voyer, 2014; Nisbett et al., 2001). For example, time orientation varies among Arabic and Westerns cultures. Arabs are likely to be casual about time, while Americans tend to be very time conscious and highly accurate in regards to appointments (Wunderle, 2006). This gives an indication that Arabic people could show poor orientation to time in comparison to Westerners when assessed in formal tests. Also, individuals originating from the Arabic cultures show different attentional abilities than Americans in which they spend more time on saccading and skimming different parts of an image before the first fixation on the image. This is attributed to the assumption that Americans adopt an analytical cognitive style while Arabs apply a holistic cognitive style, attending to the entire field more than analysing the image (Qutub, 2008). Other cognitive process such as memory, constructional ability, and judgment are also suggested to be influenced by culture (Adeep, 2008; Ji, Peng, & Nisbett, 2000; Rosselli & Ardila, 2003).

When adults experience an acquired brain injury such as a stroke or a traumatic brain injury, which can impair cognitive processing (Cumming et al, 2012), it is all the most critical that practitioners use culture-specific screening tools (Uysal-Bozkir et al., 2013). Given that most cognitive tests target the English population, it is recommended to adapt existing measures to assist professionals in examining the patients in their own cultural context (Uysal-Bozkir et al., 2013). Therefore, the aim of this first study was to translate, culturally adapt and test the validity of a cognitive screening tool (Cognistat) from English to Arabic to be used with the Arabic-speaking population with ABI, and to examine the cultural differences in cognition among the Arabic and English populations.

Literature review

Cultural differences in perception and cognition

Every culture has its own values, needs and life expectations and these cultural elements modulate the person's perception (mainly basic sensory perception) and cognition (Kitayama, Duffy, Kawamura, & Larsen, 2003). Perception classically refers to as the process of organising, integrating and interpreting information gathered through our senses – vision, hearing, touch, smell and taste (Jones, 2011). Research concerning cultural differences in sensory perception focused mainly on olfactory, auditory and visual perception. Regarding olfaction, a comparison of Japanese and German individuals' smell abilities reported that both groups had better recognition of their own familiar cultural smell (Jones, 2011). With regards to auditory memory, a study on cross-cultural differences in music perception revealed that Westerners recognise their own culturally familiar melodies better than Easterners (Curtis & Bharucha, 2009). Regarding visual perception, a study of optical illusions found that Europeans are better at perceiving significant length differences between arrows of the same length than individuals in collectivist societies like Africa and Philippines (Campbell & Herskovits, 1963 cited in Kastanakis & Voyer, 2014). In addition, depth perception appears to differ between people from Africa and Europe. It was reported that European children at 7–8 years demonstrated a great difficulty perceiving three-dimensional pictures, however around the age of 12, children had the ability to recognise these pictures unlike Africans who did not perceive the three dimensions of the picture (Hudson 1960, 1962 cited in Rosselli, 1993). Finally, perception of the environment can differ across cultures. Nisbett and Masuda (2003) reported that patterns of attention and perception are not the same among people from different cultures, with people in the

Western cultures mainly directing their attention to focal objects (analytical or focal perspective), whereas Asian cultures focused more on the context or field (holistic perspective). The existence of variations on perceptual and cognitive style will be further illustrated through examples from attention and information processing.

In short, there appears to be perceptual variations between people from different cultures, leading to the idea that culture should be considered as a variable like age or gender (Eviatar, 2000).

It has also been stated that culture has a role in shaping our cognitive processes (Chiao, Li, Seligman, & Turner, 2016), and that the impact of culture might primarily be triggered by what we experience in our childhood (Boroditsky, 2011) and the language we speak (Hussein, 2012). In particular, it was suggested that the impact of culture on perception and cognition could be linked to the acquisition of specific attentional patterns developed through participation in socialisation processes, including child rearing practices (Bornstein et al., 1990; Fernald & Morikawa, 1993). With regards to language, the well-known Sapir-Whorf hypothesis claims that the language we speak has an impact on our thought and our perception of the world (Whorf, 1956 cited in Hussein, 2012): languages make us perceive the reality differently, so that each language community develops their own world view. This strong claim was made following a study on the Hopi Indian Language, an American Indian language. The Hopi Indian linguistic structure was compared to the linguistic structure of English, French, and German. It was found that the structural characteristics of the Hopi were extremely different from those of these three languages (which will be referred to as 'Standard Average European', SAE). For instance, grammatical categories of SAE offer speakers a fixed orientation toward time and space, so they distinguish between things that must be counted and those that need not be counted (such as trees, fire, and courage), while the grammatical categories in Hopi do not offer such differences. The perception of time also differed between the SAE and Hopi: SAE focuses on time in terms of events that already happened or will happen in a certain time (e.g. events happened in the past or future) whereas Hopi thinks in the way an event is about to be occurring or is expected to be to happening. It was argued that these differences made both SAE and Hopi speakers view the world in a different way: SAE speakers would see almost everything in the world as discrete, measurable, countable, and recurrent. In contrast, the Hopi would regard the word as an important and ongoing set of processes where events and objects are not discrete and countable, and time not limited to fixed segments such as minutes, mornings, and days. Accordingly, different languages with a variety of grammatical categories may lead to different observations about how the world is structured (Hussein, 2012).

Gutchess, Schwartz and Boduroglu (2011) proposed three reasons for explaining cultural differences in cognition. Firstly, people from different cultures adopt different cognitive strategies such as using variable taxonomic categories to organise memory. Second, different information is stored and accessed differently by people across cultures such as object vs. context. Third, the degree of a task difficulty varies across cultures, as one task can be more challenging and require more demands from members of one culture than another. Altogether, these reasons would account for the existence of cultural variations in cognition.

In what follows we will illustrate these differences by reviewing cultural variations in the domains assessed by cognitive screening tools, namely attention (Savani & Markus, 2012), information processing (Nisbett, Peng, Choi, & Norenzayan, 2001), memory (Conway et al., 2005; Kastanakis & Voyer, 2014; Megreya & Bindemann 2009), construction (Rosselli & Ardila, 2003), judgment (Ji et al., 2000), decision making (Kastanakis & Voyer, 2014), and calculation (Imbo & LeFevre, 2008).

Attention

Cultural differences in attention were reported in the study of Savani and Markus (2012). Asian and American individuals were asked to track moving items among identical distractors. It was found that Americans tracked more objects than the Chinese participants, which was related to their greater focusing ability and their ability to ignore irrelevant objects (Savani & Markus, 2012). In a different study, it was found that Americans paid less attention than Chinese people to the background information of an image when processing visual information (Chua et al., 2005). Therefore, people from East Asian cultures might have the ability to pay attention to both the object and the context, while the Americans may attend more to the object only (Chavajay & Rogoff, 2000; Rogoff, Mistry, Goncii, & Mosier, 1993).

Information processing

In terms of processing of information, Nisbett, Peng, Choi, and Norenzayan (2001) showed that East Asians use more holistic information-processing, jointly encoding object and background information. On the other hand, Westerners tend to process central objects and organize information through rules and categories. Consistently with these findings, Nisbett and Masuda (2003) indicated that there are differences in processing of information between people from the East Asian and Western cultures, which they attributed to opposing cultural values and beliefs.

Memory

Other cultural differences were noted in the memory domain. For instance, differences in personal memory (a type of autobiographical memory/episodic memory that encodes past personal events; Nelson, 1993) among people from different cultures were reported by Conway et al. (2005). They found that individuals originating from individualist cultures (individuals from this cultural group are known to take care of themselves and close family members more than those originating from collectivist cultures), such as the Americans from the US, had more independent memories (memories related to the individual) than collectivist cultures such as Chinese who were found to have more interdependent memories (memories related to others; Kastanakis & Voyer, 2014). Similarly, Schmitt et al. (1994) found that Chinese speakers attended to visual memory more than English speakers when information was recalled. These variations showed that functioning and quality of memory over time were affected by culture (Kastanakis & Voyer, 2014).

The effect of culture was also found in the memory of faces, and particularly in the ability to recognise unfamiliar faces. Typically, people tend to recognise unfamiliar faces using external features (Bruce et al., 1999). However, this finding was challenged by Megreya and Bindemann (2009) who showed variations in the ability to recognise unfamiliar faces in the British and Egyptian populations. British individuals showed the expected advantage of using external facial features, unlike Egyptians who recognised unfamiliar faces accurately from the internal features (presumably arising from life-long exposure to veiled women). Altogether, these results suggest important variations in the style of cognitive processing as a function of culture (Megreya et al., 2011).

Construction

Constructional ability is another cognitive process that is suggested to differ across cultures. Rosselli and Ardila (2003) conducted a study that focused on the impact of culture on neuropsychological measures. The initial assumption that measures free of verbal items would show no cultural effect was proven incorrect. Researchers found greater differences in performance among different cultural groups using non-verbal cognitive tests than verbal tests. Group differences were found for tasks such as drawing a map and copying figures (Rosselli and Ardila, 2003), which were previously considered as universal skills for most healthy adults (Lezak, 1995). It was argued that drawing a map or copying a figure were skills that were not encouraged in many cultures (Ardila & Moreno, 2001; Berry et al., 1992; Irvine & Berry, 1988). Thus, such findings indicate that participants' performance in constructional abilities tasks could be different depending on the culture. In China for example, the Chinese elderly, both educated and non-educated, did not have the ability or willingness to complete written and drawing tasks, as reported by Salmon, Jin, Zhang, Grant, and Yu (1995). They suggested that Chinese individuals performed worse than Finnish individuals in copying designs while they were better in recalling words. Chinese education may have placed less emphasis on writing and drawing with pen or pencil while the acquisition of this skill may be highly over-trained in the West.

Judgment ability and decision making

Judgment ability and decision making are additional cognitive processes that could be affected by culture. Ji et al. (2000) reported that Chinese individuals out-performed Americans in judgment tasks. Further, decision making was affected by culturally dependent dominant modes of thinking (Kastanakis & Voyer, 2014). Americans tended to adopt solutions that favour the side they believe was correct, whereas Chinese participants were prone to compromising solutions to inter- or intra-personal conflicts (Nisbett et al., 2001). These differences manifested in the context of predicting future changes as Westerners were prone to linear predictions for change (e.g. if there is a drop in the stock market this year, there will also be a drop next year). In contrast, Easterners made non-linear predictions as they perceived events to have wider consequences (Maddux & Yuki, 2006).

Calculation

Imbo and LeFevre (2008) tested three different population groups (English speaking Canadians, Flemish speaking Belgians and Chinese speaking Chinese). Participants were asked to solve "complex addition problems (e.g., 58 + 73) under no-load and load conditions, in which one component of working memory (either the central executive or the phonological loop) was loaded" (Imbo & LeFevre, 2008, p. 2144). Chinese were faster and more accurate in solving complex arithmetic than Belgians and Canadians. Canadians required considerable working memory resources to solve complex arithmetic problem, while Belgians used less resources and Chinese used even fewer resources.

In summary, past studies on the links between culture and cognition show potential variation in participants' performance in attention, information-processing, memory (mainly personal memory, working memory and memory of faces), construction, judgment, decision making, and calculation. As culture could be a variable that shapes the individual's performance, this variable should be taken into consideration when testing participants. Therefore, there might be differences in cognitive performances between the target population (Arabic) and the English population, which need to be examined using a culturally adapted cognitive screening tool.

Arabic culture and cognition

In order to understand and anticipate the effect of the Arabic culture on cognition, it is important to highlight first some of the key points related to the Arabic language. For Arabs to be literate, they must be able to speak and write Arabic alongside speaking their own local dialect. In daily speech, Arabs speak either formal Arabic (a mix of standard Arabic and local dialect) or their local dialect. Standard Arabic, also referred to as classic Arabic, is similar across countries and regions that use the Arabic language. Standard Arabic is not used in daily speech, however it is used in formal discussion, news broadcast and speeches. There are five predominant dialects that are used for every day speech – but not written communication: peninsular (for Saudi Arabia, Jordan and Gulf States), Egyptian, Levantine (for Lebanon and Syria), Iraqi and Magrebi (Morocco, Algeria and Tunisia) (Wunderle, 2006).

As one of the main features of the Arabic language, Arabic tends to be highly context-sensitive. This means that the meaning of what is said depends on the context rather than the meaning of the words. For example, the word 'harem' in Arabic can be translated differently depending on the surrounding context as this word can mean wife, prohibited, taboo, scared, sanctuary or forbidden (Wunderle, 2006).

Written Arabic contains 28 characters and it is written from right to left unlike English. An Arabic character might be presented in up to four shapes including an isolated shape, a connected shape, a left-connected shape and a right connected shape. For example, the letter هـ ‘ha’ in Arabic is written in four different ways depending on its position in the word (Al-Muhtaseb & Mellish, 1998).

In general, differences in social practice and social structure seem to translate into differences in perception (Ji, Peng, & Nisbett, 2000). Arabic societies are known to be collectivist, meaning that a person acts as a member of a certain group rather than as an individual. In contrast, Western societies promote individualism. Thus, distinctive attributes, personal goals, characteristics and desire to be different from others vary across cultures (Qutub, 2008). These distinctions might, to some extent, have an impact on the person's perception and cognition, as predicted by Qutub, (2008).

Only a limited number of studies have focused on the cognitive and perceptual processing differences between Arabs (Middle Eastern) and Westerners. The available literature, which is related to our current study, mainly focuses on attention, problem solving, orientation, and memory. Visual attention and problem solving were examined in 30 native Saudi Arabians (Middle Eastern), 30 Saudi Arabian immigrants living in the United States, and 30 Americans by Qutub (2008). Three tasks included a visual attention task, the Group Embedded Figure Test (GEFT), and a visual problem-solving task. In the visual attention task, differences in visual attention were examined through eye-movement tracking. The GEFT determined the extent to which participants were able to stay focused on a given shape, overcoming the distraction of a background. Finally, imagining and creating mental images and finding solution to a problem were required for the visual problem-solving task.

The result of the visual attention task revealed significant differences between Arabs and Americans in terms of fixation on the background regions. Arabs spent more time saccading and skimming the different parts of images before the first fixation. On the other hand, Americans had faster fixation on the object, and the immigrants' fixation speed was between Americans and Arabs'. In the GEFT Arabs found it difficult to distinguish an object from its context unlike Americans who processed the attributes of the objects independently from the context, meaning that they paid more attention to the objects rather than the context. As suggested previously, this was attributed to Arabs having a more holistic or contextual cognitive perceptual style, while Americans have a more analytical cognitive perceptual style (Hannah, Boland, & Nisbett, 2005; Masuda & Nisbett, 2001; Nisbett & Norenzyan, 2002; O'Leary, Calsyn, & Fauria, 1980 cited in Qutub, 2008). These differences in visual attention were suggested to emerge between 5 and 15 years. However, no significant differences were noted between immigrants and either Americans or Arabs, showing that these cognitive styles can be reversed with different cultural experience. Finally, no differences were found in the visual problem-solving among the cultural groups. In sum, this study shows differences in cognitive processing style between Arabs and Americans, with immigrants standing in between, suggesting that cognitive styles can dynamically adapt.

Time orientation is another factor that is different across Arabic and Western cultures. It is common knowledge that Arabs are likely to be casual about to time, while Americans tend to be very time conscious and very accurate in regards to appointments. It was mentioned that when an Arab host arranges a meeting at a certain time, the time-keeping most likely will not be precise (Wunderle, 2006). This suggests that Arabic people could show lower orientation to time in comparison to Westerners when assessed in formal tests.

In regards to memory differences across cultures, research suggested that Arabs' learning habits rely on culturally constrained strategies. For example, students in the Arab cultures memorise long passages, search for perfection and review detailed outline lists (Oxford & Anderson, 1995), as well as look for high quality language and comprehension. Accordingly, the learning strategies that are adopted in Arab learners are focused on memorising and paying attention to micro details (Adeep, 2008).

In summary, past studies demonstrate that cognitive and perceptual abilities of the Arabic individuals are not entirely similar to those from the English culture members. Visual attention, problem solving, time orientation, and memory, can be influenced by the person's culture. These cognitive and perceptual differences emerge due to the variations in social practices and social structures, as stated by Ji, Peng and Nisbett (2000). This has important consequences for the assessment of cognitive function for clinical purposes, as it is clear that culturally adapted cognitive screening tools must be developed and used.

Before introducing our adaptation and development of culturally-adapted tools for Arabic patients, in what follows we will review what is available today as cognitive screening tools in acquired brain injury (mainly traumatic brain injury and stroke).

Cognitive impairments in patients with acquired brain injury

The term “acquired brain injury” (ABI) refers to any injury occurring in the brain after birth (Kamalakannan, Gudlavalleti, Gudlavalleti, Goenka, & Kuper, 2015). There are two main causes of ABI, involving traumatic and non-traumatic causes. Traumatic causes (or traumatic brain injury, TBI) are known as brain damage caused by an external force, for instance, a penetrating object (such as gunshot), rapid acceleration or blast waves (Maas, Stocchetti, & Bullock, 2008). Non-traumatic brain injury occurs as a result of an illness or disease that affects the brain, such as strokes, brain tumours, brain haemorrhage, lack of oxygen in the brain, or infections (Brain injury association of Queensland, 2013). TBI and stroke are the most common forms of ABI. In the UK alone, it was reported that there was a 10 % increase of the ABI admissions since 2005-6, with 348,934 individuals with ABI admitted in 2013-14; out of these, 162,544 patients suffered from TBI while 130,551 were diagnosed with stroke (Tennant, 2015). Internationally, ABI is considered as one of the leading causes of long term disability (Chen et al., 2012), especially in young adults (Tabish & Syed, 2015).

There are numerous complications and difficulties that arise following ABI such as sensori-motor dysfunction, cognitive deficits, and emotional problems (Brain injury association of Queensland, 2013). Cognitive impairments are among the most common problems experienced in ABI patients (Tennant, 2015; Whyte, Skidmore, Aizenstein, Ricker, & Butters, 2011), and they vary from one person to another based on the type, location and severity of the injury (Rice-Oxley & Turner-Stokes 1999). These cognitive impairments range from memory impairment, aphasia, problems with attention and executive functions (Brain injury association of Queensland, 2013). Other studies found that apraxia (inability to carry out purposeful movement using correct force, timing and direction) (Holmqvist, 2012), visuo-spatial neglect, planning and organisation difficulties are also experienced by ABI patients (Bernspang & Fisher, 1995; Olver, Ponsford, & Curran, 1996). These cognitive problems affect all areas of daily living activities (Butler, 2008; Carlsson, Moller, & Blomstrand, 2004), and consequently, ABI may possibly be life changing to the patients and their families (Brain injury association of Queensland, 2013).

In general, TBI patients tend to have more extensive and severe cognitive impairments than stroke patients, particularly in orientation and recall, as suggested by Zhang et al. (2016). As TBI and stroke account for the most ABI conditions and there might be different profiles of cognitive problems, a brief overview of cognitive impairments in those two conditions will be provided.

Cognitive impairments in TBI patients

TBI is considered being an important public health problem (Kamalakannan, Gudlavalleti, Gudlavalleti, Goenka, & Kuper, 2015) and is a major cause of death, disability and economic costs (Chen et al., 2012). Motor vehicle accidents are the major cause of TBI (Upadhyay, 2008), followed by fall and violence (Gururaj, 2002). The severity of TBI, which can be mild, moderate or severe, is usually measured by the use of the Glasgow Coma Scale (GCS) scores. The GCS assesses level of consciousness with a total score of 15 which indicates full consciousness (mild TBI) whereas the score of 3 indicates lack of consciousness (Severe TBI) (Matis & Birbilis, 2008). Cognitive impairment is frequent following TBI (Soldatovic-Stajic, Misic-Pavkov, Bozic, & Gajic, 2014; Vogenthaler 1987 cited in Upadhyay, 2008), with the most common cognitive problems including deficits in orientation (Zhang et al., 2016), attention, memory, executive functions (Upadhyay, 2008), language, and visuospatial processing (Dikmen et al., 2009), but also intelligence and speed of processing (Johnstone, Hexum, & Ashkanazi, 1995). Cognitive assessment is important to determine areas of cognitive strength and cognitive impairment, evaluate the outcomes of the treatment and to monitor improvement and deterioration (Bleiberg, 2001). Assessment of cognitive function is also recommended to guide rehabilitation interventions (Sherer et al., 2002).

Cognitive impairments in stroke patients

The World Health Organisation (WHO) defined stroke (also known as Cerebro-Vascular Accident, CVA) as “a clinical syndrome typified by rapidly developing signs of focal (at times global) disturbance of cerebral function, lasting more than 24 hours or leading to death within 24 hours, with no apparent causes other than vascular origin” (WHO, 1980 cited in Bracewell, Gray, & Rai, 2010 p. 161). The effect of stroke depends on the affected area of the brain and on the severity of the area affected. More than 5.5 million people worldwide have residual chronic disabilities caused by stroke, and cognitive impairments significantly contribute to these disabilities (Cumming et al., 2012). Bour, Rasquin, Boreas, Limburg and Verhey, (2010) stated that cognitive impairment is widely seen in more than half of the patients with stroke, with memory, executive functions, speed of information processing and visuo-spatial abilities being the most affected areas (Edwards et al., 2006; Tatemichi et al., 1994), besides mental slowness (Bour et al., 2010).

To sum up, cognitive deficits are common consequences following ABI – TBI and stroke, requiring health care professionals to use a range of neuropsychological instruments to examine patients’ cognitive functions. TIB and stroke seem to produce different profiles of cognitive impairments, in terms of severity but also in terms of specificity (orientation and recall more impaired in TBI).

Cognitive screening tools

Health care professionals are regularly required to administer a rapid assessment of the patients' cognitive abilities. The administration of screening tests is warranted to highlight areas of impairment (Lincoln, Drummond, Edmans, Yeo, & Willis, 1998) such as cognitive impairments (Oudman et al., 2014), measure treatment effects, and detect cognitive decline that may occur over time (Koekkoek, et al., 2013). Ideally, it is very useful if the screening tests are quick and easy to administer so it can be used by professionals with little training in neuropsychological testing (Blake, McKinney, Treece, Lee, & Lincoln, 2002). Most importantly, cognitive screening tests need to be sensitive enough to capture potential impairments (Nysa et al, 2005).

The Mini Mental State Examination (MMSE) (Folstein et al., 1975) is the mostly used screening tool. It was originally developed to be used in a psychiatric setting with people with dementia and delirium. Since its publication it has been commonly used to examine global cognitive deficits (Nysa et al, 2005), especially in older adults (Kochhann et al., 2009). The MMSE examines orientation, registration, attention and calculation, recall, naming, repetition, comprehension (verbal and written), writing, and construction (Mitchell, 2009). Generally, people who score from 30 to 23 (max = 30) are considered to have normal cognitive functions, scores from 22 to 19 are borderline, and scores below 18 suggest some sort of cognitive deficit (Folstein et al., 1975). A copy of the original MMSE cannot be attached for copyright issues.

The MMSE has been criticised for generating a high false positive rate (Nelson et al., 1986), especially within persons with low education and socioeconomic status

(Fountoulakis, 1998). This is a common problem in measures that depend on a single score to interpret impairment of abilities (Moss & Albert, 1988). Moreover, there is a conflict of opinion regarding the cut-off score of the MMSE, which is essential for differentiating between intact and impaired cognition (Nys et al., 2005). Further, it was pointed out that the MMSE is not a useful cognitive screening measure for memory complaints or overall cognitive deficits (Blake, 2002). Recently, Van Heugten et al. (2014) reported that the MMSE presented poor criterion validity and had insufficient sensitivity in capturing cognitive deficits in neurological patients such as those with stroke. In addition, Iracleous et al. (2010) conducted a survey to investigate the views of primary care physicians on cognitive screening. A postal survey questionnaire was randomly sent to 249 physicians who were registered with the College of Family Physicians of Canada. It was found the MMSE is among the top three commonly used screening tools, but that the physicians did not strongly agree that it was effective. Therefore, there was an indication of a need to develop a better screening test that can be used in primary care.

In sum, although these studies show that the clinicians mostly administer the MMSE, it suffers from some limitations, which reinforces the recommendation that health care professionals should not rely on one single measure (Benson et al., 2005). Thus, using an alternative screening tool that provides more accurate psychometric properties would be recommended. However, despite its limitations, the MMSE remains the most commonly used cognitive screening tool, and as such, will be considered as a gold standard in the current study. In the following section we will review the studies concerning the Cognistat, an accurate cognitive screening tool (Van Heugten et al., 2014) which overcomes many limitations identified in the MMSE and other commonly used tests.

The Cognistat

The Cognistat (previously named Neurobehavioral Cognitive Status Examination; Kiernan, Mueller, Langston, & Dyke, 1987) is a cognitive screening tool that provides more sensitivity than the MMSE and enables clinicians to understand and identify the patient's areas of cognitive strengths and weaknesses. It was also developed to detect cognitive deficits among patients with neurological and psychiatric conditions. The test takes about 20 to 40 minutes to administer (Kiernan et al., 1987). Up to this date, the Cognistat is available in 12 languages and the Arabic language is not yet among these versions (Mueller, Kiernan, & Langston, 2014). The Cognistat provides a quick identification of intact cognitive areas and areas of dysfunction. It examines different major ability areas including language (speech, comprehension, repetition and naming), reasoning (similarities and judgment), orientation (to person, place and time), construction, memory registration, calculation, consciousness and attention. Each subtest of the Cognistat, except memory and orientation, starts with a more difficult screening item. If the patient is able to answer correctly, the examiner can proceed to the following subtest, otherwise the metric items would need to be administered (Kiernan et al., 1987). A copy of the original Cognistat cannot be attached for copyright issues.

Use and limitations of the Cognistat

The Cognistat initial standardisation data was established by Kiernan, Mueller, Langston and Dyke (1987) through the testing of 119 healthy English speaking adults (from 20 to 92) and 30 English speaking patients with brain lesions. The healthy group was further divided in three groups based on age (30 young adults between 20 to 39 years, 30 older adults between 40 to 66 years, and 59 geriatric adults between 70 to 90 years). A health check questionnaire was completed by all participants for medical history and use of drugs or substances that might have an impact on testing. The geriatric adults had no history of medical or psychiatric illness that may affect cognitive function, and did not take anti-psychotropic medications that may have an impact on cognition. The standardisation data obtained from this study provided a description of the range of normal scores in healthy individuals (see table 1). The healthy participants showed almost perfect performance on all sub-tests.

Table 1

Sub-tests	Max	Young adults (n = 30)		Older adults (n = 30)		Patients (n = 30)		Geriatrics (n = 59)	
		Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Age		28.2	4.7	50.8	7.2	54.2	16.9	77.6	5.2
Orientation	12	11.9	0.2	12	0	10.5	2.6	11.7	0.7
Attention	8	7.5	0.8	7.1	1.2	6.3	2.4	7.7	0.9
Comprehension	6	5.9	0.3	6	0.2	5	1.5	5.9	0.4
Repetition*	12	11.94	0.25	12.5	0.7	11.1	2.9	12.4	0.8
Naming*	8	7.31	0.60	8.5	0.7	7.1	2.1	8.2	1.1
Construction	6	5.0	0.7	5.0	0.4	3.6	1.8	4.1	1.5
Memory	12	11.8	0.5	11.5	0.7	6.3	3.6	10.1	2.2
Calculation	4	3.9	0.2	3.8	0.6	3.17	1.2	3.9	0.3
Similarities	8	6.2	0.5	6.1	0.6	4.3	2.5	5.6	1.3
Judgment	6	5.0	0.2	5.6	0.9	4.9	1.3	5.8	0.8

Table 1. For each subtest of the Cognistat, mean score (and standard deviation) of the English population, as taken from Kiernan, Mueller, Langston, and Dyke (1987). Note: an experimental error was noted by the authors for the Repetition and Naming (the maximum possible scores for Repetition and Naming were higher than the theoretical values of 12 and 8).

A separate study (detailed below) was conducted on 30 neurosurgical patients with documented brain lesions, with a mean age of 54.2 (from 25 to 88 years) (Schwamm, Van Dyke, Kiernan, Merrin, & Mueller, 1987).

Further to this initial study, the Cognistat was validated for patients with different neurological conditions such as brain injury (mainly Stroke and TBI) (Hinkle, 2012; Nabors, Millis, & Rosenthal, 1997; Nokleby et al., 2008; Schwamm et al., 1987), Alzheimer's disease (Tsuruoka et al., 2016; Gorp et al., 1999) and dementia (Drane & Osato, 1997). It is worth mentioning that there are a limited number of studies that focused on patients with ABI – especially stroke and TBI.

In one of the validation studies by Schwamm et al. (1987), the original English Cognistat was compared with the Cognitive Capacity Screening Examination (CCSE; Jacobs, Bernhard, Delgado, & Strain, 1977) and the MMSE to determine its sensitivity in detecting cognitive impairment in English speaking patients with brain lesions due to stroke and brain tumours. Thirty patients with documented brain lesions (with a mean age of 54.2) were included in the study. The exclusion criteria involved patients who underwent surgery 6 months prior to the testing sessions, patients with dementia or delirium, those with history of significant neuromedical or metabolic disorder, patients with substance abuse, patients with psychiatric illness or learning disabilities. Participants also produced spontaneous speech and were able to follow simple instructions. The three cognitive tests (Cognistat, CCSE and MMSE) were administered to the patients in a single session. The sequence of the tests was counterbalanced to control for possible order effect. Testing was completed within the 5 days of hospitalization and prior to the neurosurgery. Results showed that the examination scores were not affected by the order of test administration. Twenty eight patients were found to have cognitive impairment using the Cognistat. In contrast, the MMSE identified cognitive impairment in 16 patients and the CCSE identified only 13 patients. In addition, the results revealed that the Cognistat is more sensitive than the MMSE: the false negative rate of the MMSE was 43% whereas the

Cognistat had a much lower false negative rate (7%). According to Schwamm et al. (1987), the Cognistat was more sensitive than the other two tests (MMSE and CCSE) because (1) it does not have a global score but a separate score for each cognitive domain; (2) it follows a screen and metric procedure in which the person who fails the screen item (difficult items) is evaluated for possible dysfunction with the metric items (involving test items with graded difficulties). Finally, additional areas of cognitive function are examined in the Cognistat compared to the MMSE and CCSE. In conclusion, the Cognistat appeared to have a higher sensitivity to detect cognitive deficits than the other two tests, at least in patients with brain lesions.

A further study involving stroke patients was conducted by Nokleby et al. (2008), who compared three cognitive screening tests, the Cognistat, the Screening Instrument for Neuropsychological Impairments in Stroke (SINS; Sodring, Laake, Sveen, Wyller, & Bautz-Holter, 1998) and the Clock drawing test (Shulman, 2000). The study involved 49 patients with stroke as defined by the WHO (1980), and they were tested in a stroke rehabilitation setting. The participants' ages were between 25 and 91 years. As gold standard the Norwegian standard battery of neuropsychological assessment was used (Andresen, Sundet, 1990; Sundet, 1991). The Cognistat was found to have the highest sensitivity in detecting cognitive deficits (82%) among the other tests, with a specificity of 50%. Also, it was found that the memory subtests involved in the Cognistat were the best indicators of memory problems, and that the Cognistat language area showed a good performance.

The Cognistat was also validated for the use with TBI patients (Nabors, Millis, & Rosenthal, 1997). A retrospective study was conducted to test the relationship between established neuropsychological measures and the Cognistat. Forty five patients (with a mean age of 39.5 years; mean years of education of 10.4) who were diagnosed with TBI and tested by the Cognistat were included in the study. It was hypothesised that there would be some association between the neuropsychological measures and the Cognistat scores in related constructs. The Cognistat was administered on patients as part of the neuropsychological examination. It was found that the TBI patients showed impairment in construction, memory and similarities sub-tests. Orientation, repetition, calculation and judgment sub-tests were in the average and mildly impaired range. It was also found that education was related to the Cognistat scores, unlike the other demographic variables (age, gender and race). Education modulated half of the sub-tests of Cognistat including orientation, naming, memory, calculation and construction. The authors of the study stated that level of education should be considered when interpreting Cognistat with TBI patients. Finally, attention, memory, construction and comprehension sub-tests showed correlation with the neuropsychological measures, but no correlation was found between the reasoning sub-test of the Cognistat and the neuropsychological measures. As hypothesised, some of the sub-tests of the Cognistat were positively correlated with the neuropsychological measures. The findings of the study suggested that the Cognistat is a sensitive tool that has the ability to detect cognitive deficits following TBI (Nabors, Millis, & Rosenthal, 1997)**.**

Altogether, the aforementioned studies suggest that the Cognistat provides a high sensitivity in detecting cognitive deficits in patients with TBI and stroke.

Adapting the Cognistat to other cultures

The Cognistat is currently available in 12 languages – Spanish, French, Japanese, Indian, Chinese (Mandarin and Cantonese), Swedish, Hebrew, Norwegian, Finnish, and Czech (Mueller, Kiernan, & Langston, 2014). Here we compare the different adaptation approaches, and anticipate the potential issues.

Katz, Elazar and Itzkovich, (1996) validated the Cognistat for the Israeli population. The aim of the study was to assess the construct validity of the Cognistat in distinguishing between healthy elderly and elderly patients with Cerebral Vascular Accident/stroke (CVA) in Israel. The study also aimed at examining the complementary information of the Cognistat and the Loewenstein Occupational Therapy Cognitive Assessment (LOTCA; Katz, Itzkovich, Averbuch, & Elazar, 1989) for the assessment of post CVA patients and healthy elderly. It was hypothesised that (1) the Cognistat would be able to differentiate patients from the healthy elderly, and (2) there would be significant positive correlations between the Cognistat and the LOTCA sub-tests. Twenty four healthy independent elderly with a mean age of 78 years and 15 CVA patients with a mean age of 76 years were included in the study. Demographic variables showed no significant differences between both groups. Patients with severe aphasia and severe hearing or vision impairments were excluded. All participants were tested using the LOTCA followed by the Israeli version of Cognistat. Most of the testing was completed in two sessions in the same day or the following day.

For the Cognistat, a positive correlation was found between years of education and orientation, repetition and similarities. A significant negative correlation was found between age and construction subtest, and memory (the older the age, the lower the scores). For the healthy elderly group, age was correlated with repetition and similarities. LOTCA presented similar results in regards to age-related correlation. These results showed that age and level of education as demographic variables should be taken into consideration. There were significant differences between the healthy elderly group and elderly CVA patients in two sub-tests (orientation and language). Correlations were found between the LOTCA and the Cognistat, particularly in orientation, construction and calculation sub-tests. Memory, language and reasoning sub-tests could not be compared as they were not assessed in the LOTCA.

In summary, the Israeli version of Cognistat appeared to be suitable for its use with the elderly population by distinguishing between healthy and CVA patients, and there were positive correlations between compatible sub-tests of the LOTCA and the Cognistat. However, the scores of the healthy elderly for some of the Cognistat sub-tests were lower than those in the original validation study (the geriatric healthy American adults in Kiernan, Mueller, Langston and Dyke, 1987).

The Indian version of the Cognistat was adapted and validated for its use with patients with TBI by Gupta and Kumar (2009). The Indian Cognistat's content, administration and scorning procedure differ somehow from the original English version. For instance, the original Cognistat employs the screen and metric approach whereas in the Indian version, all metric items are administered to the patients as some researchers reported that the screen and metric approach have a high frequency of false positive (Fountoulakis et al., 1998; Oehlert et al., 1997). Also, the Indian Cognistat had an additional item in the language domain: the researchers added a checklist that involved common problems that could impact spontaneous speech such as dysarthria (disturbance of speech), anomia (difficulty finding words) and dysfluency (characterised by stuttering). In addition to this, five subtests required some modifications (such as word changes) to suit the Indian population including memory, language (mainly repetition and naming), similarities and judgment subtests. On the other hand, six subtests (orientation, attention, calculation, construction, comprehension and spontaneous speech) did not require cultural adaptation.

Fifty five healthy participants and 30 patients with moderate to severe TBI were included in the evaluation of the concurrent validity of the MMSE and the Indian Cognistat. For the test retest reliability, a sample of eight patients was examined.

The Indian Cognistat was found to be valid and reliable for detecting cognitive deficits in patients with TBI. Gupta and Kumar (2009) recommended the translation of the adapted Indian Cognistat to different languages and dialects in India. However, an important limitation to the study was that there were no available GCS scores for most of the patients at the time of injury, which are normally required to determine the severity of injury, as acknowledged by the authors. Despite these limitations, the results of the study encourage clinicians to use the Cognistat in clinical settings to screen cognitive function among patients with neurological conditions such as TBI.

The Japanese version of the Cognistat was adapted by Matsuda and Nakatani (2004), (the adaptation study was published in Japanese). For the validation study – published in English - Murakami et al. (2013) compared the Japanese version of the Cognistat and the MoCA (Nasreddine et al, 2005) in screening Parkinson's disease patients with Mild Cognitive Impairment (MCI). The MMSE, MoCA and Cognistat were administered to 50 patients with Parkinson's and Parkinson's with dementia, with sufficient rest time or in different days. Twenty five patients had a high score in the MMSE (27 or above, which is within the average range), and 13 scored below 25 in the MoCA (which is below average). Out of the 25 patients scoring high in the MMSE, 7 were found to have cognitive impairment in four or more subtests included in the Cognistat. Lower scores were mostly found in calculation, construction and similarity subtests. The results of the study also indicated that both the Japanese versions of the Cognistat and the MoCA were able to differentiate the characteristics of Parkinson's disease from MCI in patients who had a high MMSE score (Murakami et al., 2013). From the findings of the study we can conclude that the MMSE has a low sensitivity in detecting cognitive impairments but that the Cognistat alongside MoCA provide a better screening for cognitive function.

Finally, the Chinese-Cantonese Cognistat version was adapted and initially validated on 62 stroke patients and 33 healthy participants by Chan, Lee, Wong, Fong and Lee (1999). Four sub-tests were found culturally inappropriate: attention, language, memory, and reasoning. Thus, they were modified to suit the Chinese culture. The results of the study indicated that the stroke patients scored significantly lower than the healthy group in attention, calculation, and similarity sub-tests. An additional validated study by Chan et al. (2002), aimed at investigating the usefulness of the Chinese version of the Cognistat for use in elderly Chinese patients with stroke. Participants' age (around 70), gender and literacy level were matched. The study involved 53 stroke patients and 34 healthy elderly participants, with around 75% illiterate. Patients were at the post-acute stage and were recruited from two rehabilitation hospitals. The healthy elderly included had no reported mental or physical illness and they were living independently in the community. Only the metric items were administered to the patients and healthy participants in order to gain an optimal performance of the patients, as it was stated that the metric items helped in providing more information on the variation and consistency of the patient performance on each sub-test. The results indicated that the patients group scored significantly lower than the healthy group on 6 out of 10 sub-tests (orientation, attention, comprehension, repetition, calculation and similarities). High sensitivity (0.79) and specificity (85%) were reported for the orientation, attention and calculation sub-tests. Yet, the low literacy level of the elderly population and language structure seemed to slightly alter the patient's cognitive profile. According to Chan et al. (2002), having biased characteristics of the Chinese elderly population (low level of literacy) was an important limitation to the study. Establishment of Chinese normative data for people with different demographic and socio-cultural groups was recommended. In addition, it was suggested that the relationship between the different cognitive functions, detected by the Cognistat, functional performance and treatment outcomes of stroke patients, are a worthy area of investigation.

Chan et al. (2016) recently investigated the content validity of the Putonghua (or Mandarin, the standard language of China) version of the Cognistat, which was originally adapted by Chan et al. (1999). The study also aimed at examining the Cognistat structural and discriminative validity in relation to the effect of age and brain lesions after a stroke. It was hypothesised that the Cognistat profiles would distinguish between individuals with different brain lesions – frontal, parietal, fronto-parietal, and subcortical lesions. The methodology of the study involved two parts. First, the authors established the content validity and quality of the newly developed Putonghua version of the Cognistat, through an expert panel. Second, they investigated the construct and discriminative validity of the Putonghua Cognistat.
Participants (from 25 to 70 years of age) were divided into three groups: 91 post-stroke patients with a mean age of 56 years, 34 young healthy adults with a mean age of 33 years and 40 healthy older adults with a mean age of 75 years. Medical screening was administered to all patients. The inclusion criteria for the patients

involved patients who were diagnosed with stroke for the first time, patients with lesions in the frontal-lobe region, patients speaking Putonghua as a maternal language and stroke onset time between 6 months to 3 years. The exclusion criteria involved those who were illiterate, people with aphasia, psychosis, or dementia. The areas of the brain affected in post-stroke patients were confirmed by rehabilitation doctors or neurologists.

The results first indicated that some items of the Cognistat required amendments to suit the Putonghua Chinese population, that is, in the naming, memory and similarities subtests. The results also showed that construction, similarities and judgment subtests distinguished patients with frontal or parietal lesions from those with subcortical lesions. The construction subtest was found to be the most useful subtest in differentiating between patients with parietal lesions and those with subcortical lesions, and between the fronto-parietal and subcortical groups. The similarities and construction sub-tests were most likely to differentiate between patients with frontal lesions and those with subcortical lesions. These findings add to the body of knowledge on the validity and usefulness of the Cognistat in stroke rehabilitation. In addition, these results can be helpful to clinicians to help them relate specific brain lesions to neurobehavioral problems, which can in turn help in designing effective clinical interventions for post-stroke patients (Chan et al., 2016).

In summary, the Cognistat as a cognitive screening measure appears to be a valid and reliable tool, with potential for providing fine-grained assessment information; yet adjustments are needed when adapting it to new cultures and language groups. The translation, cultural adaptation and validation of the Cognistat from English to Arabic language would be of major help in detecting cognitive deficits among the Arabic speaking population, and it would assist in improving the health care services in the Arabic world.

Existing cognitive screening tools translated and adapted to Arabic

To date, the majority of cognitive assessment measures have been developed in the English language (Siedlecki et al., 2010) and only a few of them, such as the MMSE and MoCA, have been adapted for Arabic speakers (Abdel Rahman & El Gaafary, 2009). Although Uysal-Bozkir et al. (2013) stated that the MMSE was among the most commonly used cognitive tools and the only test found in Arabic, the MoCA was found to be available in the Arabic language (Abdel Rahman & El Gaafary, 2009). The MoCA was developed following criticisms of the MMSE, to screen cognitive functions and identify MCI (Nasreddine et al, 2005). It is a quickly administered test that contains a wider range of cognitive items than the MMSE. Short-term memory recall, visuospatial ability, executive function, attention, concentration, working memory, language, and orientation to time and place are its the main items, scoring to a maximum of 30 (Lee et al., 2008). The MoCA uses the cut-off score of 26 to distinguish people with normal cognition from individuals with cognitive impairments (Luis et al., 2009). It only takes 10 minutes to administer, and has a high sensitivity in detecting MCI (Lee et al., 2008), although it was developed primarily to assess cognition in people with cardiovascular conditions (Hachinski et al, 2006; Ismail et al., 2010). Most importantly, similarly to the MMSE, the MoCA provides a global score that might be problematic in causing a high rate of false positives (Moss & Albert, 1988). Therefore, the adaptation or development of more specific cognitive measures for Arabic speakers is greatly required to overcome the current limitation of existing assessment measures (Wrobel & Farrag, 2008).

To sum up, the reviewed literature on the MMSE (as the most widely used cognitive screening tool) shows that a number of limitations to the MMSE should drive health care professional to use alternative, more sensitive, screening tools. In addition to this, it is acknowledged that there is a need for adapting and/or developing cognitive tools for the Arabic population. Our review of the studies using Cognistat strongly suggests that this test provides a sensitive set of screening measures that helps in determining different cognitive deficits, including level of orientation, attention, short term memory, language, calculation, constructional abilities and reasoning. Based on the author's clinical experience in a rehabilitation setting in Saudi Arabia, it was anticipated that the Cognistat would be widely used to assess Arabic patients with a neurological condition such as TBI and stroke.

Cross-cultural adaptation

It has been stated that the appropriate method for developing a reliable health assessment tool is through cross-cultural adaptation of existing health assessment scales. "The term cross-cultural adaptation is used to encompass a process which looks at both language (translation) and cultural adaptation issues in the process of preparing a questionnaire for use in another setting" (Beaton et al., 2007, page 3). Cross-cultural adaptations of existing health measures assist professionals in the examination of patients in their own cultural context. The psychometric properties of the adapted measures should be tested straight after the completion of the cross-cultural adaptation. Such a testing helps in getting a valid knowledge about the usefulness of the adapted measure. It has also been acknowledged that a gold standard that addresses similar phenomena to the adapted test should be used for the validity criterion (Uysal-Bozkir et al., 2013).

Wrobel and Farrag (2008) acknowledged that translation of items involved in the chosen measure is not an easy process. In fact there are often no comparable words or expressions that resemble the items on the original English measure. A good example of this is the item in the MMSE “No ifs, ands or buts” (Wrobel & Farrag 2008, p. 78). This item is problematic even for the English speakers in the UK, as “No ifs or buts” is found to be the most common expression (Gibbons et al., 2002 cited in Wrobel & Farrag 2008, p. 78). A number of investigators have chosen different culture-specific phrases that could be more appropriate to their target population (Werner et al., 1999).

The difficulty to translate can go beyond language. For example, testing orientation to time can be problematic as the use of calendar or identification of the seasons can vary from one culture to another, which could have an impact on the test results (Wrobel & Farrag, 2008). Therefore, it is important to consider both translation and cultural adaptation to gain a better use of the test. Accordingly, the cultural adaption of the Cognistat needs to be pursued with several objectives in mind: a) obtain a validated and culturally appropriate tool for the assessment of cognitive function in Arabic patients with ABI, b) help in improving healthcare services in the Arabic world by having a validated tool in the Arabic language, and c) enable the investigation of cultural differences in cognitive functions in Arabic and English speaking populations.

Aims of the first study

The aims of the first study are as follows: a) to translate and culturally adapt the Cognistat from English to Arabic to be used with the Arabic speaking population with ABI, b) to test its validity and c) to examine the cultural differences in cognitive performance between the Arabic and English populations.

It is hypothesised that a) the Cognistat will be a valid and reliable tool in detecting cognitive deficits in Arabic patients with ABI; b) significant differences will be found between the healthy group and patients with ABI, and following Zhang et al. (2016) findings, there might be different cognitive profiles between TBI and stroke patients especially in orientation and recall; c) based on our review on the Arabic culture and cognition, it is also predicted that there might be cultural differences in cognitive processes between the Arabic and English populations, especially in memory and orientation to time (Oxford & Anderson, 1995; Wunderle, 2006, respectively).

Methodology

The study was completed in two stages. First the guideline for the cross-cultural adaptation process suggested by Beaton et al. (2007) was followed. The cross-cultural adaptation process started with a forward translation of the original English Cognistat. Two bilingual professionals with Arabic as a native language (translator and author of this thesis) translated and culturally adapted the Cognistat from the source language (English) to standard Arabic. The Cognistat manual (about 82 pages), the scoring sheet for the paper and pencil format of the Cognistat, and the computerised version of the Cognistat were all translated and culturally adapted. The two forward translators agreed on the final translation/adaptation versions (translation synthesis). For the backward translation, a bilingual professional with English as native language (a final year law student) translated the Cognistat from Arabic back to English, this process considered as a validity checking. The backward translation was done for the Cognistat manual and the scoring sheet for the paper and pencil format. An expert committee of five professionals discussed and agreed on the items changed/adapted to suit the Arabic population, especially the Saudi culture. Three of the committee members were qualified occupational therapists, with two of them being PhD students. The fourth member was a qualified translator. The last member was a final year law student with no medical background.

Cultural adaptation of the Cognistat items

The Cognistat examines different major ability areas including level of language, construction, memory, calculations, reasoning, consciousness, orientation, and attention. The expert committee panel suggested that the orientation, attention, comprehension, construction and calculation did not require any changes. In the comprehension subtest, the sentence length and structure remained unchanged in Arabic. Yet, some items in the memory, language (repetition and naming) and reasoning (similarities and judgment) sub-tests were adapted to suit the Arabic speaking population. Specifically, in the memory task the words, ‘robin’, ‘blue jay’, ‘violin’ and ‘guitar’ were replaced with ‘falcon’, ‘parrot’, ‘oud’ (an Arabic musical instrument known in most Arabic countries i.e. Gulf countries, Egypt, Iraq and Morocco) and ‘drum’, respectively. In the language sub-test - repetition - the sentence ‘The beginning movement revealed the composer’s intention’ did not sound understandable when translated to Arabic, thus it was replaced with an Arabic appropriate sentence ‘The higher the human the more clouds surrounds’. Also, the literal translation of the sentence ‘No ifs, ands or buts’ was replaced with ‘No refuses and excuses or exceptions’. The number of syllables and length of the Arabic sentences were equivalent to the replaced English ones. In the naming subtest, ‘kite’ and ‘xylophone’ were replaced with ‘airplane’ and ‘flute’ respectively. In the similarities task, ‘rose’ and ‘tulip’ were replaced with ‘daffodil’ and ‘jasmin’ which are common flowers in Arabic countries. For the judgment task, the screening question ‘What would do if you were stranded in an airport 1,000 miles from home with only $1.00 in your pocket?’ was clarified with ‘What would you do if you found yourself alone in an airport 1000 miles/ 1600 km away from your home country with only 1 dollar/ 5 Saudi riyals in your pocket, and you wanted to go back to your country?’

A number of secondary challenges were encountered during the translation and cultural adaptation of the Cognistat.[1]

Pre-testing/pilot study

As a final step of the cross-cultural adaptation process, pre-testing was conducted to investigate differences in the performance of the Arabic adults and those in the original validation study in the different sub-tests of the Cognistat.

Participants: 22 healthy Arabic speaking adults with a mean age of 26 (including 12 females and 10 males) and a mean number of 15.8 years in education, recruited through Plymouth University psychology studies advertisement and word of mouth, originating from various Arabic-speaking countries. Participants were paid £4 for their participation. A consent form was signed at the beginning of the testing session.

Measures: The two assessment tools used were the Cognistat and the Mini Mental Status Examination (MMSE) as a gold standard.

- [1] Translation of the lengthy privacy policy included in the computerised version of the Cognistat was challenging due to its technicality. Because of this, a legal expert was consulted to help writing it in the appropriate Arabic format.
- To assist in the translation of the medication names, a pharmacist was consulted to review the generic names of the medications in Arabic. The medications brand names were problematic because some of the medication names were not available in Saudi Arabia under those names, in which case they were translated phonetically.
- For the word “lethargic” in level of consciousness, there is no exact meaning in the Arabic language. It is worth mentioning that such a difficulty was only experienced with this word. Merriam Webster dictionary defines it as ‘feeling a lack of energy or a lack of interest in doing things’. So it was translated based on the meaning.
- In the memory section, the words ‘sparrow’ and ‘robin’ were difficult to translate as they both have a similar meaning in Arabic. Thus, ‘sparrow’ was kept and ‘robin’ was replaced with another bird ‘falcon’.
- Finding the backward translator with English as a maternal tongue and Arabic as a second language was challenging.
- The translation process was time and money consuming. The Cognistat manual included more than 80 pages which required a long time and effort to professionally translate and culturally adapt. In regards to the expenses, the second forward translator and backward translator needed to be paid.

Procedure: After completing a health check questionnaire, all participants were tested using the adapted Arabic Cognistat and MMSE in a counterbalanced order in a quiet room at Plymouth University. The order of item presentation followed exactly that in the original Cognistat. The average participating time was 30 minutes.

Results: The mean scores for each subtest included in the MMSE are reported in Table 2. Arabic participants scored at ceiling in all subtests except for attention and calculation. However, the mean scores for the attention and calculation subtests provided a satisfactory level for their testing purpose, neither ceiling nor flooring.

The mean scores for the Arabic Cognistat were compared to those of the original English Cognistat through paired t-tests for each subtest. As seen in Table 3, the mean scores of the Arabic participants were similar to those of the English participants except for the calculation, memory and similarities subtests. Arabic speakers scored significantly lower in calculation and memory compared to the English speakers, whereas they scored significantly higher for the similarities subtest.

Table 2

Sub-tests		Arabic group (n = 22)	
	Max	Mean	(SD)
Age		26.0	4.7
Orientation	10	9.9	4.7
Registration	3	3	0
Attention and Calculation	5	3.5	1.3
Recall	3	2.7	0.7
Naming	2	2	0
Repetition	1	0.95	2.1
Three-stages commands	3	3	0
Reading	1	1	0
Writing	1	1	0
Copying	1	0.86	0.3

Table 2. For each subtest of the MMSE, mean score (and standard deviation) of the Arabic population.

Table 3

Sub-tests	Max	Arabic group (n = 22)		English group (n = 30)		t	p-values
		Mean	(SD)	Mean	(SD)		
Age		26.0	4.7	28.2	4.7	ns	
Orientation	12	11.8	0.3	11.9	0.2	ns	
Attention	8	7.6	0.7	7.5	0.8	ns	
Comprehension	6	6	0	5.9	0.3	ns	
Repetition*	12	11.8	0.3	11.94	0.25	ns	
Naming*	8	7.2	0.9	7.31	0.60	ns	
Construction	6	5.3	1.2	5.0	0.7	ns	
Memory	12	11.1	1.4	11.8	0.5	2.28	0.03
Calculation	4	3.40	0.6	3.9	0.2	3.80	0.0004
Similarities	8	7.8	0.4	6.2	0.5	12.18	0.001
Judgment	6	5.3	1.2	5.0	0.2	ns	

*Table 3. For each subtest of the Cognistat, mean score (and standard deviation) of the English population as taken from Mueller et al. (2014); mean score of the Arabic population and paired t-test. Values marked with * are those for the adolescent sample of the English standardisation data (due to an experimental error in Mueller et al., (2014) the maximum possible score for Repetition and Naming was higher than the theoretical values of 12 and 8).*

Pilot study discussion

Pre-testing data suggests that most adapted items produced similar responses from Arabic-speaking healthy adults as compared to English-speaking participants. The memory and calculation subtests, although providing lower scores in the Arabic population provide satisfactory next-to-ceiling scores. Our result on memory was similar to the findings of Chan et al. (2002) for which the Chinese healthy adults performed significantly lower than the American control group. Low calculation scores were also found among Arabic adults using the MMSE. The lower scores in calculation could be due to a cultural specificity; the author’s personal experience is that adult Saudis tend to rely on calculators even for simple calculations.

The next step was to engage into the validation data collection process with 75 to 100 healthy adults and 60 patients with Acquired Brain Injury (ABI) – 30 patients with stroke and 30 patients with Traumatic Brain Injury (TBI).

Validation Study

The main validation study aimed at comparing normal adults and patients with stroke and TBI between the ages of 18-60, similarly to those in the original validation study (Kiernan et al., 1987). Adults aged over 60 were not part of this study because accessing this particular population is problematic and challenging in the Arabic world as pointed out by Wrobel and Farrag (2008).

Participants

A total of 62 ABI patients (30 stroke and 32 TBI) and 107 healthy adults took part in the validation study. As in the original English Cognistat study, the controls and patients were put in two groups – young (18-39 years of age) and old (40-60 years of age), (Kiernan, Mueller, Langston, & Van Dyke, 1987). Patients were recruited from a rehabilitation hospital in Saudi Arabia (61 out of 62 were Saudis). This group was made of 45 males (72.6%) and 17 females (27.4%) with a mean age of 37.6 years and a mean number of 11.6 years in education. More men were diagnosed with TBI than women as a result of road traffic accident - women do not drive in Saudi Arabia. Patients were in the post-acute phase of their illness - a stage in which the primary incident starts to be under control (Ayres, Harrison, & Nichols, 2010).

The inclusion criteria were as followed for the stroke patients: individuals who were diagnosed with stroke according to the WHO definition, patients who were medically stable (patient is conscious, vital signs are stable/unchanging and within normal limits, confirmed by the medical notes), patients between 18-60 years of age.

The inclusion criteria for the TBI patients were as follows: individuals who were diagnosed with TBI according to the WHO definition, patients who were medically stable, patients between 18-60 years of age, and Glasgow Coma Scale (GCS) (Balestreri et al., 2004) score of 15 at the time of testing.

The exclusion criteria for the TBI patients included those with severe visual or hearing impairment alongside those with aphasia. TBI patients with orthopaedic problems were also excluded as these problems might interfere with performance on paper-pencil tasks. We also excluded patients with history of psychiatric illness and substance abuse, patients unable to speak Arabic, and patients unable to provide informed consent. The exclusion criteria for the stroke patients included those with post stroke depression as it might limit the generalisability of the findings. As for TBI, patients with history of psychiatric illness and substance abuse were excluded, together with those with severe visual or hearing impairment, aphasia, patients unable to speak Arabic and unable to give their consent. It is worth mentioning that the GCS was reported in the patients' medical records, at the time of recruitment in the study, with no indication of the severity of cognitive impairment.

Members of the control group were recruited through a rehabilitation hospital in Saudi Arabia, the University of Plymouth school of \\psychology advertisement website and word of mouth. More than half of the healthy controls (n = 72) were tested in Saudi Arabia (care givers of the patients, health care professionals at a rehabilitation hospital in Saudi Arabia, friends, and family members of the author). The rest of the participants (n = 35) were tested in the UK. The control group involved 45 males (42.1%) and 62 females (57.9%) with a mean age of 30.9 years and a mean number of 14.6 years of education. This healthy Arabic speaking adults originated from various Arabic-speaking countries including Saudi (n=86) and other Arabs (n= 21).

Procedure

Patients completed a written consent form prior to their participation. Some of the patients required help at that stage, as they had difficulty reading (due to low level of education) and writing (due to a low level of education and injury-related physical limitations that affected the dominant hand). In those cases, the examiner read the consent form to the patient and patient orally agreed to take part in the study. After completing a health check questionnaire, all participants were tested using the adapted Arabic Cognistat and the MMSE in a counterbalanced order in a quiet room at the University of Plymouth or at the rehabilitation hospital in Saudi Arabia. The order of item presentation followed exactly that in the original Cognistat manual (Mueller, Kiernan, & Langston, 2014). The average participating time was 30 minutes. The paper and pencil versions of the Cognistat and the MMSE were administered by the first author and two trained occupational therapists.

Data Analysis

Mean and standard deviation were calculated for each sub-test and each population to establish standardisation data. Then the Arabic data was compared to the original English data. T-tests were used to compare (1) mean scores of the Arabic control group and the English control group data from Kiernan et al. (1987), (2) mean scores of the Arabic ABI patients and the English neurosurgical patients from Kiernan et al. (1987), and (3) mean scores of the Arabic ABI patients and the Arabic control group. The English neurosurgical patients from Kiernan et al. (1987) involved patients who were diagnosed with a range of brain conditions including brain tumours and stroke.

In the control group, Pearson's r correlations were used to assess the effect of demographic variables (age, education and gender) on scores of the sub-tests of the Cognistat. For example, we expected a positive correlation between years of education and scores in the reasoning sub-tests, but no effect of gender.

Internal consistency was calculated through Cronbach's alphas, and intra-class correlations were used on a subgroup of 12 healthy participants for the test re-test reliability.

For the concurrent validity, Pearson's r correlations were used to compare the Arabic patients' performance on the Cognistat sub-tests to the similar items of the MMSE. Pearson's r correlations were also used to compare the performance of the Arabic control group on the Cognistat to the MMSE.

For the discriminative validity, t-tests were used to compare the performance of Arabic patients and the Arabic control group. Further, a MANOVA was run to compare the performance of Saudi control group to that of other Arabs on the Cognistat, and to compare stroke and TBI groups. Following Zhang et al. (2016), we expected TBI patients to have more extensive and severe cognitive impairments than stroke patients.

Finally, percentile norms for the Arabic individuals between the age of 18 and 60 years were provided for each sub-test.

Results

The Arabic sample included 107 healthy adults and 62 patients with ABI. Information regarding the demographic characteristics of the patients and the control groups is presented in Table 4.

Table 4

Variable	Group	N	Percent	Mean (SD)	Range
Age	1 = young Arabic 2 = older Arabic 3 =young patients 4 = older patients			27.1 (5.2) 47.7 (5.5) 24.9 (5.5) 54.1 (6.7)	18-39 40-59 18-39 41-60
Gender Male	1 = young Arabic 2 = older Arabic 3 = young patients 4 = older patients	36 10 27 18	41.4 50 77.1 66.7		
Female	1 = young Arabic 2 = older Arabic controls 3 = young patients 4 = older patients	51 10 8 9	58.6 50 22. 9 33.3		
Total	1 = young Arabic 2 = older Arabic 3 = young patients 4 = older patients	87 20 35 27			
Type of Injury Stroke	3 = young patients 4 = older patients	4 26	11.4 96.3		
TBI	3 = young patients 4 = older patients	31 1	88.6 3.7		

Education in years	1 = young Arabic			14.9 (2.8)	7-20
	2 = older Arabic			13.2 (5.1)	6-17
	3 = young patients			13.0 (2.7)	8-20
	4 = older patients			9.7 (5.1)	0-17
School	1 = young Arabic	26	29.9		
	2 = older Arabic	10	50		
	3 = young patients	22	62.9		
	4 = older patients	18	11.1		
Undergraduate	1 = young Arabic	50	57.5		
	2 = older Arabic	6	30		
	3 = young patients	12	34.3		
	4 = older patients	6	22.2		
MSc	1 = young Arabic	0	0		
	2 = older Arabic controls	7	35		
	3 = young patients	0	0		
	4 = older patients	0	0		
PhD	1 = young Arabic	4	4.6		
	2 = older Arabic	4	20		
	3 = young patients	1	2.9		
	4 = older patients	0	0		
Nationality					
Saudi	1 = young Arabic	68	78.2		
	2 = older Arabic	17	85		
	3 = young patients	35	100		
	4 = older patients	26	96.3		
	1 = young Arabic	19	21.8		
	2 = older Arabic	3	15		
Other Arabs	3 = young patients	0	0		
	4 = older patients	1	3.7		

Occupation prior to injury/testing					
Student	1 = young Arabic	41	47.1		
	2 = older Arabic	4	20		
	3 = young patients	12	34.3.		
	4 = older patients	0	0		
Stay at home parent	1 = young Arabic	1	1.1		
	2 = older Arabic	0	0		
	3 = young patients	2	5.7		
	4 = older patients	7	25.9		
Soldier	1 = young Arabic	1	1.1		
	2 = older Arabic	2	10		
	3 = young patients	8	22.9		
	4 = older patients	0	0		
Public sector	1 = young Arabic	35	40.2		
	2 = older Arabic	5	25		
	3 = young patients	1	2.9		
	4 = older patients	8	29.6		
Private sector	1 = young Arabic	3	3.4		
	2 = older Arabic	1	5		
	3 = young patients	2	5.7		
	4 = older patients	4	14.8		
Retired	1 = young Arabic	0	0		
	2 = older Arabic	1	5		
	3 = young patients	8	12.9		
	4 = older patients	8	29.6		
Unemployed	1 = young Arabic	6	6.9		
	2 = older Arabic	7	35		
	3 = young patients	10	28.6		
	4 = older patient s	0	0		

Table 4. Demographic characteristics of the Arabic population.

Table 5 presents the mean and SD of the Arabic Cognistat scores for young adults (18-39 years), older adults (40-60 years), young ABI patients (18-39), and older ABI patients (41-60). Age groups were chosen to be similar to those in the original Cognistat study.

Table 5

Sub-tests	Max	Young adults (n = 87)		Older adults (n = 20)		Young patients (n = 35)		Older patients (n = 27)	
		Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Age		27.1	5.1	47.7	5.4	24.9	5.5	54.1	6.7
Orientation	12	11.8	0.4	11.6	0.7	9	2.9	10.2	2.3
Attention	8	7.7	0.8	6.2	2.3	5.8	2.7	5.2	2.5
Comprehension	6	6	0	6	0	5.6	0.9	5.4	1.0
Repetition	12	11.9	0.2	11.7	0.9	8.9	4.6	10.1	3.0
Naming	8	7.5	0.8	7.7	0.7	6.2	1.8	6.5	1.9
Construction	6	5.2	1.2	4.4	1.3	2.1	2.2	1.6	2.3
Memory	12	10.9	1.8	10.5	1.9	7.1	3.2	6.7	3.8
Calculation	4	3.3	1.0	2.6	1.5	1.8	1.2	2	1.5
Similarities	8	7.7	1.0	7.1	1.6	3.2	3.1	4.2	5.6
Judgment	6	5.5	1.0	6	0	3.4	2.3	3.7	2.4

Table 5. Arabic Cognistat standardisation data.

Comparison of Arabic and English groups

The mean scores of the Arabic Cognistat control groups were compared to those of the corresponding groups in original English Cognistat through t-tests for each subtest. The results (Table 6) revealed that the young Arabic population scored significantly higher than the young English in comprehension and reasoning (similarities and judgment), but scored significantly lower in naming, memory and calculation – however these scores were deemed satisfactory as they were consistently close to ceiling. No significant differences were found in orientation, attention, repetition and construction. For the older adults (Table 7), Arabic participants scored higher in reasoning (mainly similarities) than English participants, while they scored lower in orientation, repetition, naming, construction, memory and calculation. Orientation, repetition, construction, and memory scores of the Arabic older adults are satisfactory as they are close to ceiling. No statistically significant differences were found between attention, comprehension and judgment.

Table 6

Sub-tests		Young Arabic (n = 87)		Young English (n = 30)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age	39	27.1	5.1	28.2	4.7	ns	
Orientation	12	11.8	0.4	11.9	0.3	ns	
Attention	8	7.7	0.8	7.5	0.8	ns	
Comprehension	6	6	0	5.9	0.3	3.1	0.002
Repetition*	12	11.9	0.2	12.6	0.7	ns	
Naming*	8	7.5	0.8	8.7	0.5	-7.7	0.0001
Construction	6	5.2	1.2	5.0	0.7	ns	
Memory	12	10.9	1.8	11.8	0.5	-2.7	0.008
Calculation	4	3.3	1.0	3.9	0.2	-3.2	0.001
Similarities	8	7.7	1.0	6.2	0.5	7.9	0.0001
Judgment	6	5.5	1.0	5.0	0.2	2.7	0.007

*Table 6. For each subtest of the Cognistat, mean scores (and standard deviations) of the young English population as taken from Kiernan et al. (1987); mean scores of the young Arabic population and t-tests (df = 115). Values marked with * are those for the adolescent sample of the English standardisation data. Due to an experimental error in Kiernan et al, (1987), the maximum possible score for Repetition and Naming was higher than the theoretical values of 12 and 8.*

Table 7

Sub-tests		Older Arabic (n = 20)		Older English (n = 30)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		47.7	5.4	50.8	7.2	ns	
Orientation	12	11.6	0.7	12	0	-3.1	0.0028
Attention	8	6.2	2.3	7.1	1.2	ns	
Comprehension	6	6	0	6	0.2	ns	
Repetition	12	11.7	0.9	12.5	0.7	-3.5	0.0009
Naming	8	7.7	0.7	8.5	0.7	-3.9	0.0002
Construction	6	4.4	1.3	5.0	0.4	-2.4	0.0216
Memory	12	10.5	1.9	11.5	0.7	-2.6	0.0112
Calculation	4	2.6	1.5	3.8	0.6	-3.9	0.0003
Similarities	8	7.1	1.6	6.1	0.6	3.1	0.0030
Judgment	6	6	0	5.6	0.9	ns	

Table 7. For each subtest of the Cognistat, mean scores (and standard deviations) of the older English population as taken from Kiernan et al. (1987); mean scores of the older Arabic population and t-tests (df = 48).

Table 8 compares the Arabic patients and the English patients from Kiernan et al. (1987). Orientation, attention, naming, memory and similarities sub-test showed no significant differences between these two populations, whereas differences were found for comprehension, repetition, construction, calculation and judgment sub-tests. Arabic patients scored lower in repetition, construction, calculation and judgment in comparison to the English patients, whereas they had slightly higher scores in comprehension.

Table 8

Sub-tests		Arabic patients (n = 62)		English patients (n = 30)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		37.6	15.7	54.2	16.9	-4.63	0.0001
Orientation	12	9.5	2.7	10.5	2.6	ns	
Attention	8	5.5	2.6	6.3	2.4	ns	
Comprehension	6	5.5	0.9	5	1.5	1.9	0.0494
Repetition	12	9.4	4	11.1	2.9	-2.07	0.0407
Naming	8	6.4	1.8	7.1	2.1	ns	
Construction	6	1.9	2.2	3.6	1.8	-3.6	0.0004
Memory	12	7	3.4	6.3	3.6	ns	
Calculation	4	1.9	1.3	3.17	1.2	-3.6	0.0005
Similarities	8	3.6	3.4	4.3	2.5	ns	
Judgment	6	3.5	2.3	4.9	1.3	-3.09	0.0026

Table 8. For each subtest of the Cognistat, mean scores (and standard deviations) of the English patients as taken from Kiernan et al, (1987); mean scores of the Arabic patients and t-tests (df = 90).

Comparison of Arabic healthy controls and patients

The mean scores of the young Arabic control group were compared to the mean scores of the young Arabic patients through t-tests for each subtest (Table 9). The results indicated statistical significant differences between the two groups in all sub-tests.

Table 9

Sub-tests		Young Arabic control group (n = 87)		Young Arabic patients (n = 35)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		27.1	5.1	24.9	5.5	1.9	0.0372
Orientation	12	11.8	0.4	9	2.9	8.8	0.0001
Attention	8	7.7	0.8	5.8	2.7	5.9	0.0001
Comprehension	6	6	0	5.6	0.9	4.2	0.0001
Repetition	12	11.9	0.2	8.9	4.6	6.1	0.0001
Naming	8	7.5	0.8	6.2	1.8	5.5	0.0001
Construction	6	5.2	1.2	2.1	2.2	9.9	0.0001
Memory	12	10.9	1.8	7.1	3.2	8.3	0.0001
Calculation	4	3.3	1	1.8	1.2	7.1	0.0001
Similarities	8	7.7	1	3.2	3.1	12.1	0.0001
Judgment	6	5.5	1	3.4	2.3	7.0	0.0001

Table 9. For each subtest of the Arabic Cognistat, mean scores (and standard deviations) of the young Arabic control group, mean scores of the young Arabic patients, and t-tests (df = 120).

For the comparison between the older Arabic control group and the older Arabic patients (Table 10), the results showed statistical significant differences among all sub-tests apart from attention and calculation.

Table 10

Sub-tests		Older Arabic control group (n = 20)		Older Arabic patients (n = 27)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		47.7	5.4	54.1	6.7	-3.5	0.0010
Orientation	12	11.6	0.7	10.2	2.3	2.6	0.0117
Attention	8	6.2	2.3	5.2	2.5	ns	
Comprehension	6	6	0	5.4	1.0	2.6	0.0104
Repetition	12	11.7	0.9	10.1	3.0	2.3	0.0259
Naming	8	7.7	0.7	6.5	1.9	2.7	0.0101
Construction	6	4.4	1.3	1.6	2.3	4.9	0.0001
Memory	12	10.5	1.9	6.7	3.8	4.1	0.0002
Calculation	4	2.6	1.5	2	1.5	ns	
Similarities	8	7.1	1.6	4.2	5.6	2.2	0.0298
Judgment	6	6	0	3.7	2.4	4.3	0.0001

Table 10. For each subtest of the Cognistat, mean scores (and standard deviations) of the older Arabic control group, mean scores of the older Arabic patients, and t-tests (df = 45).

Correlation between demographic variables and performance in the test

When pooling all Arabic control participants, correlation between demographic variables (years of education, age and gender) and scores in the Cognistat sub-tests indicated that years of education were positively correlated with the orientation sub-test ($r = .29$, $p < .002$), construction ($r = .19$, $p < .041$), calculation ($r = .28$, $p < .002$), and similarities ($r = .35$, $p < .0001$). Age was positively correlated with the judgement sub-test ($r = .26$, $p < .005$), whereas a negative correlation was found between age and orientation ($r = -.19$, $p < .04$), attention ($r = -.41$, $p < .000$), construction ($r = -.36$, $p < .000$), and calculation ($r = - .34$, $p < .000$). As expected, no significant correlation was found with gender.

Internal consistency

The Arabic Cognistat showed an acceptable internal consistency, for the healthy group, with Cronbach's alphas of .78. As seen in Table 11, high internal consistency (> = .71) was found for 8 out the 10 sub-tests. Borderline internal consistency was found for the memory sub-test (.67), whereas low internal consistency was found for the orientation sub-test (.24). This is due to the orientation-to-time item, where 15 participants out of 107 performed lower than in the other items of the orientation subtest.

Table 11

Sub-tests of Cognistat	Cronbach's alpha	No. of items
Orientation	.24	8
Attention	.95	8
Comprehension	1.0	6
Repetition	.99	6
Naming	.97	8
Construction	.71	3
Memory	.67	4
Calculation	.85	4
Similarity	.88	4
Judgment	.90	3

Table 11. Internal consistency for the Arabic healthy group. N = 107

Test-retest reliability

A subgroup of 12 healthy participants (22-52 years) was tested twice over an interval of 7-10 days. Table 12 shows the test-retest reliability coefficient measured by intra-class correlation. The test retest reliability coefficients for the sub-tests showed a high stability of scores over time. Notably, the intra-class correlation coefficient (ICCC) for the orientation, attention and judgment sub-tests was 1.00. The ICCC for the memory sub-test was 0.81, 0.96 for construction and 0.84 for calculation. It was not calculated for the language (comprehension, repetition and naming) and similarities sub-test because all healthy participants obtained maximum scores in both test and retest (SD = 0).

Table 12

Sub-test		1st testing		2nd testing		Intra-class correlation
	Max	Mean	(SD)	Mean	(SD)	
Orientation	12	11.9	0.2	11.9	0.3	1.00
Attention	8	7.4	1.2	7.4	1.2	1.00
Comprehension	6	6	0	6	0	nc
Repetition	12	12	0	12	0	nc
Naming	8	8	0	8	0	nc
Construction	6	5.8	0.5	5.7	0.8	0.96
Memory	12	11.4	1.3	11.7	0.8	0.81

Calculation	4	3	1.3	3.2	1.2	0.84
Similarity	8	8	0	8	0	nc
Judgment	6	5.9	0.3	5.9	0.3	1.00

Table 12. Test-retest reliability coefficients. N = 12, NC = not calculated

Concurrent validity

Pearson's r correlations were used to compare the globe scores of the Cognistat and global scores of the MMSE. No significant result was found for the patients group (r = -.029; p = .822) presumably because scores were at ceiling in the MMSE. However, a significant correlation was found for the Arabic control group (r = .492; p = .0001).

Pearson's r correlation was used to compare the Arabic patients' performance on the Cognistat sub-tests to the similar items of the MMSE. A significant correlation was found for orientation (r = .97; p < 0.0001) and comprehension (r = .44; p < 0.0001). Attention, repetition, naming and calculation sub-tests showed no significant correlation (respectively r = 0.15, p = .90; r = .02, p = .82; r = .10, p = .39; r = .05, p = .66). Since the delay interval in recall is not comparable in the Cognistat and MMSE, the correlation between the memory sub-test of the Cognistat and the MMSE memory item was not examined. The validity of the construction abilities, similarities and judgment subtests was not tested as these sub-tests are not evaluated in the MMSE.

Similarly, the performance of the Arabic control group in the Cognistat sub-tests was compared to the similar items of the MMSE. Significant correlations were found for orientation (r = .85, p < 0.001), attention (r = .40, p < 0.001), and calculation (r = .49, p < 0.001). No significant correlation was found between the repetition sub-test of the Cognistat and the repetition item of the MMSE. Comprehension and naming sub-tests could not be compared because participant's performance were the same in the two tests, reaching maximum scores (SD = 0). Again, no correlation was conducted for the memory, constructional abilities, similarities and judgment subtests as these sub-tests are not evaluated in the MMSE.

In general, the Arabic Cogistat provides a satisfactory concurrent validity for items in which significant correlations were found (mainly in orientation, comprehension, orientation, attention, and calculation).

Discriminative validity

Pairwise t-tests indicated statistically significant differences between the patients and control group in all sub-tests (even when corrected for multiple comparisons). Table 13 presents the t-tests results.

Table 13

Sub-tests		ABI Patients (n = 62)		Control group (n = 107)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Orientation	12	9.5	2.7	11.8	0.4	8.62	0.0001
Attention	8	5.5	2.6	7.4	1.3	6.35	0.0001
Comprehension	6	5.5	0.9	6	0	5.75	0.0001
Repetition	12	9.4	4	11.8	0.4	6.37	0.0001
Naming	8	6.4	1.8	7.5	0.8	5.46	0.0001
Construction	6	1.9	2.2	5.1	1.3	11.89	0.0001
Memory	12	7	3.4	10.8	1.8	9.50	0.0001
Calculation	4	1.9	1.3	3.1	1.2	6.07	0.0001
Similarity	8	3.6	3.4	7.6	1.2	11.21	0.0001
Judgment	6	3.5	2.3	5.5	1	7.82	0.0001

Table 13. Comparison of Cognistat profile between patients with ABI and control group (df = 167).

Effect of country origin

Using a MANOVA – for the Cognistat sub-tests as dependent variables – no significant difference was found between Saudis (N = 86) and other Arabs (N = 21) in the healthy control group, F (9, 97) = 1.3, p = .24; Wilk's Λ = 0.892, partial η2 =.11. It is worthy to note that this analysis cannot be performed with the patient group as they were 98% Saudis.

Comparing stroke and TBI

A MANOVA – for the Cognistat sub-tests as dependent variables – comparing the stroke and TBI groups showed significant differences between the two groups, F (10, 51) = 2.68, p = .010; Wilk's Λ = 0.656, partial η2 = .34. TBI patients had more extensive and severe cognitive impairments than stroke patients, especially in orientation and similarity (see Table 14). Although patients in the TBI group were significantly younger than the stroke patients, their performance was still lower in these sub-tests than the stroke group.

Table 14

Sub-tests		TBI Patients (n = 32)		Stroke Patients (n = 30)			
	Max	Mean	(SD)	Mean	(SD)		
Age		24.8	6.1	51.4	10.3	12.47	0.0001
Orientation	12	8.9	2.9	10.4	2.3	2.25	0.028
Attention	8	5.7	2.7	5.5	2.6	ns	
Comprehension	6	5.7	0.9	5.4	1.1	ns	
Repetition	12	8.9	4.7	10.1	3.1	ns	
Naming	8	6.2	1.8	6.7	1.9	ns	
Construction	6	2.1	2.2	1.7	2.2	ns	
Memory	12	7.5	3.1	6.4	3.7	ns	
Calculation	4	1.8	1.2	2	1.5	ns	
Similarity	8	2.8	3	4.6	3.5	2.18	0.033
Judgment	6	3.2	2.2	3.9	2.5	ns	

Table 14. Comparison of Cognistat profile for TBI and stroke patients (df = 60).

Percentile norms

Percentile norms for the Arabic individuals were calculated for each sub-test and each group (Tables 15 and 16).

Table 15

		ORI	ATT	COMP	REP	NAM	CONST	MEM	CALC	SIM	JUD
Max		12	8	6	12	8	6	12	4	8	6
Percentiles	5	11.00	6.00	6.00	11.00	5.40	2.00	7.00	1.40	4.00	3.00
	10	11.00	6.80	6.00	12.00	6.00	3.80	9.00	2.00	6.80	4.00
	25	12.00	8.00	6.00	12.00	8.00	4.00	11.00	3.00	8.00	6.00
	50	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00
	75	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00
	95	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00
	99	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00

Table 15. Percentile norms for the young Arabic healthy individuals.

Note. ORI= Orientation ATT= Attention COMP= Comprehension
REP= Repetition NAM= Naming CONST= Construction
MEM= Memory CALC= Calculation SIM= Similarities
JUD = Judgment

Table 16

		ORI	ATT	COMP	REP	NAM	CONST	MEM	CALC	SIM	JUD
Max		12	8	6	12	8	6	12	4	8	6
Percentiles	5	9.10	0.15	6.00	08.15	5.10	2.00	7.00	0.00	2.10	6.00
	10	11.00	3.10	6.00	11.10	7.00	2.00	7.00	0.00	4.20	6.00
	25	11.25	4.25	6.00	12.00	8.00	4.00	9.25	0.25	8.00	6.00
	50	12.00	8.00	6.00	12.00	8.00	4.50	11.50	2.50	8.00	6.00
	75	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00
	95	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00
	99	12.00	8.00	6.00	12.00	8.00	6.00	12.00	4.00	8.00	6.00

Table 16. Percentile norms for the older Arabic healthy individuals.

Note. ORI= Orientation ATT= Attention COMP= Comprehension
REP= Repetition NAM= Naming CONST= Construction
MEM= Memory CALC= Calculation SIM= Similarities
JUD = Judgment

Discussion

The main aim of this first study was to translate and culturally adapt the Cognistat from English to Arabic to be used with the Arabic-speaking population with ABI, and to validate this tool. We also wanted to examine potential cultural differences in cognitive functions in the Arabic and English speaking populations. As planned, the Arabic Cognistat was validated to be used with acquired brain injury patients, focussing on those with stroke or TBI. All translations were made in standard Arabic, to be used widely across the Arabic speaking communities. Five sub-tests were modified in order to suit the Arabic population, namely repetition, naming, memory, similarities and judgment. These sub-tests were also changed by Chan, Lee, Fong, and Wong (2002) while adapting the Chinese version of the Cognistat and by Gupta and Kumar (2009) for the Indian Cognistat.

Standardisation data and cultural differences between the Arabic and English populations

Standardisation data were established for two age groups (younger adults aged 18-39 years and older adults aged 40-60 years). Indeed it is notoriously difficult to acquire diagnostic information concerning the Arabic elderly which would be required to test the accuracy of any assessment: Arabic families tend to take care of the elderly themselves (Salari, 2002), which causes difficulties to find patients tested and diagnosed by health care professionals (Wrobel & Farrag, 2008). In addition, it is common in the Arabic culture (particularly Saudi) that elderly do not have an accurate date of birth, as the majority of them were born in their homes with no systematic registration of the date.

The data from the young and older Arabic adults groups were compared to those found in the original validation study (Kiernan et al., 1987). We expected possible cultural differences between the Arabic and English populations in orientation and memory. Our findings support this hypothesis in which the young Arabic participants underperformed English adults in memory whereas the older Arabs scored lower in both orientation and memory sub-tests than their English counterparts. Interestingly, variations in scores were extended to language (mainly repetition and naming), construction and calculation sub-tests – with the young Arabic adults scoring lower in the language (naming) sub-test than the young English group, and the older Arabic group performing lower in the language (repetition and naming) and construction sub-tests than the older English adults. Both young and older Arabic groups experienced significant calculation difficulties as compared to the English groups.

It is not unusual in the literature to find similar variations in sub-test scores when compared to other population groups. Katz, Elazar, and Itzkovich (1996) reported that there were differences between some of the sub-test scores of the Israeli healthy group and the American standardisation group. Similarly, Chan et al. (2002) stated that sub-test scores (repetition, naming, construction and memory) were substantially different for the Chinese healthy group compared to the American orthopaedic patients with no brain dysfunction (used as a control group). Further, Chan et al. (2002) found some discrepant scores between the Israeli and American control groups particularly in attention, naming and construction sub-tests. These discrepancies in results resemble the variation which was found between the Arabic adaptation scores and the original scores. It is worth mentioning, however, that the lower scores in calculation could be due to a straightforward cultural reason; it is noted that Saudi adults tend to depend on using calculators even for simple calculations and are very reluctant to engage into mental calculation. Thus, the recommendation could be not to rely on the calculation sub-test while examining old adults.

To further study the normative data for the Arabic population, scores of the young Arabic healthy group were compared to the scores of the young Arabic patients group. As expected, significant differences were found between the healthy and patients group, in all sub-tests. Similar results were obtained for the older Arabic patients group and the older Arabic healthy group in which the Cognistat distinguished healthy people from those with ABI conditions apart from two sub-tests (attention and calculation; see Table 9). The insignificant results in the attention sub-test were attributed to age, corroborated by a significant negative correlation between age and attention scores. Age was also found to be negatively correlated with orientation, construction and calculation. These findings were supported by Drane and Osato (1997) who acknowledged that both age and years of education have an impact on several Cognistat scores, with age having the most significant effect. They also suggested that the attention and memory sub-tests are strongly affected by age, whereas similarities are likely affected by years of education, and construction is influenced by both age and education. We found similar results to Drane and Osato (1997) suggesting that age had an impact on attention scores while years of education significantly affected the similarities scores. It is therefore strongly recommended that age and education should be taken into account when examining the patient's performance (Drane & Osato, 1997).

Internal consistency

Results indicated that most of the sub-tests of the Arabic Cognistat showed very high internal consistency with the exception of memory which was borderline. However, borderline internal consistencies are not necessarily problematic when using a sub-test (Schmitt, 1996). More problematic is the low internal consistency found for the orientation sub-test, which is however not surprising given the strong cultural differences between Arabic and Western cultures in terms of attitude towards time: Wunderle (2006) documented how Arabic people tend to be casual about time and are not accurate when it comes to appointments, whereas Americans are likely very time conscious and very accurate in regards to appointments. Accordingly, these cultural variations in time awareness could easily explain the lower scores in the time orientation item.

Finally, it is worth noticing that the Arabic version of the Cognistat has a higher internal consistency than the Indian adaptation in seven sub-tests (Gupta & Kumar, 2009).

Concurrent validity

Our results showed an excellent correlation between the global scores of the Cognistat and the global scores of the MMSE for the Arabic healthy group, confirming that the Arabic Cognistat has a good concurrent validity. To further assess concurrent validity, patients' performance on the Cognistat sub-tests was compared to the similar items of the MMSE. A significant correlation was found in orientation and comprehension. However, no correlation was found between the patients' performance on the mental balance item of the MMSE and the attention and calculation sub-tests of the Cognistat. The mental balance item of the MMSE requires the patient to perform 5 subtractions of 7 from 100 in order to examine attention and calculation. Gupta and Kumar (2009) also reported a poor correlation between the patients' performance on the mental balance item of the MMSE and calculation sub-test of the Indian Cognistat. They acknowledged that the mental balance item of the MMSE requires greater loading of working memory as compared to the calculation and attention sub-tests of the Cognistat. Thus, the poor correlation could be attributed to having different attention and calculation tasks with different cognitive demands across the two tests. Alternatively, the poor correlation could have straightforward cultural origins, as Arabs are, again, usually reluctant to engage into mental calculation and prefer to use calculators even for simple calculations.

Further, we found no correlation between the patients' performance on the repetition and naming items of the MMSE and the similar sub-tests of the Cognistat. Yet the performance of the patient group on both items of the MMSE was comparatively higher than on the similar sub-tests of the Cognistat. For repetition, this could be simply explained by the fact that the sentence in the MMSE ("no ifs, ands, or buts") was shorter in length than the one used in the Cognistat ("the higher the human the more clouds surrounds"). Also, the repetition sub-test of the Cognistat contained 6 other sentences - graded in difficulty - used if patients failed to accurately repeat the initial screening sentence. Such variations may explain the absence of correlation between the repetition item of the MMSE and the repetition sub-test of the Cognistat.

In regards to the naming item of the MMSE, patients were asked to name two simple items (pen and watch), whereas four items were used in the Cognistat (pen, cap, clip and point). In the case that patients failed to name the four screening items, they were then asked to name 8 other items graded in difficulty. These variations between the repetition and naming items of the MMSE and similar sub-tests of the Cognistat may explain the absence of correlation across these items.

Discriminative validity

For the discriminative validity, it was found that the Arabic patient group performed worse than the control group overall and for each sub-test. This demonstrates that the Arabic Cognistat has the ability to reliably distinguish patients from healthy controls. Based on these results the Arabic Cognistat also provides a better discriminative validity than its Chinese adaptation (Chan et al., 2002) for which 4 subtests out of 10 did not reveal any significant differences between patients and controls. Our results are in agreement with the findings of Nabors, Millis, and Rosenthal (1997) who found that the English Cognistat was able to detect cognitive deficits in patients with TBI. Our results are also supported by Gupta and Kumar (2009) who found systematic significant differences between the Indian TBI patients and the control group.

As expected, significant differences were found between stroke and TBI patient groups. Zhang et al. (2016) reported significant differences between TBI and stroke patients when assessed with the MMSE and the MoCA – TBI patients tended to have more extensive and severe cognitive impairments than those with stroke. Overall, our results are similar to Zhang et al. (2016) with TBI patients scoring lower than stroke patients. Similar to Zhang et al. (2016) we found that orientation was lower in TBI patients than stroke patients, however contrary to them we did not find a significant difference for delayed recall. Finding different results for the recall is probably due to the fact that the delay interval in recall is not comparable in the Cognistat and MMSE. In addition, we noted that orientation, language (mainly repetition and naming), calculation and reasoning (similarities and judgment) are more impaired in TBI patients than stroke patients. These results show that TBI and stroke seem to produce different profiles of cognitive impairments, in terms of severity but also in terms of specificity.

Percentile norms

Percentile tables were constructed to describe the performance on the Cognistat of the young (18-39 years) and older (40-60 years) Arabic adults. There are different ways to calculate percentiles and different software may use different methods. However, it was reported that whatever procedure used will produce the same results (Chatburn, 2011). In the present study, the percentiles were calculated using SPSS ranging from 5 to 99 percentiles. Half of the population obtained maximum scores in all sub-tests which is consistent with the original English Cognistat (Kiernan et al., 1987).

This study offers data that we hope will be beneficial to Saudi patients and, more generally, Arabic-speaking patients, given the high prevalence of long-lasting cognitive problems in those patients with ABI. Studies have indicated that about 135,000 persons in Saudi Arabia have disabilities that limit their independence, mostly caused by head injury (Al-Jadid, 2014). It is hoped that the Arabic version of the Cognistat will allow a very precise evaluation of the cognitive deficits of ABI patients and open up the road to the assessment of other categories of cognitive impairments. Also, valuable data concerning the cultural differences in cognitive functions in the Arabic and English speaking population was provided, through comparing the Arabic normative data to the original English Cognistat data.

Conclusion

The Arabic version of the Cognistat was found to be a valid and reliable cognitive screening tool. The findings of the study emphasise the importance of using the adapted version of the Cognistat in clinical practice to detect potential cognitive deficits among Arabic patients. Further, this study should enhance practitioners' awareness of potential cultural differences in cognition. The present study has limitations in which information concerning the severity of injury was lacking. Even though parametric tests were performed, we did not perform tests of normality on the data which is required to ensure that these data has been drawn from a normally distributed population. Also, the study was restricted to young (18-39) and older (40-60) adult group which limits the generalisability of normative Cognistat profile to these age ranges. Further studies including adults aged above 60 are recommended to be useful for patients with ABI. It is also suggested to validate the Arabic Cognistat for its use with patients with different neurological conditions.

Chapter 2: Development and validation of the Plymouth Saudi Memory Test (PSMT) for the Arabic speaking population with acquired brain injury

Introduction

Memory deficits are considered as one of the most common cognitive problems in patients with acquired brain injury (ABI) such as traumatic brain injury (TBI) and stroke (Budson & Price, 2005; Capruso & Levin, 1992; Tatemichi et al., 1994). Both TBI and stroke, as the most common forms of ABI, are known to cause difficulties in the different aspects of memory. Studies indicate that most aspects of memory are affected in ABI patients- working memory, episodic memory, prospective memory, and recognition memory (MacPherson, Turner, Bozzali, Cipolotti, & Shallice, 2016; Mioni, Stablum, McClintock, & Cantagallo, 2012; Raskin, Shum, Ellis, Pereira & Mills, 2017; Schouten, Schiemanck, Brand, & Post, 2009; Shum, Valentine, & Cutmore, 1999; Vakil 2005). Some researchers suggested difficulties in semantic memory or impaired access to the semantic memory system (McWilliams & Schmitter-Edgecombe, 2008; Tyerman & King, 2008), while Donders et al. (2001) reported no semantic memory deficits in ABI patients - especially TBI patients. Again, as stated in chapter 1 (in the literature review section, p. 34), Zhang et al. (2016) acknowledged that there might be different cognitive profiles in stroke and TBI patients, with TBI patients showing more extensive and severe cognitive deficits than those with stroke, and more impairment in orientation and recall.

A number of cognitive tests – that are available in the Arabic language – can detect and estimate a deficit in memory (Woodford & George, 2007), and these include the

Mini-Mental cognitive Status Examination (MMSE; Folstein, Folstein, & Mchugh, 1975), the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), the Addenbrooke's Cognitive Examination (ACE; Alexopoulos, Mioshi, EGreim & Kurz, 2007) and the Cognistat (Kiernan, Mueller, Langston, & Van Dyke, 1987; Almubark, Cattani & Floccia, submitted). However, these tests were not designed with the intention to assess specifically the different types of memory; rather, their purpose is to screen a wide range of cognitive deficits (Woodford & George, 2007). The National Institute for Health and Care Excellence (NICE, 2014) indicates that when a cognitive deficit such as memory is identified following the use of a cognitive screening tool, a detailed valid, reliable and responsive assessment would need to be considered. Such tool should be administered on patients before designing the treatment program (NICE, 2014). Since cognitive screening tools do not offer a comprehensive assessment to the memory function, a number of neuropsychological tests can be utilised, at least for English-speaking patients.

The Wechsler Memory Scale (WMS; Stone & Wechsler, 1946; Wechsler, 1945), the California Verbal Learning Test (CVLT-II; Delis, Kaplan, Kramer, & Ober, 2000), the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1941), the Brief Visuospatial Memory Test-Revised (BVMT-R; Benedict, 1997), the Hopkins Verbal Learning Test-Revised (HVLT-R; Brant & Benedict, 2001), and the Boston Naming Test (BNT; Kaplan, Goodglas, & Weintraub, 2001) are the most popular examples of neuropsychological tests that address memory function. The WMS is a commonly used memory test that involves abstract, laboratory-type memory tasks. The CVLT-II focuses on episodic verbal learning and memory, while the RAVLT evaluates verbal memory. The BVMT-R requires individuals to learn and recall six non-traditional shapes together with copying figures, the HVLT-R asks participants to learn and recall twelve words in any order, and the BNT examines naming of a series of pictures. However, these tests suffer from the inability to predict performance in everyday activities (Wilson, 1993), and do not test the wide range of long term memory skills (Efklides et al., 2002). To overcome these limitations, the Rivermead Behavioural Memory Test – Third Edition (RBMT-3) was designed to measure daily-life memory functioning (Wilson et al., 2008). In the RBMT-3 long-term memory is assessed alongside prospective memory. Yet, it has been criticised for not detecting mild memory deficits. Besides, the norms were mainly established for English speakers (Occupational Therapy Cognitive Assessment Inventory, 2014), which may not be appropriate when used with people from different cultures. In addition, the RBMT-3 does not test all aspects of everyday memory that are often reported as failing in adults such as semantic memory for words and working memory. In addition to the illustrated neuropsychological tests, a computerised neurocognitive assessment tools (NCATs; Broglio, Ferrara, Macciocchi, Baumgartner, & Elliott, 2007), which comprises of different neurocognitive batteries, was designed to assess cognitive function following mild TBI. The NCATs is available for use in different settings such as neuropsychology, sports, medicine, and psychiatry. Yet, it was noted to frequently be used to test large groups in athletic and military settings (Cole et al., 2013), research indicated that testing in a group setting could negatively affect scores (Moser, Schatz, Neidzwski, & Ott, 2011). Despite the wide use of the NCATs, it was suggested to have some limitations. Specifically, computers settings might cause errors in RT measurement. Further, the NCATs batteries were assigned for professionals (e.g., athletic trainers) who might not receive cognitive testing training. Additionally, there is no full establishment of the psychometric properties of the NCATs (Echemendia et al., 2012).

All tests mentioned so far were originally developed in the English language and targeted English speaking population. It was estimated that the number of individuals with limited English proficiency will be increasing (Shin & Ortman, 2011), and the norms for the most commonly used neuropsychological tests are for native English speakers. According to the American Academy of Clinical Neuropsychology (AACN, 2007), the application of English norms to individuals with limited English proficiency may not be appropriate and pose a threat to assessment validity. As a result, it is highly recommended to use a culturally appropriate cognitive tool to get an accurate indication of cognitive deficits (Uysal-Bozkir et al., 2013). Such a recommendation gives an indication that culture could have an impact in our cognition, such as memory functioning. For instance, Chinese adults have been reported to outperform Americans in certain working memory tasks (Gutchess, Schwartz, & Boduroglu, 2011). In addition, a number of researchers observed cultural differences in the functioning of different aspects of long term memory – episodic memory (MacDonald et al., 2000; Mullen, 1994; Wang, 2006), semantic memory (Farid & Grainger, 1996; Kelly et al., 2011; Masuda & Nisbett 2001), recognition memory (Tavassoli, 1999), and prospective memory (Chang, 2012).

Since memory deficits are commonly experienced in patients with ABI and because it is important to use a culturally appropriate measure, we aimed to develop a memory test that assesses long term memory - involving episodic memory, semantic memory, prospective memory, and recognition memory - and short term memory (or working memory) in the Arabic speaking population with ABI. Developing such a memory test can provide guidance to health care professionals and enhance better clinical management (Wester et al., 2013). Alongside this work, we aimed at examining the cultural differences in the different types of memory between the Arabic and English populations.

Literature review

Definition of memory

Memory, which is central to all cognitive functions (Lezak et al., 2004), can be defined as the mental systems that receive, encode, store, organise, alter, and retrieve information (Dennis et al., 2010). Another definition of memory is that it is responsible for the acquisition and retention of information (Loring, 1999).

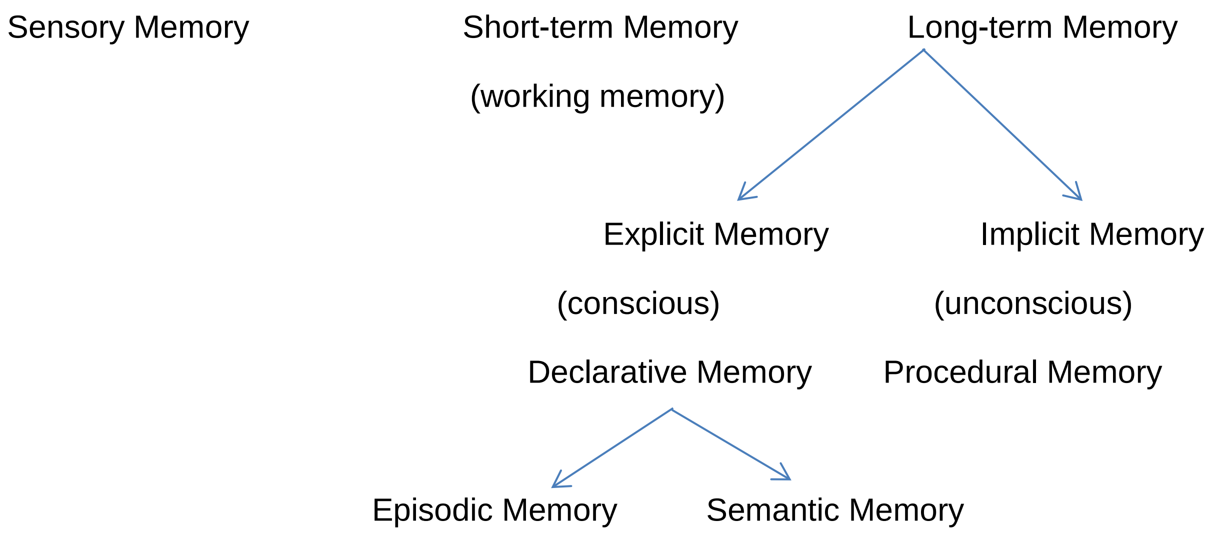
The nature of memory has been debated in classic philosophy and in modern neuroscience. Memory is a vital process in our everyday life and our sense of self. For instance, it has a role in our anticipated future, personal history, preferences, and tastes, and any difficulties in memory may lead to a devastating impact (Foley, 2007). It is well documented that memory is not a unitary system, but rather involves many sub-systems (Squire & Zola-Morgan, 1991).

For our memory to function properly, our brain needs to go through many stages – encoding, storage and retrieval of information. Encoding allows gathering of information that is read, heard, seen or experienced so that the information is registered in the brain. The storage stage is a complex process that enables storage of gathered information in the brain for future reference. Information can be stored on a short or long term basis. In the retrieval stage, information that has been stored can be remembered or recalled when needed (Jasskelainen, 2012).

Types of Memory

How many different sub-systems of memory are there? This question has preoccupied psychologists over the past 30 years, and remains an area of controversy (Wilson & Moffat, 1984). Although it has been suggested that there is no consensual model of memory, we started from the Atkinson and Shiffrin model (Atkinson & Shiffrin, 1971), which is also known as the multi-store model of the human memory system. This model of memory categorises memory into three main types: sensory memory, short term memory (working memory) and long term memory. Another model by Atkinson and Shiffrin (1968), known as the dual memory model, introduced different types of long term memory. This model distinguishes between explicit memory (declarative memory; episodic memory and semantic memory) and implicit memory (procedural memory). The figure below illustrates the combination of the two models.

Human Memory



In addition, there are further sub-categories of long term memory that were not defined in the dual memory model (Atkinson & Shiffrin, 1968). These types involve recognition memory (Pascalis & de Haan, 2003), associative recognition memory

(Suzuki, 2005), and prospective memory (Grieve & Gnanasekaran, 2008). For example, recognition memory addresses the person's ability to recognise faces and words that were previously seen (Warrington, 1984), whereas learning and remembering the relationship between unrelated items involves associative recognition memory (Suzuki, 2005). Remembering to take medication or to complete a task in a particular time is an example of prospective memory (Bahrainian et al., 2013). Such memory types are important in our daily life, with impairments commonly experienced in patients with neurological conditions such as TBI or stroke (Chellappan et al., 2012). An overview of the short term memory/working memory and the different types of long term memory (episodic, semantic, procedural, prospective, and recognition) is provided below.

Working memory

Working memory describes the maintenance and manipulation of verbal and nonverbal information in order to attain goal-directed tasks and behaviours (Matthews, 2015), such as repeating digits backwards (Hitch, 1978 cited in Tayim, Flashman, Wright, Roth, & McAllister, 2016). This type of memory is used to describe the initial holding place of information. According to Baddeley (1986), working memory is the best way to characterise short term memory. The famous Baddeley's (1986) model, using the term working memory rather than short term, suggested that working memory may involve a verbal loop and visual scratchpad, for which phonological and visual information are maintained in an active state across time. Also, Baddeley (1986) argued that an executive control system plays a role to coordinate information flow through the working memory system and other memory systems such as long term memory (e.g., semantic memory). For example, when we want to take part in a discussion, we need to hold in mind what each participant said while simultaneously working out the response to the discussion or anticipate what will be said. This demonstrates the exact role of the central executive system (Valik, 2005).

It was proposed that both short term memory and working memory share a close relationship, yet it was argued that there are important distinctions between the two. The concept of short term memory is explained as a more or less passive temporary store of information whereas the concept of the working memory is described as a more dynamic system related to temporary retention and transformation of information (Baddeley & Hitch 1974). Tasks related to short term memory need only the preservation of sequential order information. For instance, when administering a digit span task the person is required to listen to or read a list of digits then repeat them in order. On the other hand, examining working memory is less straightforward as there are different views to what working memory refers to. Traditionally, working memory has been evaluated by the reversed digit-span test in which the person is requested to repeat back long series of digits (Emilien, Durlach, Antoniadis, Linden, & Maloteaux, 2004). The capacity of this type of memory in a typical adult's memory span is approximately 7 (Miller, 1956 cited in Revlin, 2012), and information is stored and manipulated for about 20 to 30 seconds with no rehearsal (Baddeley & Hitch 1974).

Finally, it is thought that working memory tasks involve areas in the frontal and parietal regions of the brain, and that verbal working memory is mostly located in the left hemisphere (D'Esposito et al., 1998).

Episodic memory

Episodic memory represents the ability to consciously recall personal events that have been previously experienced (Grieve & Gnanasekaran, 2008; Matthews, 2015). This type of memory enables traveling back in time to an event from the recent or distant past. Different details regarding the events, such as what happened, when it happened, and where it happened are included in episodic memory. It is typically thought that episodic memory comes under declarative memory, suggesting that episodic memory requires explicit or conscious recall. However, it was reported that we can recognise the details of episodic memories without conscious recollection of the event (UCSF Memory and Aging Center, 2014).

Verbal episodic memory and visual episodic memory are the two common forms of episodic memory. Verbal episodic memory is commonly examined through asking the examinee to recall a story or remember a list of word, while visual episodic memory is often tested by asking to copy a figure and then recall it later (UCSF Memory and Aging Center, 2014), or through hiding personal objects and then asking the patient to recall the location of the hidden item (Matthews, 2015).

The recall of episodic memory is suggested to be located in the frontal lobes, with a role of thalamoprefrontal and thalamoretrosplenial connections (Pergola & Suchan, 2013), and in the left medial temporal lobe (Denkova, Manning, 2014). In addition, episodic verbal memory is found to involve the left hippocampus and the basal ganglia (Chen, Chuah, Sim, & Chee 2010; Maril et al., 2010). On the other hand, episodic visual memory was found to be associated with the right hippocampal (Deipolyi et al., 2007).

Semantic memory

Semantic memory refers to memory of facts and knowledge about the world that are not related to personal events, besides knowledge about words and their meanings (Grieve & Gnanasekaran, 2008; Rogers et al., 2004). Semantic memory is unlimited in its capacity to hold and process information, representing large and complex systems. Also, semantic memory is referred to as declarative memory in which it requires conscious effort (Matthews, 2015). Bedside mental status screening or formal neuropsychological testing, especially those that address a wide range of general knowledge and naming, assist in documenting the clinical symptoms specific to semantic memory (Matthews, 2015).

It is not surprising that the networks supporting the storage and retrieval of semantic information appear to be widely distributed throughout the brain (Matthews, 2015). When involved in semantic tasks, the left lateral prefrontal cortex becomes activated, together with an anterior and inferior prefrontal region (Martin, 1998; O'Craven, Kanwisher, 2000). Further, left temporal lobes were found to be involved in semantic memory (Martin, 2001), and damage to these areas was documented to cause difficulty in naming objects besides impairment in recognition (Tranel, Damasio, & Damasio, 1997). The superior temporal sulcus was found to be activated when naming animals and viewing faces (Chao, Haxby, & Martin, 1999; Tranel et al., 1997). In addition, the recognition of personal names and recognition of faces are thought to takes place in the right hemisphere (Benton & Van Allen 1968; Van Lancker et al, 1991). However, Schweinberger, (2002) argued that the right hemisphere does not control the recognition of names.

Procedural memory

Unlike episodic and semantic memory, procedural memory is implicit (or non-declarative) indicating that previously learnt activities do not require conscious effort (Grieve & Gnanasekaran, 2008). This type of memory enables us to learn and use information and skills across the life span, such as riding a bicycle (Ward, Shum, Wallace, & Boon 2002), solving puzzles or learning pattern sequences (Graf & Schacter, 1985; Schacter, Wagner, & Buckner, 2000). Procedural memory is usually assessed through experience-dependent learning of skilled performance (Finn et al., 2016). Procedural memory is not routinely assessed with standardized testing, rather, an individualized task based on a patient's specific symptoms is devised by the clinicians (Lum and Conti-Ramsden, 2014).

The brain areas involved in learning a new procedure and habit formation are the basal ganglia, cerebellum, and the frontal cortex (Lum & Conti-Ramsden, 2014; Matthews, 2015).

Since the majority of patients with acquired brain injury (ABI) might have motor function limitations such that individualised tasks may need to be designed for testing, the procedural memory will not be considered in this current study.

Prospective memory

Prospective memory is described as the person's ability to remember to execute intended actions at a certain time in the future. Such a memory type is very important in our daily life (Bahrainian, Bashkar, Sohrabi, Azad, & Majd 2013). As compared to the other sub-systems of memory, research on prospective memory, as an everyday type of memory, is still in its infancy (Groot et al., 2002). Shimamura et al. (1991)

argued that prospective memory does not only involve memory, but also planning and decision-making processes, together with inhibitory control mechanisms.

Previous memory models suggested that prospective memory is another form of episodic memory that involves formation, maintenance, and carrying out of future intentions (McDaniel & Einstein, 2011). It was also stated that prospective memory is responsible for remembering maps and intentions (Bahrainian et al., 2013).

There are three main types of prospective memory including event-based, time-based (Cardenache, Burguera, Acevedo, Curiel, & Loewenstein, 2014), and activity-based prospective memory (Levin, Shum, & Chan, 2014). Event-based prospective memory refers to performing an action upon the occurrence of a specified event (i.e. to remember taking a drug after breakfast; Bahrainian et al., 2013, or to post a letter when seeing a letterbox; Levin, Shum, & Chan, 2014), whereas time-based prospective memory refers to performing an action after a designated amount of time (i.e. to remember taking a drug every morning and night; Bahrainian et al., 2013, or taking medication at 16.00; Levin, Shum & Chan, 2014). Activity-based prospective memory is about remembering to do a task upon the completion of a specific thing (i.e. to remember turning off the oven after finishing baking; Levin, Shum & Chan, 2014). Patients are usually evaluated using one of these types of prospective memory (Cardenache, Burguera, Acevedo, Curiel, & Loewenstein, 2014), and tasks can contain remembering a routine or a novel action which can be self-imposed or imposed by someone else (Cohen, 1996).

The frontal lobe seems to be involved in prospective memory (Burgess, Quayle, & Frith 2001; Burgess, Scott, & Frith, 2003; Kesner, 1989; McDaniel, Glisky, Rubin, Guyunn, & Routhieaux, 1999), however it was argued that frontal lobe functioning may be involved in any memory task (Foley, 2007). Also, the hippocampus was thought to play a role in prospective memory (Cohen & O'Reilly, 1996; Ferbinteanu & Shapiro, 2003).

Recognition memory

Recognition memory refers to the remembering of a stimulus that was previously presented (Pascalis & de Haan, 2003). A recollective (episodic) component and a familiarity component are two forms of recognition memory. A recollective component supports the ability to remember the episodic information related to an item, whereas the familiarity component helps in telling whether an item was presented before, but without providing memory of the episode (Mandler, 1980, Tulving, 1985, Yonelinas, 2002). For example, both familiarity and recollective components can be addressed through asking the participants to judge whether an item had been encountered previously or not (familiarity), and then ask them to recall the contextual details of the item (recollection). In addition to this, recognition memory was suggested to entail associative memory (Ngo, 2013), which allows us to learn and remember the relationship between unrelated items such as the aroma of a particular perfume or the name of a person we have just met (Suzuki, 2005).

The hippocampus is found to be associated with recognition memory for both recollection and familiarity components (Manns et al., 2003). The hippocampal region is part of the medial temporal lobe – where recognition memory takes place (Squire and Zola-Morgan, 1991). The frontal lobe was also found to be related with recognition memory (Janowsky et al., 1989; Shimamura, Janowsky, & Squire, 1991), although other researchers suggested that recognition memory is not impaired in patients with frontal lobe damage (Delbecq-Derouesne et al., 1990; Schacter, Curran, Galluccio, Milberg, & Bates, 1996). Thus, the evidence on the role of frontal lobe on recognition memory is inconsistent at this point.

To sum up, the different long term memory sub-systems or terminology are defined in table 17.

Table 17

Terms	Explanation
Implicit memory	Refers to the unconscious recollection of encoded information during a particular episode (Schacter, 1987).
Procedural memory	Refers to previously learned activities that do not require conscious effort (Grieve & Gnanasekaran, 2008).
Explicit memory	Related to conscious recollection of information that was presented recently (Schacter, 1987).
Declarative memory	Responsible for the representations of the new information or data (Schacter, 1987).
Episodic memory	Memory for personal events that have been previously experienced (Grieve & Gnanasekaran, 2008).
Semantic memory	Memory for facts and knowledge about the world that are not related to personal events (Grieve & Gnanasekaran, 2008).
Associative memory	Learning and remembering the relationship between unrelated items (Suzuki, 2005)
Recognition memory	Memory for stimuli previously presented (Pascalis & de Haan, 2003).
Prospective memory	Described as the person's ability to remember to execute intended actions at a certain time in the future (McDaniel & Einstein, 2011).

Table 17. Glossary of long term memory terms

Cultural differences in memory

Variations in memory across cultures are suggested to occur due to three possible mechanisms. First, cultural differences could be based on the distinct processing of information, i.e., objects versus context, or different cognitive processes, i.e., categorical verses rational (Gutchess, Schwartz & Boduroglu, 2011). For example, Gutchess et al. (2006) required American and Chinese participants to recall words from different categories (i.e. fruits: apple, banana and orange, and modes of transportation: car, train and bus). It was found that Americans used categorical clustering to organise their recall more than Chinese participants. Such a finding on categorical clustering was reported to be relevant to identify strategy differences, which is different from the amount of information remembered. It was indicated that categories offered a more powerful strategy to organise and retrieve information from memory. Another example that shows differences in processing of information across cultures was provided by Nisbett, Peng, Choi and Norenzayan, (2001), who suggested that individuals from Eastern cultures tend to process information in relation to its context, whereas Westerns appear to pay more attention to details, pieces and parts of information.

Second, cultural variations could emerge because different kind of information is stored, and accordingly the access to information would vary between individuals from different cultures. For instance, storage of semantic knowledge necessarily varies across cultures depending on individuals' experiences in their environments and what is important within their culture (Gutchess et al., 2011). Typically, experiments that assess the content of knowledge through asking individuals to name pictures or list objects that belongs to different categories, can present dramatic differences across cultures. For instance, listing of animals or flowers can vary across cultures based on what is native to participants' environment (Yoon, 2004).

The third mechanism that could lead to cultural variations has to do with the task difficulty (Gutchess, et al., 2011), as a task difficulty can be perceived differently across cultures. For example, a research on cultural differences in the way that focal line is interpreted in relation to its frame showed that East Asians found it difficult to ignore the frame and judge the verticality of the road, whereas Americans were able to ignore the frame and accurately judge the verticality of the road alone (Ji, Peng, &

Nisbett, 2000). Such an example demonstrates that the task demands can be viewed differently across cultures.

In what follows, we will review the (relatively few) existing studies of the role of culture in the different sub-systems of memory.

Working memory

Cultural differences are relatively well documented for working memory. Hedden, Park, Nisbett, Jiao and Ji (2002) examined cultural differences on working memory and speed processing in 128 Chinese and American adults. To measure working memory, they used two verbal working memory tasks - forward and backward digit span from the Wechsler's Adults Intelligence Scale (WAIS-R; Wechsler 1981) and 2 visuospatial working memory tasks, that is, the Corsi blocks task (forward and backward versions; Milner, 1971). For speed processing, the digit comparison task - a verbal task - and the pattern comparison task - a visuospatial task - were used. Cultural differences were found in numerically based tasks for both working memory and speed processing, with Chinese participants outperforming Americans. No cultural differences were shown on visuospatial tasks for both speed processing and working memory.

Episodic memory

Chen, McAnally and Reese (2013) examined cultural differences in episodic memory among New Zealand European (NZE) and New Zealand Chinese (NZC) participants. Participants were asked to tell their life stories as if they were chapters from a book. NZE participants were predicted to include more chapters in the life story than the NZC. This assumption was made based on the claim by Nisbett and Miyamoto (2005) that individuals from Eastern cultures are likely to adopt a holistic approach in memory encoding (e.g., the details related to the story are integrated and processed as a whole so that fewer details are remembered), in contrast to Europeans who are more prone to analytical processing style. As predicted, fewer life story chapters were told by the NZC than the NZE. Another study by Wang (2009) examined episodic memory through asking American and Asian college students to list specific daily events that occurred for seven consecutive days. The results indicated that fewer specific memories were recorded by Asian students, compared to their American counterparts.

In addition, Fivush and Nelson (2004) suggested that the developmental process, content and structure of autobiographical memories – also known as self-related episodic memories – are influenced by culture. For example, autobiographical memories are better recalled in people from Western cultures than those from Eastern cultures (MacDonald et al., 2000; Mullen, 1994; Wang, 2006). Further, individuals from Eastern cultures recall autobiographical memories that are socially oriented and based on generic events, while individuals from Western cultures are more likely to recall memories that are self-oriented and are based on specific events (Wang, 2006). The idea behind this assumption is that there are wide differences between Western and Eastern cultures in how the self is conceptualised. Westerners pay more attention to the self as an autonomous self-directed entity, while people from Eastern cultures have a more relationally oriented, communal notion of self (Oyserman & Marcus 1993; Triandis 1989; Wang & Ross 2007).

These cultural differences in episodic memory appear to mirror the early maternal reminiscing style: Eastern mothers are less elaborative and more didactic, as they focus on moral behaviour and place the child's individual experiences in the context of the group. In the contrary, Western mothers are more elaborative and focus on the child than on the group (Mullin & Yi, 1995; Wang & Fivush 2005).

Semantic memory

It is well documented that semantic memory varies across cultures, especially storage and processes of semantic knowledge, as stated above (Gutchess et al., 2001). Cultural variations in this type of memory were found between East Asians and Americans, for which people from those cultures tend to adopt different processing strategies of semantic knowledge such as thematic or functional associations (i.e., cow-grass) versus categorical associations (i.e., cow-chicken) (Gutchess, Hedden, Ketay, Aron, & Gabrieli, 2010). Besides, the use of semantic information differs in people from different cultural contexts (Gutchess et al., 2006). For example, Americans were found to use categorisation-based strategy to organise information in memory more than Chinese people.

Prospective memory

Similar to the above illustrated types of memory, prospective memory might be influenced by culture. Chang (2012) compared the prospective memory performance in 42 Chinese and 35 Canadian adults. Participants were examined using three computer based prospective memory measures, addressing all three prospective memory sub-types (event-based, time-based and activity-based). Chinese adults outperformed their Canadian counterparts in all prospective memory tasks. The variation in performance was suggested to be due to possible differences in socio-cultural factors between the two populations; the Chinese participants might be more intrinsically motivated to comply with the laboratory instructions and succeed in the tasks, while Canadians may not have the same intrinsic motivation.

Recognition memory

Recognition memory, and mainly associative recognition memory, are prone to cultural variations. Tavassoli (1999) compared the performance of Chinese and American adults on associative memory and temporal memory (the way in which words are organised and retrieved from memory). Participants completed a free recall task (n = 63) and a sorting task (n = 80). In the free recall task, either 12 words from 3 different semantic categories were read or seen. Both English and Chinese participants had to write each item they remembered in the order in which it came to mind. For the sorting task, 18 written words or their pictorial counterparts were learnt and participants were required to remember their order of presentation. It was revealed that the Chinese speakers relied more on semantic association in the retrieval of Chinese words, while English speakers demonstrated a greater reliance on temporal order in the retrieval of English words. This was attributed to the differences in processing of Chinese and English words. It was suggested that in the Chinese language, written and spoken Chinese words seem to rely to a greater degree on a visual code (Hung & Tzeng 1981; Schmitt et al. 1994), and semantic access is unmediated by phonology (Perfetti & Zhang, 1991) whereas phonological aspects are dominant in the processing of English (Tavassoli,1999).

To sum up, the above studies demonstrate cultural influences on working, semantic and prospective memory together with possible influences on specific sub-types of episodic (autobiographical memories) and. recognition memory (associative memory). This has important consequences for the assessment of memory, as it is clear that memory tests would need to be culturally appropriate. Prior to introducing our developed memory tool for Arabic patients, in what follows we will review what is available today as memory tools in acquired brain injury (mainly traumatic brain injury and stroke).

Memory assessment in the Arabic language

A number of cognitive screening tools – that are available in the Arabic language – can assess memory problems (Woodford & George, 2007), including the MMSE (Folstein et al., 1975), the MoCA (Nasreddine et al., 2005), the ACE; (Alexopoulos, Mioshi, EGreim & Kurz, 2007) and the Cognistat (Kiernan, Mueller, Langston, & Van Dyke, 1987; Almubark, Cattani & Floccia, submitted). However, these tests were not designed with the intention to assess the different types of memory, but rather to screen a wide range of cognitive deficits. Therefore, there is a lack of memory tests in the Arabic language that can target ABI patients and do address the full range of memory types.

In summary, from the above studies it is noted that memory function is commonly affected in patients with ABI, requiring the use of a suitable memory assessment. Until now, no memory tests are available for assessing the full range of memory aspects in the Arabic population with ABI, calling for the development of an appropriate tool. Developing such a memory test can provide guidance to health care professionals and enhance better clinical management as suggested by Wester et al. (2013). The development of an appropriate memory tool for the Arabic ABI patients will be such that any written or reading responses can be avoided, as it might be a difficulty to some Arabic ABI patients with limited educational level or illiterates.

Aims of the second study

The aim of the study was to develop and test a memory assessment tool that examines different types of memory, including working, episodic, semantic, recognition and prospective memory, in Arabic people with ABI. Alongside this work, we also aimed at investigating the cultural difference in memory functioning between the Arabic and English individuals.

Following the preceding review, specific hypotheses the study addressed were as follows:

1. We expected ABI patients to underperform the control healthy group in all principal memory domains.
2. We expected variations between the Arabic and English populations in some of the memory types, and especially working memory, semantic memory, and prospective memory.
3. TBI patients were predicted to score lower in the episodic memory/recall than stroke patients.

Methodology

The study was completed in two stages: (1) development of the Plymouth Saudi memory test (PSMT), and (2) validity and reliability study.

Development of the PSMT

The Plymouth Saudi memory test (PSMT) was developed based on the most popular Atkinson-Shiffrin model (Atkinson & Shiffrin, 1971) and the dual memory model by Atkinson and Shiffrin (1968). By combining the Atkinson-Shiffrin model and the dual memory model, a wide range of memory types was covered – working memory, episodic memory, and semantic memory. As stated above, further sub-categories of long term memory that were not defined in the dual memory model involving recognition memory (Pascalis & de Haan, 2003), and prospective memory (Grieve & Gnanasekaran, 2008), were included in the developed memory test. Such memory types are important in our daily life, with impairments commonly experienced in patients with ABI such as stroke or TBI (Chellappan, Mohsin, Bin Md, & Islam, 2012; Grooty, Wilson, Evans, & Watson, 2002). We decided not to include procedural memory, as some of the ABI patients might have physical limitations that make assessment difficult if using relevant daily-living tasks.

Based on the literature search, there are different ways of how to measure the varying aspects of memory – working, episodic, semantic, prospective, and recognition memory. For example, Vakil (2005) reported that the digit span sub-tests (forward and backward) from the Wechsler Adults Intelligence Scale-Revised (WAIS-R; Wechsler, 1981) were used in several studies to examine working memory post TBI – which is what we used here.

Regarding episodic memory, the Rey Audio-Verbal Learning Test (RAVLT; Rey, 1964) is commonly utilised to address immediate and delayed recall in ABI patients – TBI and stroke (Callahan, Johnstone, 1994; Schouten, Schiemanck, Brand, & Post, 2009). In addition, Godefroy, Roussel, Leclerc and Leys (2009) examined episodic memory through administrating the Grober and Buschke test (Grober and Buschke, 1987). This test focuses on verbal episodic memory/recall. Besides these tests, Rasmussen and Berntsen (2014) assessed episodic memory difficulties through asking participants to complete tasks that require recording of series of memories related to both past and future events that may happen to them. From these studies, it is clear that episodic memory can be addressed through immediate and delayed recall tasks. Accordingly, our episodic memory principal domain was addressed through these two tasks (immediate recall and delayed recall).

Semantic memory is assessed through a number of semantic memory tests or tasks such as the semantic priming (Koivisto, 1999), the category fluency task Lezak (1995), the picture naming task (Adrados & colleagues, 2001; Hawkins & Bender, 2002), and object definition test (Antonucci & MacWilliam, 2015). Semantic priming is a known test for measuring the individual's reaction time to words or non-words, whereas the picture naming task is a common tool for naming pictures that belong to several semantic categories. The participant's capacity to generate words belonging to a specific category, for example the category of animals, is examined in the category fluency task (Adrados, 2001). Different researchers adopted the object definition test to assess ABI patients - stroke and TBI, for which participants were required to describe living objects and non-living objects (Antonucci & MacWilliam, 2015; McWilliams & Schmitter-Edgecombe, 2008). As it is obvious that there are a number of methods that can be used to assess semantic memory, we included both words and pictorial tasks in our memory test (words and faces recognition tasks), in order to increase the specificity of assessment.

Prospective memory is often assessed using time-based, event-based, and activity-based prospective memory tasks or tests. Mioni, Stablum, McClintock, and Cantagallo (2012) required TBI participants to completed a time-based prospective memory task (a time monitoring task requiring participates to perform certain actions after watching a 20 minutes carton-movie, i.e. pressing the red key every 5 minutes), and a time reproduction task (i.e. asking participants to press the space key if the same duration and same stimuli were seen before). Further, Groot, Wilson, Evans and Watson, (2002) implemented event-based and time-based prospective memory tasks in brain injury survivors (including but not limited to TBI and stroke) using a modified prospective memory instrument – the Cambridge Behaviour Prospective Memory Test (CBPMT; Wilson et al., 2005). This test consisted of 8 prospective memory tasks – 4 time-based and 4 event-based tasks. For instance, in one of the time-based tasks the participants were requested to remind the examiner of her key after 15 minutes, or of five hidden objects after at the end of the testing. Brooks, Rose, Potter, Jayawardena and Morling (2004) investigated the performance of people with stroke through event-, time- and activity-based prospective memory retrieval tasks. For example, they used virtual reality tasks to address all three prospective memory types i.e. the examiner was asked to navigate around the environment following instructions provided by the patient. Besides, Brooks et al. (2004) implemented the belonging task from the Rivermead Behavioural Memory Test (RBMT; Wilson, Cockburn, & Baddeley, 1991) as an event-based task, for which participants were instructed to give the examiner a personal item (such as a watch), and to remember to ask for the item back at the end of the session, and to recall the location of the hidden item. Generally, these studies indicated that time-based, event-based, or activity-based prospective memory tasks are commonly utilised to measure prospective memory, leading us to create the coin tasks - as an event-based task.

Concerning the assessment of recognition memory, Millis and Dijkers (1993) and Ariza et al. (2006) tested TBI patients with the Warrington's Recognition Memory Test (RMT; Warrington, 1984). This test focuses on faces and words recognition. The Salford Objective Recognition Test (SORT; Burgess, Dean, Lincoln, Pearce, 1996), which similarly examines words and faces recognition, was implemented by Yeo, Lincoln, Burgess, and Pearce (1996) in individuals with stroke. Schouten, Schiemanck, Brand, and Post (2009) tested stroke patients with the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1941) (for words recognition) and a sub-test of the Doors and People Test – the Doors Test (Baddeley et al., 1994). The Doors Test focuses on visuospatial recognition memory through presenting 12 images of doors (i.e., a door of a church) which need to be memorised and recognised. Consistent with the illustrated studies, we designed different recognition memory tasks including face recognition and word recognition together with associative recognition.

Following the above mentioned review, the PSMT was developed in standard Arabic. It was designed to assess five principal domains of memory, including four types of long term memory – episodic memory, semantic memory, recognition memory, and prospective memory –, alongside testing the working memory. There are 14 tasks organised as follows: (1) two tasks test working memory: forward digit span and reverse digit span; (2) two tasks for episodic memory: story I (immediate recall) and story II (delayed recall); (3) three tasks for semantic memory: face recognition/

recognition, face recognition/ naming, and word recognition I; (4) three tasks for recognition memory: face recognition II, word recognition II, and associative recognition; and (5) four tasks for prospective memory: the coin task/ comprehension, the coin task I, the coin task II and the coin task III (table 18 provides a summary of the PSMT principal domains and tasks).

Table 18

No.	Principal domains	Tasks	Type	Description	Scoring
1	Working memory	Forward Digit Span	Verbal	The examiner says to the patient: I am going to read you a series of numbers and I want you repeat them exactly as they were given. Listen carefully. The examiner reads one digit at a time.	The maximum score is 9. Scores are given based on the number of digits correctly repeated. For example, if the patient is able to repeat 2 digits correctly a score of two is given, and if 3 digits are repeated a score of three is given and so on. Discontinue after 2 misses at one level.
		Reverse Digit Span	Verbal	The examiner says to the patient: Now, I am going to read you a series of numbers and I want you repeat them backward. Listen carefully. The examiner reads one digit at a time.	The maximum score is 9. Scores are given based on the number of digits correctly repeated. For example, if the patient is able to repeat 2 digits correctly a score of two is given, and if 3 digits are repeated a score of three is given and so on. Discontinue after 2 misses at one level.

2.	Episodic memory	Story I (immediate recall)	Verbal	The examiner says to the patient: I am going to read you a short story and I want you to tell me as much as you can remember from the story. Listen carefully. (The examiner should read the story once). If the patient did not remember the examiner says: the story I read you about the man who went to work.	The maximum score is 22. Score 1 point for each correctly recalled idea, ½ point for partially recalled idea, and 0 point for incorrect answer. If patient required prompting to remember the story 1 point should be deducted.
		Story II (delayed recall)	Verbal	The examiner says to the patient: I am going to read you a short story and later in the test I want you to tell me as much as you can remember from the story. Listen carefully. (The examiner should read the story once).	The maximum score is 22. Score 1 point for each correctly recalled idea, ½ point for partially recalled idea, and 0 point for incorrect answer. If patient required prompting to remember the story 1 point should be deducted.
3	Semantic memory	Face recognition/ recognition	Visual-Object	The examiner says to the patient: I am going to show 10 faces, one by one, and I want you to tell me whether you recognise the faces, and then who is it. You will see each picture for 2 seconds, look at them carefully. The examiner starts to show the patient the pictures one at a time.	The maximum score is 10. Score 1 point for the correctly identified familiar face, 1 point for correctly saying that the face is not recognised, and 0 point for incorrect answer.
		Face recognition/ naming	Visual-Object	It is the same instructions provided above for the face recognition/ recognition.	The maximum score is 10. Score 2 points for each correct answer, 1 point for correct answer with prompt, 0 point for incorrect answer.
		Word recognition I	Verbal	The examiner says to the patient: I am going to read you a mixture of 20 familiar and less familiar words, one by one, and I want you to tell me the words you recognise, and what they mean (ask the patient to descript the animals, For example, a Rabbit is an animal with four legs or Rabbit eats grass).	The maximum score is 20. Score 1 point for the correctly identified familiar word, 1 point for correctly saying that the non-word is not recognised, and 0 point for incorrect answer.

4	Recognition Memory	Face recognition II	Visual – Object	The examiner says to the patient: I am going to show you 20 faces, one by one, and I want you to identify the faces you have seen earlier in the test. I will ask you whether you have seen this picture earlier. You will see each face for 5 seconds, look carefully. The examiner starts to show the patient the faces one at a time.	The maximum score is 20. Score 1 point for each correctly identified familiar face and unfamiliar face, -1 point for each face which has been wrongly recognised as familiar, and 0 point if the patient says yes or no to everything.
		Word recognition II	Auditory	The examiner says to the patient: I am going to read you a mixture of familiar and less familiar words, one by one. Some are the same as those I read you before and some are not. Some of the words I read were in a singular format and some were plural. I want you to tell me whether you have heard each word previously in the test.	The maximum score is 20. score 1 point for each correctly identified familiar and less familiar word (correct recognition and correct rejections), -1 point for each word which has been wrongly recognised as familiar or less familiar (incorrect acceptance and rejection), and 0 point if the patient says yes or no to everything.
		Associative recognition	Auditory	The examiner says to the patient: I am going to read you 24 pairs of unrelated words. Listen carefully. The Examiner should allow 2 seconds only between each pairs of words. Then, later in the test the examiner says to the patient: I am going to read you again pairs of words, and for each pair I want you to tell me whether you heard them together.	The maximum score is 24. Score 1 point for each correctly identified pair of words, -1 point for each pair which has been wrongly recognised together i.e saying that Lion -Tree were together, 0 point if the patient says yes or no to everything.
5	Prospective memory	The coins task/ comprehension	Verbal	The examiner says to the patient: I am going to give you a box of coins (the examiner gives the box of coins to the patient) and I want you to keep it and when I say the word thank you give me the first coin from the box, when I say we are half way through the test hand me the second coin, and when I say we have finished the	The maximum score is 3. Score 3 points if the patient repeated the three instructions correctly, 2 if repeated 2 instructions correctly, and 1 if repeated one instruction correctly, and 0 point if failed to repeat.

				test hand me the third coin.	
		The coin task I	event-based	The examiner says to the patient: Thank you. When you say this phrase the patient would need to hand you the first coin. If patient did not remember after 2 seconds, say: is there something that you needed to do.	The maximum score is 3. Score 3 points if one coin is handed without prompt, 2 points if one coin is handed with prompt, 1 point if more than one coin are handed at the same time or handed the whole box of coins, and 0 point if failed to hand in any coin.
		The coin task II	event-based	The examiner says to the patient: We are half way through. When you say this phrase the patient would need to hand you the second coin. If the patient did not remember after 2 seconds, say: is there something that you needed to do.	The maximum score is 3. Score 3 points if one coin is handed without prompt, 2 points if one coin is handed with prompt, 1 point if more than one coin are handed at the same time or handed the whole box of coins, and 0 point if failed to hand in any coin.
		The coin task III	event-based	The examiner says to the patient: we have finished the test. When you say this phrase the patient would need to hand you the third coin. If patient did not remember after 2 seconds, say: is there something that you needed to do.	The maximum score is 3. Score 3 points if one coin is handed without prompt, 2 points if one coin is handed with prompt, 1 point if more than one coin are handed at the same time or handed the whole box of coins, and 0 point if failed to hand in any coin.

Table 18. Summary of the PSMT principal domains and tasks.

Pre-testing

Three successive pilot studies were completed. The first pilot study was completed on 17 healthy Arabic speaking adults with a mean age of 25.6 (including 10 females and 7 males). The results indicated that the mean scores of the working and episodic memory provided a satisfactory level for their testing purpose, neither at ceiling nor flooring. Participants’ scores in semantic, prospective, and recognition memory were at ceiling (reaching maximum or close to maximum scores). Accordingly, those provided maximum or close to maximum scores were modified, and a second pilot study was carried out.

The second pilot study involved 15 healthy Arabic speaking adults with a mean age of 30.2 (including 9 females and 6 males). Similar to the first pilot study, the working memory and episodic memory provided a satisfactory level for their testing purpose, neither at ceiling nor flooring. Participants' scores in the modified semantic memory, recognition memory and prospective memory also provided satisfactory level for their testing purpose. However, the word recognition (as a task of the recognition memory) was at ceiling. Thus, the word recognition task (addressing both semantic and recognition memory) was further modified and a third pilot study was conducted.

In this last pilot study, 6 healthy Arabic speaking adults with a mean age of 26.7 (including 4 females and 2 males) were tested. The mean score of the word recognition I task (for the semantic memory) provided a satisfactory level for its testing purpose, close to ceiling (participants were required to recognise familiar words and reject less familiar words). Participants' scores in the word recognition II (for the recognition memory) provided a satisfactory level for its testing purpose, neither at ceiling nor flooring.

Following the completion of the pilot studies, the healthy adults were asked about the clarity, appropriateness and cultural relevance of the test. Since no concerns were reported, full data collection was undertaken and the validity and reliability of the PSMT were examined.

Adaptation of the PSMT to British English

For the purpose of examining the cultural differences between the Arabic and English population, an English version of the PSMT was created (see appendix 1). The original Arabic PSMT was translated and culturally adapted to the English language by the author and the first supervisor of this thesis. The related tasks to the working memory principal domain (the forward digit span and the backward digit span tasks), and the prospective memory principal domain (the coins task I, the coins task II, and the coins task III) did not require any changes. Yet, the tasks related to episodic memory principal domain (the story I and story II tasks), semantic memory principal domain (the face recognition task, and the word recognition task I), and recognition memory principal domain (the associative recognition task) were modified to suit the English population. Specifically, in the semantic memory principal domain mainly the face recognition task, the familiar faces, 'King Abdullah', 'Prince Sultan Bin Abdulaziz', and 'Sultan Qaboos', were replaced with 'Gorbachev', 'Tony Blair', and 'Prince William' respectively, to stick with the idea of using politicians. Further, Arabic unfamiliar faces were replaced with English unfamiliar faces. In the word recognition task I – as part of semantic memory principal domain –, less familiar words, 'atood', 'solajan', 'shajo', 'amazer', 'qmeen', 'maho', 'rathem', 'qsham', 'tlad', and 'snwan' were replaced with 'nelipot', 'paroxysm', 'gowpen', 'sapient', 'camlets', 'gimlets', 'mullion', 'ratoon', 'lambent' and 'mungos'. In the recognition memory principal domain, namely the associative recognition task, the words, 'mosque', 'date', 'thobe', 'laban', 'niqab', and 'riyal' were replaced with 'church', 'banana', 'dress', 'coffee', 'trousers' and 'pound'. A native English speaker, (PhD) student, reviewed and agreed on the items changed/adapted to suit the English population.

Validity and reliability study

Participants

The sample consisted of 61 ABI patients (30 stroke and 31 TBI), 80 Arabic healthy adults, and 83 English healthy adults. The Arabic control group involved young adults group (18-30) and middle age adults group (31-59 years). Age groups were adapted from Al-Ghatani, Obonsawin, Binshaig and Al-Moutaery (2011) in which they had age categories that are relevant to the Arabic population, mainly the Saudi population. Members of the Arabic control group were recruited through the University of Plymouth psychology advertisement website and word of mouth. The control group involved 35 males (43.7%) and 45 females (56.3%) with a mean age of 29.6 years and a mean number of 14.4 years of education. These healthy Arabic speaking adults originated from various Arabic-speaking countries including Saudi (n = 73) and other Arabs (n = 7). Information regarding the demographic characteristics of Arabic patients and Arabic controls is presented in table 19. Some of the Arabic patients and the Arabic healthy controls were part of a different study on the translation, cultural adaptation and validation of the Cognistat (Almubark, Cattani & Floccia, submitted).

For the English healthy group, 70 young adults (between 18-30) and 13 middle age adults (between 31-59 years) were included. Sixty three of the participants were female and 20 were males with a mean age of 25.2 and 14.1 years of education. The healthy English adults were all from the UK. Information regarding the demographic characteristics of the English controls is presented in table 19.

Patients were recruited from a rehabilitation hospital in Saudi Arabia (59 out of 60 were Saudis). This group was made of 47 males (77%) and 14 females (23%) with a mean age of 37.9 years and a mean number of 11.7 years in education. As in the

Cognistat study, more men were diagnosed with TBI than women due to a road traffic accident - women do not drive in Saudi Arabia. Patients were in the post-acute phase of their illness - a stage in which the primary incident starts to be under control (Ayres, Harrison, Nichols, & Maynard, 2010). The inclusion and exclusion criteria are similar to those in the first study (the Cognistat study).

Table 19

Variable	Group value	N	Percent	Mean (SD)	Range
Age	1 = young Arabic			24 (2.7)	18-30
	2 = middle age Arabic			39 (8.9)	31-59
	3 = young English			22.3 (2.4)	18-30
	4 = middle age English			41.1 (3.3)	31-59
	5 = young patients			23 (3.6)	18-30
	6 = middle age patients			50.5 (9.8)	31-60
Gender					
Male	1 = young Arabic	21	42		
	2 = middle age Arabic	14	46.7		
	3 = young English	19	42.1		
	4 = middle age English	1	7.7		
	5 = young patients	24	58.7		
	6 = middle age patients	23	69.7		
Female	1 = young Arabic	29	85.7		
	2 = middle age Arabic	16	35.3		
	3 = young English	51	72.9		
	4 = middle age English	12	92.3		
	5 = young patients	4	14.3		
	6 = middle age patients	10	30.3		
Total	1 = young Arabic	50			
	2 = middle age Arabic	30			
	3 = young English	70			
	4 = middle age English	13			
	5 = young patients	28			
	6 = middle age patients	33			
Type of Injury					
Stroke	5 = young patients	2	6.7		
	6 = middle age patients	28	93.3		
TBI	5 = young patients	26	83.9		
	6 = middle age patients	5	16.1		

Education in years	1 = young Arabic			15.3 (2.6)	7-19
	2 = middle age Arabic			13.1 (5.6)	0-21
	3 = young English			14.1 (0.5)	14-18
	4 = middle age English			14 (0)	14-18
	5 = young patients			12.4 (2.0)	8-14
	6 = middle age patients			11.1 (5.5)	0-17
Illiterate	1 = young Arabic	0	0		
	2 = middle age Arabic	1	3.3		
	3 = young English	0	0		
	4 = middle age English	0	0		
	5 = young patients	0	0		
	6 = middle age patients	3	9.1		
School	1 = young Arabic	13	26		
	2 = middle age Arabic	16	53.3		
	3 = young English	0	0		
	4 = middle age English	0	0		
	5 = young patients	20	71.4		
	6 = middle age patients	21	63.6		
Undergraduate	1 = young Arabic	31	62		
	2 = middle age Arabic	5	16.7		
	3 = young English	64	91.4		
	4 = middle age English	13	100		
	5 = young patients	7	25		
	6 = middle age patients	9	27.3		
MSc	1 = young Arabic	3	6		
	2 = middle age Arabic	2	6.7		
	3 = young English	5	7.1		
	4 = middle age English	0	0		
	5 = young patients	1	3.6		
	6 = middle age patients	0	0		
PhD	1 = young Arabic	3	6		
	2 = middle age Arabic	6	20		
	3 = young English	1	1.4		
	4 = middle age English	0	0		
	5 = young patients	0	0		
	6 = middle age patients	0	0		
Nationality					
Saudi	1 = young Arabic	46	92		
	2 = middle age Arabic	27	90		
	5 = young patients	28	100		
	6 = middle age patients	32	97		
Other Arabs	1 = young Arabic	4	8		
	2 = middle age Arabic	3	10		

	5 = young patients 6 = middle age patients	0 1	0 3.0		
British	3 = young English 4 = middle age English	70 13	100 100		
Occupation prior to injury/testing					
Student	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients 6 = middle age patients	28 9 70 30 11 1	56 30 100 100 39.3 3.1		
Stay at home parent	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients 6 = middle age patients	1 0 0 0 1 7	2 0 0 0 3.6 21.2		
Soldier	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients 6 = middle age patients	1 0 0 0 3 2	2 0 0 0 10.7 6.1		
Public sector	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients 6 = middle age patients	13 13 0 0 2 11	26 43.3 0 0 7.1 33.3		
Private sector	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients 6 = middle age patients	0 0 0 0 2 3	0 0 0 0 7.1 9.1		
Retired	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients	0 1 0 0 0	0 3.3 0 0 0		

	6 = middle age patients	8	24.2		
Unemployed	1 = young Arabic 2 = middle age Arabic 3 = young English 4 = middle age English 5 = young patients 6 = middle age patients	7 7 0 0 9 1	14 23.3 0 0 32.1 3.0		

Table 19. Demographic characteristics of the Arabic healthy controls, English healthy groups, and Arabic ABI patients.

Procedure

Patients completed a written consent form prior to the participation in the study. Some of the patients required help at that stage, due to reading (caused by a low level of education) and writing difficulties (caused by a low level of education and injury-related physical limitations that affected the dominant hand). In those cases, the examiner read the consent form to the patient and patient agreed to take part in the study. After completing a health check questionnaire, all participants were tested using the developed PSMT and the MMSE in a counterbalanced order in a quiet room at the University of Plymouth or at the rehabilitation hospital in Saudi Arabia. Since there is no memory test that addresses the different types of memory in the Arabic language, the MMSE, as the most widely used cognitive tool, was used as a gold standard and to assess general cognitive function. The average participating time was 50 minutes.

Data Analysis

Mean and standard deviation were calculated for each principal domain, each task and each population to establish normative data. T-tests were used to compare (1) mean scores of the young Arabic control group and the young Arabic ABI (18-30 years) patients for each principal domain and each task, (2) mean scores of the middle age Arabic control group and the middle age Arabic ABI patients (31-60 years) for each principal domain and each task, (3) mean scores of the young Arabic control group and the young English control group from the developed English version of the PSMT for each principal domain and each task, and (4) mean scores of the middle age Arabic control group and the middle English control group from the developed English version of the PSMT for each principal domain and each task. We expected patients to underperform control group in all principal domains and tasks.

Pearson's r correlations and t-tests were used to examine the relationship between demographic variables (including age, education and gender) of the control group and the principal domains and tasks of the Plymouth Saudi Memory Test (PSMT). For example, we expected a negative correlation between age and scores in the working memory, episodic memory and recognition memory principal domains, as suggested by a number of researchers (Brickman and Stern, 2009; Cabeza et al. 1997; Kinugawa et al., 2013; Nyberg, Backman, Erngrund, Olofsson, & Nilsson, 1996; Park et al. 1996; Schroeder 2014).

For the concurrent validity, Pearson's r correlations were used to compare the Arabic patients' performance on the PSMT tasks to the similar items of the MMSE. Pearson's r correlations were also used to compare the performance of the Arabic control group on the PSMT tasks to those in the MMSE.

For the discriminative validity, A MANOVA and t-tests were used to compare stroke and TBI groups.

Finally, percentile norms for the Arabic individuals between the age of 18 and 59 years were calculated for both principal domains and tasks.

Results

Mean and SD of the Arabic control group and ABI patients were calculated for each principal domain and task on the PSMT, and each age group. Mean and SD of the Arabic control group and ABI patients were also calculated for the MMSE, for each age group.

Comparison of the young Arabic group and the young Arabic patients

To establish normative data, the mean scores of the Arabic young control group (see Tables 20 and 21) were compared to the mean scores of the Arabic young patients through t-tests for each principal domain and each task. The results indicated statistical significant differences between the two groups in all principal domains and tasks except the face recognition/ recognition task[2], part of the semantic memory principal domain, although patients score lower than the control group.

Table 20

Principal domains		Young Arabic control group (n=50)		Young Arabic patients (n=23)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		24	2.7	23	3.6	ns	
Working memory	18	10.8	2.1	7.6	2.2	5.9587	0.0001
Episodic memory	44	21.4	7.5	6.6	6.7	8.0895	0.0001
Semantic memory	40	39.3	2.5	34.8	8.6	3.2897	0.0016
Recognition memory	64	52.5	4.5	36.9	11.8	8.1925	0.0001
Prospective memory	12	10.4	2.1	7.3	4.2	4.2179	0.0001

[2] The semantic memory principal domain contains three tasks; (1) face recognition/ recognition task, (2) face recognition/ naming task, and (3) word recognition I task.

Table 20. For each principal domain of the PSMT, mean score (and standard deviation) of the Arabic young control group, mean score of the Arabic young patients, and t-test (df = 71).

Table 21

Tasks		Young Arabic control group (n=50)		Young Arabic patients (n=23)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		24	2.7	23	3.6	ns	
Working memory							
Forward digit span	9	6.5	1.1	4.7	1.3	6.1290	0.0001
Reverse digit span	9	4.3	1.2	2.9	1.2	4.6306	0.0001
Episodic memory							
Story I (immediate recall)	20	11.8	4.2	4.4	4.1	7.0446	0.0001
Story II (delayed recall)	20	9.5	4.4	2.3	3.4	6.9426	0.0001
Semantic memory							
Face recognition/ recognition	10	10	1.1	9.3	2.4	ns	
Face recognition/ naming	10	9.5	1.4	7.9	3	3.1206	0.0026
Word recognition I	20	19.7	0.7	17.6	4.4	3.3110	0.0015
Recognition memory							
Face recognition II	20	17.7	1.7	13.7	4.4	5.6154	0.0001
Word recognition II	20	17.7	1.2	13	4.3	7.1945	0.0001
Associative recognition	24	16.9	3.7	10.8	6.1	5.2861	0.0001
Prospective memory							
The coin task/ comprehension	3	3	0	2.3	1	4.9912	0.0001
The coin task I	3	2.1	1.1	1.1	1.3	3.405	0.0011
The coin task II	3	2.6	0.9	1.9	1.3	2.6702	0.0094
The coin task III	3	2.7	0.7	1.9	1.4	3.2655	0.0017

Table 21. For each task of the PSMT, mean score (and standard deviation) of the young control group, mean score of the young patients, and t-test (df = 71).

Comparison of the middle age Arabic group and the middle age patients

For the Arabic middle age adults and Arabic middle age patients (see Tables 22 and 23), the t-tests results showed statistical significant differences among all principal domains apart from semantic memory principal domain. Statistical significant differences were found in all tasks except those in the semantic memory domain: face recognition/ recognition, face recognition/ naming and word recognition I tasks. Similar to the young adults group, patients performed lower than the control group.

Table 22

Principal domains		Middle age Arabic control group (n=30)		Middle age Arabic patients (n=33)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		39	8.9	50.5	9.8	4.8586	0.0001
Working memory	18	9.2	2.1	7.6	2.7	2.6066	0.0115
Episodic memory	44	20	7.8	10.7	7.9	4.6948	0.0001
Semantic memory	40	39	1.5	37.5	4.6	ns	
Recognition memory	64	49.5	5.5	40.2	11.6	3.9994	0.0002
Prospective memory	12	10.6	1.6	6.2	3.4	6.4639	0.0001

Table 22. For each principal domain of the PSMT, mean score (and standard deviation) of the middle age control group, mean score of the middle age patients and t-test (df = 61).

Table 23

Tasks		Middle age Arabic control group (n=30)		Middle age Arabic patients (n=33)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		39	8.9	50.5	9.8	4.8586	0.0001
Working memory							
Forward digit span	9	5.8	1.2	4.7	1.4	3.3319	0.0015
Reverse digit span	9	3.5	1.1	2.5	1.6	2.8622	0.0058
Episodic memory							

Story I (immediate recall)	20	11.1	4.6	7.2	6.5	2.7235	0.0084
Story II (delayed recall)	20	7.8	3.9	4.7	4.6	2.8702	0.0056
Semantic memory							
Face recognition/ recognition	10	9.7	0.7	9.5	1.2	ns	
Face recognition/ naming	10	9.3	1	8.8	1.5	ns	
Word recognition I	20	20	0	19.4	2.4	ns	
Recognition memory							
Face recognition II	20	17.5	1.7	15.3	3.3	3.2760	0.0017
Word recognition II	20	16.7	2.6	13.9	3.3	3.7150	0.0004
Associative recognition	24	16.6	3.7	11	4.9	5.079	0.0001
Prospective memory							
The coin task/ comprehension	3	3	0	2.5	0.9	3.0406	0.0035
The coin task I	3	2.1	1.1	0.9	1.2	4.1238	0.0001
The coin task II	3	2.8	0.6	1.4	1.3	5.3963	0.0001
The coin task III	3	2.7	0.8	1.4	1.2	5.0062	0.0001

Table 23. For each task of the PSMT, mean score (and standard deviation) of the Arabic middle age control group, mean score of the Arabic middle age patients and t-test (df = 61).

Comparison of the young Arabic and the young English groups

Mean scores and standard deviations of the young Arabic control group were compared to those of the English control group through t-test (see Tables 24 and 25). The results indicated that young Arabic healthy participants scored lower than the young English healthy participants in working memory and prospective memory principal domains. Further, young Arabic healthy participants scored lower than their English peers in the reverse digit span task, words recognition I task, and the coins task II task. In contrast, Arabic participants scored higher than English peers in the semantic memory principal domain, faces recognition/ recognition task, face recognition/ naming task and words recognition II task.

Table 24

Principal domains		Young Arabic control group (n=50)		Young English control group (n=70)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		24	2.7	22.3	2.4	3.6305	0.0004
Working memory	18	10.8	2.1	11.6	1.9	-2.1760	0.0315
Episodic memory	44	21.4	7.5	20.6	5.9	ns	
Semantic memory	40	39.3	2.5	35.8	1.9	8.7131	0.0001
Recognition memory	64	52.5	4.5	51.6	4.2	ns	
Prospective memory	12	10.4	2.1	11.2	1.1	-2.7116	0.0077

Table 24. For each principal domain of the PSMT, mean score (and standard deviation) of the young Arabic control group, mean score of the young English control group and t-test (df = 118).

Table 25

Tasks		Young Arabic control group (n=50)		Young English control group (n=70)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		24	2.7	22.3	2.4	3.6305	0.0004
Working memory							
Forward digit span	9	6.5	1.1	6.7	1.2	ns	
Reverse digit span	9	4.3	1.2	4.8	1.1	-2.3633	0.0197
Episodic memory							
Story I (immediate recall)	20	11.8	4.2	10.9	3.5	ns	
Story II (delayed recall)	20	9.5	4.4	9.8	3.5	ns	
Semantic memory							
Face recognition/ recognition	10	10	1.1	8.4	0.8	9.2287	0.0001
Face recognition/ naming	10	9.5	1.4	7.8	0.9	8.0912	0.0001

Word recognition I	20	19.7	0.7	19.9	0.3	2.1344	0.0349
Recognition memory							
Face recognition II	20	17.7	1.7	17.9	1.3	ns	
Word recognition II	20	17.7	1.2	16.8	1.4	3.6805	0.0004
Associative recognition	24	16.9	3.7	16.9	3.5	ns	
Prospective memory							
The coin task/ comprehension	3	3	0	3	0	nc	
The coin task I	3	2.1	1.1	2.4	0.8	ns	
The coin task II	3	2.6	0.9	2.9	0.3	-2.5978	0.0106
The coin task III	3	2.7	0.7	2.9	0.5	ns	

Table 25. For each sub-domain of the PSMT, mean score (and standard deviation) of the young Arabic control group, mean score of the young English control group and t-test (df = 118). Note. NC = not calculated.

Comparison of the middle age Arabic and the middle age English groups

Mean scores and standard deviation of the middle age Arabic control group were compared to those of the English control group through t-test (see Tables 26 and 27). Statistically significant difference was only found in the working memory principal domain. For the tasks, statistically significant differences were found in the forward digit span task, reverse digit span task, and word recognition I task. Middle age Arabic participants scored higher than middle age English participants in the word recognition I task. In contrast, middle age Arabic participants scored lower than the middle age English participants in the forward digit span task and reverse digit span task.

Table 26

Principal domains		Middle age Arabic control group (n=30)		Middle age English control group (n=13)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		

Age		39	8.9	41.1	3.3	ns	
Working memory	18	9.2	2.1	12.2	1.5	-4.6484	0.0001
Episodic memory	44	20	7.8	20.8	6.2	ns	
Semantic memory	40	39	1.5	37.9	3	ns	
Recognition memory	64	49.5	5.5	50.1	2.9	ns	
Prospective memory	12	10.6	1.6	11.2	0.4	ns	

Table 26. For each principal domain of the PSMT, mean score (and standard deviation) of the middle age Arabic control group, mean score of the middle age English control group and t-test (df = 41).

Table 27

Tasks		Middle age Arabic control group (n=30)		Middle age English control group (n=13)		t	p-values
	Max	Mean	(SD)	Mean	(SD)		
Age		39	8.9	41.1	3.3	ns	
Working memory							
Forward digit span	9	5.8	1.2	7.2	0.9	-3.7627	0.0005
Reverse digit span	9	3.5	1.1	5	0.9	-4.3211	0.0001
Episodic memory							
Story I (immediate recall)	20	11.1	4.6	11.5	3.7	ns	
Story II (delayed recall)	20	7.8	3.9	9.3	3.4	ns	
Semantic memory							
Faces recognition/ recognition	10	9.7	0.7	9.7	0.6	ns	
Faces recognition/ naming	10	9.3	1	9.1	0.9	ns	
Words recognition I	20	20	0	19.9	0.2	2.7834	0.0081
Recognition memory							
Faces recognition II	20	17.5	1.7	18.5	0.9	ns	
Words recognition II	20	16.7	2.6	16.6	1.3	ns	

Associative recognition	24	16.6	3.7	15	3.1	ns	
Prospective memory							
The coins task/ comprehension	3	3	0	3	0	nc	
The coins task I	3	2.1	1.1	2.2	0.4	ns	
The coins task II	3	2.8	0.6	3	0	ns	
The coins task III	3	2.7	0.8	3	0	ns	

Table 27. For each task of the PSMT, mean score (and standard deviation) of the middle age Arabic control group, mean score of the middle age English control group and t-test (df = 41). Note. NC = not calculated.

Correlations between demographic variables and test performance

Correlations between demographic variables (years of education, age and gender) in the Arabic control group and scores in the principal domains and tasks of the PSMT were calculated (with the two age groups collapsed for increasing statistical power). It was found that years of education were positively correlated with the episodic memory principal domain ($r = .26$, $p < .020$), with the reverse digit span task ($r = .24$, $p <.033$), and story II ($r = .29$, $p < .010$). In other words, more educated participants scored higher in these tasks.

Age was negatively correlated with the working memory principal domain ($r = -.43$, $p < .0001$), episodic memory principal domain ($r = -.24$, $p < .023$), and recognition memory principal domain ($r = -.38$, $p < .001$). Age was also negatively correlated with the forward digit span task, reverse digit span task ($r = -.33$, $p < .003$), word recognition II task ($r = -.27$, $p < .016$), and associative recognition task ($r = -.26$, $p < .020$). Positive correlation was found between age and the word recognition I task ($r = .25$, $p < .027$). Younger participants generally scored higher than older people.

Further, t tests were used to compare the PSMT profile for healthy males and healthy females in the different principal domains. The only significant difference was found for prospective memory between the healthy males and healthy females ($p < 0.0067$), for which healthy males scored higher than healthy females (see table 28).

Table 28

Principal domains	Gender Value	Mean	(SD)	t	p-values
Working memory	1= Female 2= Male	10.33 10.05	2.30 2.05	ns	
Episodic memory	1= Female 2= Male	21.34 19.32	8.39 6.60	ns	
Semantic memory	1= Female 2= Male	38.68 39.25	1.63 1.29	ns	
Recognition memory	1= Female 2= Male	52.33 50.14	5.74 3.73	ns	
	Prospective memory 1= Female 2= Male	9.97 11.11	2.17 1.20	2.7840	0.0067

Table 28. Comparison of PSMT profile for Arabic healthy males and Arabic healthy females in the principal domains (df = 78). Note. Female N = 45, Male N = 35.

Test-retest reliability

A subgroup of 10 healthy subjects were tested twice over an interval of 7-10 days. Table 29 shows the test retest reliability coefficient measured by intra-class correlation for the principal domains. The test retest reliability coefficients for the different principal domains of the PSMT showed a high stability of scores over time, as indexed by ICCs between 0.70 and 0.97. For the tasks (Table 30), ICCs were more variable, with lower values for reverse digit span (0.36), and coin task I (0.40).

Improvement of scores was found in some of the tasks, notably, reverse digit span, story II, associative recognition, and the coin task I. A lower score was found for the coin task III (0.00). The ICCC was not calculated for word recognition I and the coin task/comprehension as participants obtained similar scores in both first and second testing (SD = 0).

Table 29

Principal domains		1st testing		2nd testing		Intra-class correlation
	Max	Mean	SD	Mean	SD	
Working memory	18	10.5	1.2	10.1	1.3	0.87
Episodic memory	44	23.2	7.6	25.1	7.2	0.70
Semantic memory	40	39.3	1.2	39.4	0.9	0.97
Recognition memory	64	51.4	3.9	53.4	4.8	0.84
Prospective memory	12	11.2	0.4	11.4	0.5	0.75

Table 29. Test-retest reliability coefficients. Note. N = 10

Table 30

Tasks		1st testing		2nd Testing		Intra-class correlation
	Max	Mean	SD	Mean	SD	
Working memory						
Forward digit span	9	6.3	1.1	5.8	0.9	0.775
Reverse digit span	9	4.2	0.4	4.3	0.5	0.356
Episodic memory						
Story I (immediate recall)	22	13.2	4.1	12.5	3.6	0.828
Story II (delayed recall)	22	10.1	4.6	12.7	4.4	0.471
Semantic memory						
Face recognition/ recognition	10	9.9	0.3	9.9	0.3	1.000
Face recognition/ naming	10	9.4	1.2	9.5	0.8	0.973
Word recognition I	20	20	0	20	0	nc
Recognition memory						
Face recognition II	20	17.2	1.2	17.6	1.2	0.899
Word recognition II	20	17.5	1.8	18.2	1.9	0.947
Associative recognition	24	16.7	2.8	17.6	3.5	0.570
Prospective memory						
The coin task/ comprehension	3	3	0	3	0	nc
The coin task I	3	2.3	0.5	2.6	0.5	0.400

The coin task II	3	2.9	0.3	3	0	0.780
The coin task III	3	3	0	2.8	0.4	.000

Table 30. Test-retest reliability coefficients for tasks of the PSMT. Note. N = 10, NC = not calculated

Concurrent validity

Pearson's r correlations were used to compare the globe scores of the PSMT and global scores of the MMSE. No significant result was found for the Arabic control group (r = .208; p = .064) presumably because scores were at ceiling in the two tests. However, a significant correlation was found for the patients group (r = .733; p = .0001).

Pearson's r correlations were also used to compare the Arabic patients' performance on the PSMT tasks to the similar items of the MMSE. The MMSE examines memory through the registration and recall items. The registration item requires patients to repeat the name of three unrelated objects (maximum score = 3), and the recall item requires patients to recall the three words that were previously repeated (maximum score = 3). No significant correlation was found between the word recognition I of the PSMT and the registration item of the MMSE (r = .105; p = .419), and between the word recognition II of the PSMT and the recall item of the MMSE (r = -.115; p = .378). Participants performance on the MMSE reached close to maximum scores with a mean of 2.8 and 2.0, respectively.

Similarly, the performance of the Arabic control group in the PSMT tasks was compared to the similar items of the MMSE. The correlation between the word recognition I of the PSMT and the registration item of the MMSE could not be calculated as participants reached maximum scores (SD = 0) in the latter. No significant correlation was found between the words recognition II of the PSMT and the recall item of the MMSE (r = -.034; p = .766), as again participants' scores on the MMSE were close to maximum.

Discriminative validity

In the comparison between TBI and stroke patients, it was found that the groups significantly differ on age ($p < 0.0001$), with TBI patients being younger than stroke patients. Table 31 and 32 provides the results of the two groups, and it is clear that they score very similarly on most tasks. We hypothesised more acute impairments in TBI patients, but it could be that there was a trade-off between the condition and the natural age-related decline, so that older, stroke patients became non distinguishable from younger, TBI patients.

Table 31

Principal domains		Patients with TBI (n = 31)		Patients with Stroke (n =30)		t	p-values
	Max	Mean	SD	Mean	SD		
Age		24.8	6.1	51.4	10.3	12.2205	0.0001
Working memory	18	7.7	2	6.9	2.8	ns	
Episodic memory	44	5.9	4.6	11.8	8.9	3.2680	0.0018
Semantic memory	40	35.4	8.2	37.2	4.8	ns	
Recognition memory	64	37.9	11.8	39.5	11.8	ns	
Prospective memory	12	6.1	3.3	7.4	4.1	ns	

Table 31. Comparison of PSMT profile for TBI and stroke patients in the principal domains (df = 59).

Table 32

Tasks		Patients with TBI (n = 31)		Patients with Stroke (n =30)		t	p-values
	Max	Mean	SD	Mean	SD		
Age		24.8	6.1	51.4	10.3	12.2205	0.0001
Working memory							
Forward Digit Span	9	4.7	1.3	4.7	1.5	ns	
Reverse Digit Span	9	3	1.1	2.3	1.7	ns	
Episodic memory							
Story I (immediate recall)	22	4.8	5.9	6.9	5.2	ns	
Story II (delayed recall)	22	2.6	3.7	4.8	4.4	2.1162	0.0386
Semantic memory							
Face recognition/ Recognition	10	9.5	2.2	9.4	1.3	ns	
Face recognition/ Naming	10	8.1	2.9	8.8	1.6	ns	
Word recognition I	20	17.9	4.2	19.4	0.3	ns	
Recognition memory							
The face recognition task II	20	14.2	4.4	14.9	3.3	ns	
Word recognition task II	20	13.5	4.2	13.5	5.4	ns	
Associative recognition	24	11.9	5	11.1	4.7	ns	
Prospective memory							
The coin task/ comprehension	3	2.5	0.9	2.3	1	ns	
The coin task I	3	0.9	1.1	1.3	1.3	ns	
The coin task II	3	1.3	1.2	1.9	1.3	ns	
The coin task III	3	1.4	1.2	1.9	1.4	ns	

Table 32. Comparison of PSMT profile for TBI and stroke patients in the tasks (df = 59).

Percentile norms

Percentile norms for the Arabic individuals were calculated for each principal domain, each task of the PSMT, and each healthy group (see Tables 33, 34, 35 and 36).

Table 33

		Working memory	Episodic memory	Semantic memory	Recognition memory	Prospective memory
Max		18	44	40	64	12
Percentiles	5	7.55	8.55	35.00	44.55	5.10
	10	8.00	12.55	37.00	46.00	7.10
	25	9.00	17.00	38.00	50.00	9.75
	50	11.00	21.25	39.50	52.00	11.00
	75	12.00	24.37	40.00	55.00	12.00
	90	14.00	32.00	40.00	59.90	12.00
	95	15.00	36.52	40.00	60.45	12.00

Table 33. Percentile norms for the young healthy Arabic individuals for the principal domains.

Table 34

		Working memory		Episodic memory		Semantic memory		
		Forward digit span	Reverse digit span	Story I (immediate recall)	Story II (delayed recall)	Face recognition/ recognition	Face recognition/ naming	Word recognition I
Max		9	9	22	22	10	10	20
Percentiles	5	5.00	2.00	4.55	2.72	9.00	7.00	18.00
	10	5.00	3.00	6.10	3.60	9.00	8.00	19.10
	25	6.00	4.00	8.50	6.75	10.00	9.00	20.00
	50	6.00	4.00	11.75	9.50	10.00	10.00	20.00
	75	7.00	5.00	16.00	12.12	10.00	10.00	20.00
	90	8.00	6.00	17.00	15.90	10.00	10.00	20.00
	95	8.45	6.45	18.45	17.62	10.00	10.00	20.00

Continue table 34

		Recognition memory			Prospective memory			
		Face recognition II	Word recognition II	Associative recognition	The coin task/ comprehension	The coin task I	The coin task II	The coin task III
Max		20	20	24	3	3	3	3
Percentiles	5	16.00	14.00	10.55	3.00	0.00	0.00	1.10
	10	16.00	16.00	13.00	3.00	0.00	2.00	2.00
	25	17.00	16. 00	14.00	3.00	2.00	2.00	3.00
	50	18.00	18.00	16.00	3.00	2.00	3.00	3.00
	75	19.00	19.00	20.00	3.00	3.00	3.00	3.00
	90	20.00	20.00	22.90	3.00	3.00	3.00	3.00

95	20.00	20.00	23.45	3.00	3.00	3.00	3.00

Table 34. Percentile norms for the young healthy Arabic individuals for the principal domains.

Table 35

		Working memory	Episodic memory	Semantic memory	Recognition memory	Prospective memory
Max		18	44	40	64	12
Percentiles	5	4.65	2.75	35.10	37.85	6.55
	10	7.00	10.05	37.00	42.20	8.10
	25	8.00	13.87	38.00	47.00	9.00
	50	9.50	19.25	40.00	49.00	11.00
	75	11.00	23.87	40.00	54.25	12.00
	90	11.00	29.90	40.00	57.00	12.00
	95	12.45	32.90	40.00	57.90	12.00

Table 35. Percentile norms for the middle age healthy Arabic individuals for the principal domains.

Table 36

		Working memory		Episodic memory		Semantic memory		
		Forward digit span	Reverse digit span	Story I (immediate recall)	Story II (delayed recall)	Face recognition/ recognition	Face recognition/ naming	Word recognition I
Max		9	9	22	22	10	10	20
Percentiles	5	3.55	1.10	1.37	1.37	7.55	7.00	20.00
	10	4.00	2.00	5.05	2.55	9.00	7.10	20.00
	25	5.00	3.00	7.87	5.00	10.00	9.00	20.00
	50	6.00	4.00	11.25	7.00	10.00	10.00	20.00
	75	7.00	4.00	14.62	10.50	10.00	10.00	20.00
	90	7.00	4.00	16.90	14.45	10.00	10.00	20.00
	95	7.45	5.00	19.45	15.00	10.00	10.00	20.00

Continue table 36

	Recognition memory			Prospective memory			
	Face recognition II	Word recognition II	Associative recognition	The coin task/ comprehension	The coin task I	The coin task II	The coin task III
Max	20	20	24	3	3	3	3

Percentiles	5	14.00	11.10	8.75	3.00	0.00	1.10	0.00
	10	15.00	12.20	11.10	3.00	0.00	2.10	2.00
	25	16.00	14. 75	12.00	3.00	2.00	3.00	3.00
	50	18.00	17.50	15.00	3.00	2.00	3.00	3.00
	75	19.00	19.00	19.00	3.00	3.00	3.00	3.00
	90	19.00	19.00	20.90	3.00	3.00	3.00	3.00
	95	20.00	20.00	21.45	3.00	3.00	3.00	3.00

Table 36. Percentile norms for the middle age healthy Arabic individuals for the tasks.

Discussion

The aim of the study was to develop and test a memory assessment tool that examines working memory and different types of long term memory involving episodic memory, semantic memory, recognition memory and prospective memory, to be used with Arabic-speaking population with ABI. The resulting Arabic PSMT has been validated to be used with patients with stroke or TBI, for an age range of 18 to 59 years.

Normative data were established for two age groups (young adults aged 18-30 years and middle age adults aged 31-59 years). This study did not involve Arabic adults aged over 60 years as accessing this particular population is problematic and challenging, at least in Saudi Arabia where testing took place.

Our Arabic normative data provide the mean scores of the healthy adults for each principal domain and task. In the comparison between the two young groups, patients and healthy controls, patients expectedly underperformed the healthy control group in all principal domains, and in all tasks apart from the face recognition task that is related to the semantic memory principal domain. In this task, participants were presented with 10 faces, one by one, and were asked to identify the faces that they recognise. This might be because the faces included in the task had some contextual cues – traditional Arabic headdress – which could enhance the patient's recognition. For instance, the pictures of King Abdullah Bin Abdulaziz (previous king of Saudi Arabia) and Yasser Arafat (previous president of Palestine) were shown with the Arabic headdress 'Ghutra' that they used to always wear.

Frowd et al. (2012) reported that contextual cues such as clothing, hair and background environment facilitate face recognition.

The results from the two middle age groups, patients and healthy controls, showed that the PSMT distinguished healthy people from those with ABI conditions, apart from in one out of 5 principal domains (semantic memory), which was due to all 3 corresponding tasks (face recognition/ recognition, face recognition/ naming, and word recognition I). Again, higher scores in the face recognition tasks across all groups could be due to the presence of contextual cues, with the added factor that older adults might have a better knowledge of the selected faces. In the word recognition task, the examiner read 20 familiar and less familiar words and participants were required to tell whether they recognise the words, and what they mean. We found a positive correlation between age and the words recognition I task scores – the higher the age the higher the scores. Similar results were obtained by Park et al. (1996) who measured knowledge based verbal ability in healthy adults (between 20 to 90 years), using semantic memory tasks that tap word knowledge, suggesting that semantic knowledge increases with age (Brickman & Stern, 2009).

Cultural differences

The data from the young Arabic adults group were compared to those in the English version. As predicted, we found variations in 3 out of 5 principal domains – working memory, prospective memory and semantic memory principal domains – across the two populations. The scores for the working memory and prospective memory principal domains were lower for the Arabic healthy young adults, whereas higher scores were found for the semantic memory principal domain.

Our findings in the working memory domain were supported by the study of Hedden et al. (2002). They found that young and old Chinese participants outperformed their American counterparts in a simple working memory task (forward digit span). Besides, the young Chinese showed better performance than Americans even in a difficult working memory task (backward digit span), however no difference was found between the older Chinese and older Americans in the difficult task. Hedden et al. (2002) suggested that the cultural differences in the digit based tasks were possible due to the linguistic differences between Chinese and English. “Chinese syllables are less dense and are pronounced more quickly than English syllables” (Hedden et al., 2002, p. 70). This appears to be the case for the digits used in the Arabic language for which Arabic names for numbers are longer than in English. Ideally, longer words might take more resources to produce and might generate more errors than shorter words, as reported by Levelt (1999).

The differences between the Arabic and English adults in the semantic memory principal domain, specifically word recognition I task and face recognition tasks, could be simply due to the concept that semantic memory is influenced by culture-specific learning and experiences, as suggested by Yoon et al., (2004).

The differences between Arabic and English participants in the face recognition I task, could be because the faces used for the Arabs were overall more familiar to them than those used for the English participants. Another possibility is that the difference would be due to cultural differences, as the variation in the ability to recognise faces across cultures was highlighted by many researchers. Blais, Jack, Scheepers, Fiset and Caldara (2008) reported adults from the Western cultures spread their fixation across the eye and mouth regions when learning and recognising faces, whereas East Asian adults fixate centrally on the nose. The findings of the Blais et al. (2008) were replicated by Miellet et al. (2013) while examining Western and Eastern adults. There is a lack of evidence on the cultural variations of the ability to name faces, yet our findings indicated that cultural differences might exist in both faces recognition and faces-naming.

The variations in prospective memory were not surprising giving the potential link between time orientation and prospective memory: Cinan and Dogan (2013) documented a significant relationship between the intention to do something in the future and future-time orientation, suggesting that prospective memory tends to be good in future-time oriented people. Wunderle (2006) reported that Arabic people tend to be casual about time and are not accurate when it comes to appointments, while Americans as future time oriented are likely very time conscious and very accurate in regards to appointments. This association between orientation to time and prospective memory could explain the observed differences between the Arabic and English populations. Cultural differences in prospective memory were also found between Canadian and Chinese adults, with Chinese outperforming Canadians in prospective memory tasks (Chang, 2012).

Once more, our results in the word recognition II task – that is related to the recognition memory principal domain – indicated that the recognition memory for words could differ across cultures possibly due to the linguistic variations. Based on the literature search, the recognition memory for words across cultures appeared to be under investigated, however, our findings suggest that this memory task may be affected by the language we speak.

Regarding cultural differences in the middle age healthy adults, differences were found in one principal domain – working memory. Again, the working memory using forward and reverse digit spans was reported to vary across cultures (Hedden et al., 2002), which support our findings. Contrary to the young healthy adults, middle age healthy Arabic individuals demonstrated slightly better performance in the words recognition I task than the English individuals. However, the scores of both populations in the words recognition I provided satisfactory next to ceiling results.

Effects of demographic variables on test performance

Years of education, age, and gender were predictors of the control group scores in the principal domains and tasks. Our findings that are related to years of education were similar to Lachman, Agrigoroaei, Murphy, and Tun (2010). Further, the findings in relation to age are supported by a number of researchers (Brickman & Stern, 2009; Cabeza et al., 1997; Craik & Jennings, 1992; Park et al., 1996; Schroeder 2014). In regards to the effect of gender, a negative correlation was found in one principal domain – prospective memory principal domain –, and three tasks – associative recognition, the coins task I, and the coins task II. A recent study by Nordin, Herlitz, Larsson and Soderlund (2017) found a similar correlation between gender and associative recognition, demonstrating that men and women differ in this type of memory. In addition, it was reported by Bahrainian, Bashkar, Sohrabi, Azad and Majd, (2013) that men have a better performance in prospective memory tasks than women, which replicates our findings (see table 28).

Test-retest reliability

The low intra-class correlation coefficient (in reverse digit span, story II, associative recognition, and coins task I) was due to improvement of scores caused by the learning effect. Getting higher scores in the second testing was not surprising as it is common among neuropsychological tests such as the Wechsler Memory Scale-III (Lo, Humphreys, Byrne & Pachana, 2012), and the California Verbal Learning test (Duff, Westervelt, McMaffrey & Hass, 2001). Further, one of the tasks – the coins task III – had a low intra-class correlation coefficient because all participants had full scores in the first testing while one of the 10 participants scored lower in the second testing.

Concurrent validity

Since there is lack of validated memory measures that address both short term and long term memory in the Arabic language, the Arabic version of the MMSE (Folstein et al., 1975) – as a widely used tool – was used to measure general cognitive function and assess the concurrent validity. First, we found an excellent correlation between the global scores of the PSMT and the global scores of the MMSE for the patients group, which indicates that the PSMT has a good concurrent validity. The poor correlations between both patients' and controls' performance on the PSMT and the similar items of the MMSE could be attributed to having different tasks with different levels of difficulty among the two tests. Specifically, in the registration item of the MMSE, the examiner names three objects and the patient is asked to repeat them all. In contrast, in the words recognition I of the PSMT the examiner reads a list of 20 familiar and less familiar words and the patient is asked to tell whether she/he recognise the words with providing meaning of the recognised ones. Based on these variations between the two items, the MMSE item is apparently shorter and easier than the PSMT task. For the recall item of the MMSE, the patient is required to recall three objects that were given earlier in the test, while the words recognition II of the PSMT requires the patient to tell whether different words (n= 20) were heard previously in the test. It is worth stating that there was a ceiling effect for both patients and controls on the MMSE.

Discriminative validity

We obtained a better discriminative validity than other memory tests namely, the Extended Rivermead Behavioural Memory Test (RBMT-E) and the Wechsler Memory Scale–Fourth Edition (WMS–IV) (Carlozzi, Grech, & Tulsky, 2013).

As stated previously, although there were differences between stroke and TBI patient groups in the episodic memory principal domain mainly the story task II (delayed recall), there could be a relation between the condition and the natural age-related decline.

Generally, the findings of the study indicated that that there are possibly cultural variations between the Arabic and English populations especially in working memory, semantic memory, and prospective memory. In addition to this, our findings show that the PSMT is a valid and reliable tool to assess memory impairments in the Arabic adult population. It is worth mentioning that the study involved only two age groups – young adults group (18-30) and middle age adults group (31-59) – which limits the normative PSMT profile to these age ranges. Also, the clinical data did not indicate information regarding the severity of the TBI. An additional study including older adults is suggested to have a wider normative profile. Finally, improvement to the face recognition/ recognition task is recommended to allow better detection of deficits in the memory of faces.

Chapter 3: Cultural aspects of faces recognition

Introduction

Among the cultural-related differences identified in the first two studies, performance in face recognition appeared to differ between Arabic and English participants. Given the recent findings from Megreya and Bindmen (2009) that Arabic people seem to use different cues to recognise familiar and unfamiliar faces as compared to Westerners, we decided to investigate further how exposure to a different culture can shape processes underlying face recognition.

We can identify a person from her voice, body shapes, clothing and gait, but the face is the most commonly used source of information (Bruce, 2012). It is well established that recognition of familiar and unfamiliar faces involves different mechanisms and resources, with more accuracy overall for recognising familiar faces than unfamiliar ones (Johnston & Edmonds, 2009). Familiar faces refer to the faces that we see on a regular basis or faces of friends, family members or celebrities. Unfamiliar faces refer to faces that are new to us such as people in a restaurant, the taxi driver or passengers on the bus (Johnston & Edmonds, 2009). Using fMRI, Leveroni et al. (2000) showed an increased response in the prefrontal, lateral temporal and medial regions for familiar/famous faces, in comparison to unfamiliar faces. In the review by Johnston and Edmonds (2009) it was reported that some patients with prosopagnosia (the inability to recognise familiar faces; Bornstein & Kidron, 1959) also perform poorly on matching tasks that involve unfamiliar faces (Young, Newcombe, Dehaan, Small & Hay, 1993). In contrast, other prosopagnosic patients have the ability to perform face matching tasks using unfamiliar faces (Bauer, 1984; Benton & Vanallen, 1972; Bruyer et al., 1983; Tranel, Damasio & Damasi, 1988).

These discrepancies in the abilities of patients with the same condition are used as an evidence of differential processing of familiar and unfamiliar faces (Johnston & Edmonds, 2009).

It was acknowledged that the contrast between familiar and unfamiliar face processing could be related to the weight of internal and external facial features (Megreya et al., 2011). Eyes, mouth, nose, and cheeks are considered part of the internal features of a face. In contrast, hair, ears and sometimes chin contour as the remaining feature of the face are parts of the external features (Want et al., 2003; Bruce, 2012). Unfamiliar face recognition was found to rely mainly on the external features of the face, with the removal of external features causing a drop in performance (Johnston & Edmonds 2009; Lewin & Herlitz 2002; Sinha & Poggio 1996; Sinha, Poggio 2002; Wright & Sladden 2003), whereas familiar face recognition tends to rely on internal features (Brooks and Kemp, 2007; Bruce et al., 1999; Clutterbuck & Johnston 2002, 2004, 2005; Ellis, Shepherd & Davies, 1979; Osborne & Stevenage 2008; Stacey, Walker & Underwood, 2005). The relation between face familiarity and the use of internal and external features emerges early in development. Children at 5 and 7 years of age already show an external feature advantage for recognising unfamiliar faces and an internal feature advantage for recognising familiar faces (Bonner & Burton, 2004; Want et al., 2003; Wilson et al., 2007).

However, the conclusions regarding internal and external features dominance in the processing of faces - especially unfamiliar faces - were challenged recently by Megreya and Bindmen (2009). They found that Egyptian participants were better at recognising unfamiliar faces through internal features rather than external features, which was attributed to their extensive exposure to faces with headscarves, suggesting that the processes underlying face recognition might be shaped by experience. Since the population that is likely to be assessed with the tools developed in this current thesis might be Arabic-speaking immigrants in Western countries, we asked whether the internal feature advantage for unfamiliar faces demonstrated by Megreya and Bindmen (2009) can be unlearnt with exposure to faces without headscarves. Thus, this third study aims to investigate the effect of length of stay in the UK on unfamiliar faces recognition in Arabic participants, and compares unfamiliar faces recognition in the Arabic and English populations.

Literature review

Face recognition model

Bruce and Young (1986) provided a widely-cited and important cognitive model of face recognition (e.g. Toseeb, 2012), that involves a number of stages. When the face is first seen the structural encoding area in the brain is activated. This structural encoding builds basic information about the face through the analysis of facial features and expressions, i.e. when the person smiles. Then, information is refined through structural encoding so that a conclusion about the person emotional state is reached. Following the structural encoding stage, facial speed analysis starts; with a focus on the lips and facial movements, the brain processes what is being said. The next stage is the directed visual processing. In this stage particular characteristics of the face are noticed. For instance, if the person is wearing classes, this information goes directly to the visual processing area. Then, the facial recognition unit works fast to compare the incoming information to the familiar faces stored in memory. If successful, access is made to the person's identity nodes. At this stage, information related to the person's identity is established, i.e. what jobs or hobbies the person has or is this person studying within the same class. Finally, a name is quickly generated.

Cultural differences in face recognition

In some cultures such as Middle Eastern cultures, many women wear headscarves whereby external features of the face are covered. Also, men in Arab-Gulf countries wear a traditional clothing that covers the hair and ear. These conceals of external features raise the question as to whether people can recognise unfamiliar faces from internal features when external features are covered, a question which was investigated by Megreya and Bindemann (2009).

In their study five experiments were conducted to examine the relative importance of internal and external feature in recognising unfamiliar faces, through the use of a face matching task. The first experiment had two main aims: to determine whether Egyptian participants have a similar bias than Caucasian participants towards external feature when matching unfamiliar faces, and to examine whether matching performance was improved for the internal features of female faces, as compared to male faces (it must be noted that Egyptian men do not tend to conceal their hair like men in the Gulf states). Thirty-two male and female Egyptian undergraduate students took part in the first experiment. In this experiment, two tasks were conducted; the internal/external face matching task was presented first, followed by a whole face matching task. In the internal/external face matching task, all participants were showed an image of a whole face and an image of a face whose either external or internal facial features were removed. Participants had to decide whether the two images were for of the same or a different person. In the whole face task, participants were showed two intact faces (whole female faces or whole male faces) and had to decide whether the two images belong to the same or different persons. Both male and female faces used in the experiment were taken from a database that includes Egyptian faces, out of which 130 male faces and 60 females aged between 20 and 22 years were selected.

The result of the internal/external face matching task indicated that Egyptian participants were better at matching both male and female faces using internal feature rather than external features. The whole face matching task showed no difference in matching whole female and whole male faces, suggesting that matching both female and male faces draws on similar processes.

The second and third experiments replicated these results with a slightly different procedure (Exp 2) and a larger stimuli set (Exp 3).

Altogether, these first three experiments suggest that an internal feature advantage in matching Egyptian faces is found for Egyptian participants, irrespective of the participant gender, or the face features being preserved (whole face, internal or external features only).

In the fourth experiment participants were asked to match the internal and external features of both Egyptian and British faces. Fifty-six undergraduate students took part, 28 British (mean age 24.1) and 28 Egyptians (mean age 18.7). The images were taken from two databases: one British database and one Egyptian database. A similar procedure to that adopted in the first experiment was followed for the same-feature-matching task, however 120 British face-matching pairs were added. The results of the fourth experiment showed that British participants displayed a greater accuracy in matching Egyptian and British faces from the external feature rather than from the internal feature. In contrast, Egyptian participants showed an internal features advantage for both Egyptian and British faces. This result highlights the differences between British and Egyptian participants, as British participants tended to rely on external features whereas Egyptians matched faces accurately from the internal features. They also suggest that the facial feature bias is not restricted to people from the same race as the participant.

The final experiment was conducted to test the ability of Egyptian children in matching unfamiliar faces using internal and external features. Thirty-two primary school children (boys and girls) between the ages of 7 to 8 years participated in this experiment. The procedure was similar to the second experiment apart from the number of images, which were minimised to decrease the duration of the task. Results showed that children were better at matching faces from external features rather than from internal features. Therefore, the internal feature advantage in recognising unfamiliar faces seems to be acquired beyond childhood. A possible explanation for the external feature advantage in childhood is that children might simply find encoding of external features easier than that of internal features (Campbell et al., 1999), which "might arise because external features may vary more noticeably in their shape, size, and colour than internal features" (Megreya & Bindemann, 2009, p. 1843).

This study provides valuable knowledge about the importance of culture in the use of internal and external features for unfamiliar face identification, as Egyptians have an internal feature advantage in recognising unfamiliar faces unlike Westerner participants who show an external feature advantage. Also, these differences between performance of both Egyptians and British were not gender related (gender of the participants and gender of the faces set), or race related. Instead, the internal feature advantage in recognising unfamiliar faces only depended on the culture of the participants. The internal feature advantage in Egyptian participants was suggested to be an emerging property of the visual/attentional system, as this effect was not found in 7 to 8 years old children.

A different study investigating the headscarf effect using an eyewitness identification paradigm was conducted by Megreya, Memon, and Havard (2011). In experiment 1, 952 British and Egyptian undergraduate students were recruited to participate in the study: 467 British (involving 141 male and 326 female) and 485 Egyptians (involving 176 males and 309 female). All of the participants resided in their own native country most of their lives. The stimuli used in the study were four video clips presenting a British or Egyptian actress performing a staged theft crime. In one of the video clips versions, the actress was wearing a headscarf (headscarf condition) and in another version the actress did not wear a headscarf (no headscarf condition). Straight after acting in the videos, two full-face pictures were taken for each actress with and without the headscarf. Then, these pictures were used in line-up tests. A total of 40 distractor pictures were taken from 20 British and 20 Egyptian females to construct these line-up tests. Two versions were constructed for each target nationality, in the headscarf condition and the no headscarf condition; a version involved the person who committed the crime and another version did not. Each British or Egyptian line-up contained 10 faces that involved the person who committed the crime or a replacement person in the culprit absent condition. A similar testing procedure was followed in each country (Egypt and UK). Participants from Egypt and UK were divided into small groups of 10-15 individuals, and presented with the video showing women from their own-race performing the staged theft, in the headscarf or the no headscarf condition. After 10 minutes, each participant was presented with the line-up test involving, or not, the person who committed the crime, which was congruent or incongruent with the head scarf condition. The congruent condition means that participants who watched the culprit wearing a headscarf were congruently shown faces with a headscarf, whereas those who watched the culprit without a headscarf were congruently shown line-ups of faces without the headscarf. For the incongruent condition, viewing the culprit with a headscarf was followed by line-ups of faces without a headscarf and vice versa.

The results revealed that British observers better identified the woman who committed the crime when her hair was shown. On the other hand, Egyptian observers correctly identified the culprit even when wearing a headscarf. This difference in performance supports the existence of headscarf effect as previously reported by Megreya and Bindemann (2009).

In Experiment 2, how well Egyptian participants could identify the British woman (who was the culprit in Experiment 1) was tested; thus the variable to be tested in this experiment was whether participants used the same information irrespective of the race of the faces. Two videos showing a woman with or without a headscarf performing staged thefts were presented to 200 new participants. The procedure was the same as in experiment 1, except for the use of congruent line-ups only. The results showed that Egyptian observers accurately recognised the British culprit when she was wearing a headscarf, providing further evidence that Egyptians process other race faces relying mainly on internal features rather than external features.

In support to the findings of Megreya and Bindemann (2009) and Megreya, Memon, and Havard (2011), Wang et al. (2015) compared unfamiliar face processing in American and Emirati adults using a part–whole face recognition task (Tanaka & Farah, 1993) and a brief questionnaire about exposure to headscarves (adapted from Islam & Hewstone, 1993). As expected, Emiratis reported more exposure to women with headscarves than Americans. In a face matching task, Emiratis were found to have a larger internal features advantage than Americans in recognising unfamiliar faces, further supporting the claim that culture shapes the individual's ability to recognise unfamiliar faces (Wang et al., 2015). These results replicate the findings of Megreya and Bindemann, (2009) in which Egyptians, who are culturally exposed to faces with a headscarf, outperformed British in recognising unfamiliar faces based on internal features. Accordingly, it seems that processes underlying recognition of unfamiliar faces could vary from one culture to another.

However, Toseeb et al. (2012) obtained different results when testing the effect of the presence of hair in recognising unfamiliar faces using a yes/no recognition task. In the learning stage, participants were presented with a series of South Asian females images (some images showing whole faces with internal features and hair uncovered, and other images showing internal features only, with hair and ears cropped) and then in the testing stage participants were required to decide which faces were previously seen. The results showed that the performance of participants, from all origins, did not differ for images presented with and without hair. Thus, this result indicates that Caucasians and South Asian participants equally processed other race faces using internal features, which contradicts the classic finding that Caucasians have an external feature bias for unfamiliar faces (Johnston, & Edmonds, 2009). The inconsistency was attributed to the type of design that was used; it was reported that “when faces are learnt in a within-subjects design where each subject sees both whole faces and cropped faces intermixed, internal features play a dominant role because they are the only set of features which are present in all the different faces. Thus, attention is generally more focused on the internal features” (Toseeb et al., 2012, p. 5).

Recently, Toseeb et al. (2014) reported that eye fixations for South Asians and Caucasians mainly focus on internal features when processing unfamiliar faces, and that wearing a headscarf does not reduce performance of unfamiliar face recognition. Similar to the explanation provided in Toseeb et al. (2012), Toseeb et al. (2014) stated that the images of faces with a headscarf (used as stimuli together with whole faces) influenced the processing by directing more attention to internal features even when whole faces were presented.

To sum up, it was found that 5-8-year-olds in an Arabic country did not show an internal features advantage when processing unfamiliar faces, but that the internal advantage develops with age (Megreya & Bindemann, 2009), if exposure to faces with headscarves is commonly encountered in the environment. Further, it appears that there is inconsistency in regards to the use of external features in Caucasians when processing unfamiliar faces, which calls for clarification.

Because the internal feature advantage in Arabic participants appears to emerge in development, in the current study we ask whether it can similarly be unlearnt with prolonged exposure to faces without headscarves. To ensure that we present all face configurations (whole faces, internal features, and external features) of Arabic and English adults, our design will be similar to that used in Megreya and Bindemann (2009, fourth experiment).

Before presenting our experiment, in what follows we will review the commonly experienced bias that can be faced when processing unfamiliar faces, namely the own-race bias.

Own-race bias

Since own-race bias is a common effect that can be encountered in face recognition, a brief overview of this effect will be presented. The own-race bias – also referred to as the Other Race Effect (ORE), Cross Race Effect (CRE), and Cross Race Bias (CRB) (Sporer, 2001) – refers to the finding that people find it easier to recognise own race faces than faces from other races (Meissner & Brigham, 2001; Tanaka et al., 2013). The lack of ability to recognise individuals from other race is an alternative definition to own-race bias (Malpass & Kravitz, 1969). The Own Race Bias has been studied extensively, for instance, Toseeb et al. (2012) reported that Caucasian people are better at recognising other Caucasian individuals compared to South Asian individuals, whereas South Asians better recognised individuals from their own-race than Caucasians. Recently, Arizpe et al. (2016) showed that Caucasian adults had impaired recognition of Chinese faces relative to Caucasian and African faces, and increased eye fixations for the own-race faces (Caucasian) versus other-race faces (African and Chinese). A more recent study by Tham, Bremner and Hay (2017) indicated that British (mono-racial) children between 5-6 years and 13-14 years did not have the ability to recognise faces from other race (Malaysian, Chinese, and African), whereas Malaysian-Chinese (multiracial) children had the ability to recognise Malaysian and Chinese faces while having recognition deficit for African faces, as less experienced faces. Such findings suggest that all children tested showed an own-race bias from the age of 5-6 years. We can expect to observe such a bias in our results, with participants being overall more accurate at recognising own-race faces.

Aims and hypothesis

The aim of this study was to investigate the effect of length of stay in the UK on unfamiliar faces recognition, and to compare the use of internal versus external features between Arabic and British individuals. These aims will be examined through the completion of a face matching task in English adults and Arabs who have immigrated in the UK. From the review of the literature, we hypothesise the following: (a) an external feature bias should be found for the English participants, (b) an internal feature bias should be found for the Arabic participants, (c) an own-race effect is expected, with participants overall more accurate with faces matching their own ethnic background, and (d) there might be a correlation between length of stay in the UK and the use of external features in Arabs; that is, the longer they have been in the UK for, and the better they have become at using external features.

Methodology

Participants

A total of 64 participants (32 Arabs and 32 English) initially took part in the experiment, but the data of 29 participants (17 Arabs and 12 English) were excluded as the data was not calculated in the E-prime program resulting in missing data. The remaining 35 participants (19 Arabs and 16 English) were included in the analysis.

The Arabic sample involved 14 males and 5 females with a mean age of 28.1 years and 15.2 years of education. They were originated from different Arabic-speaking countries: Saudi Arabia (n = 9), Iraq (n = 3), Jordan (n = 1), Oman (n = 3), and Kuwait (n = 3). Length of stay for the Arabic participants was measured in two ways; time spent in the UK (mean = 22.9 months, SD = 36.4) with a range of 0.5 – 144 months and time spent back in home country since immigration (back abroad; mean = 3.8 months, SD = 5.7) with a range of 0 – 14 months. Further, participants were asked about the type of women clothing mostly seen in home country: faces with headscarf, faces with vail, faces with niqab, and faces without a headscarf – as all these clothing cover the external and internal features to various extent.

The English sample involved 6 males and 10 females with a mean age of 24.5 years and 13.8 years of education. They were all born and had lived in the UK all their life. All participants had normal or corrected-to-normal vision (using eye glasses). Arabic participants were recruited through the University of Plymouth study advertisement and word of mouth. English participants were recruited from the psychology research pool at the University of Plymouth, UK.

Stimuli

All faces used were men, and were the same as those in the Megreya and Bindemann (2009), who selected the Arabic images from a large database of Egyptian faces (see Megreya & Burton, 2008, for a full description of this database). The database contained two high-quality face images of male students from Menoufia University, Egypt, ranging from 20 to 22 years of age. No facial hair or distinguishing marks were included. One of the two pictures was taken from a digital camera, whereas the other picture was recorded with a camcorder. The two pictures were taken on the same day using the same lighting conditions. The pictures had a neutral expression and showed similar full-face view. From these pictures, face-matching pairs were constructed. Each pair contained a target face and a similar looking distractor face, or the same face. Following this, either internal or external features were removed to create two versions of match and mismatch pairs. The first version contained whole face target images and distractor faces with internal features only, whereas the second version involved whole face target images and distractor faces with external features only. Example stimuli are presented in figure 1. For the English faces, Megreya and Bindemann (2009) took the images from a database of male British faces (the UK Home Office PITO database, full details about this database is provided in Bruce et al., 1999). The versions of match and mismatch pairs were created in the same way used for the Arabic stimuli. Example stimuli are presented in figure 2.

Accordingly, in our experiment a total of 120 pair of faces were used: 60 pairs of Arabic faces containing 30 pairs of whole faces targets paired with a distractor containing internal features only and 30 pairs of whole faces targets paired with a distractor containing external features only. The same distribution was used for the

60 pairs of English faces. Pairs were arranged so that half of the pairs were matching faces and the other half were mismatching faces.

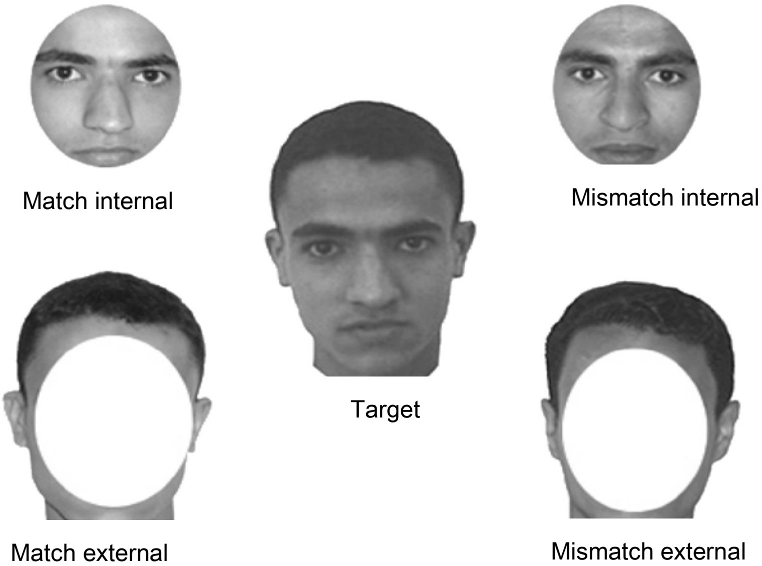


Figure 1. *Examples of the Arabic face stimuli used in the experiment (adapted from Megreya and Bindemann, 2009, p. 1834).*

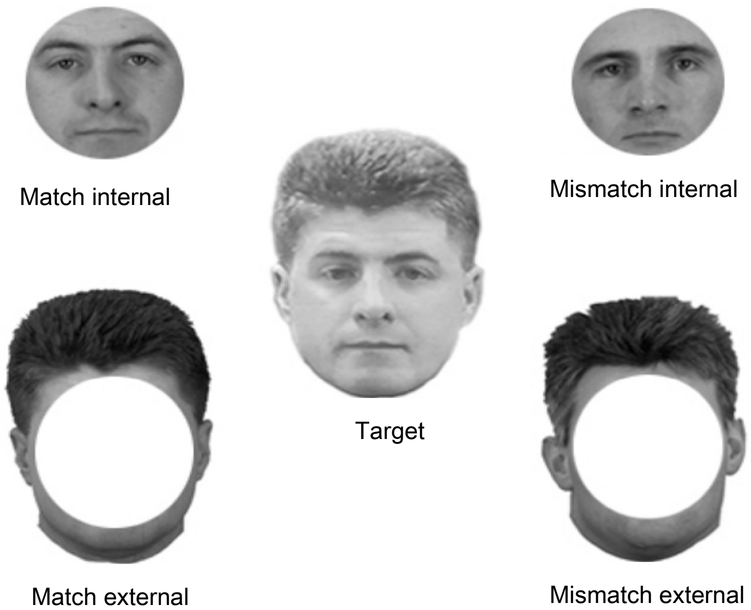


Figure 2. *Examples of the British face stimuli used in the experiment*

(adapted from Megreya and Bindemann, 2009, p. 1840).

The experiment was divided into 2 blocks. Block 1, referred to as the internal condition, contained whole faces paired with internal features distractors (including both Arabic and English faces). Block 2, referred to as the external condition, contained whole faces paired with external features distractors (including both Arabic and English faces).

Procedure

Participants were tested individually in a quiet room. Stimuli were presented on a computer screen using E-prime software. Participants were instructed, in English, to complete a matching face recognition task.

For the participants to be familiar with the face matching task they competed 4 initial training trials, with feedback – 1 match internal, 1 mismatch internal, 1 match external, and 1 mismatch external. Then, each participant was presented with two blocks of 60 pairs, each containing 30 matching and 30 mismatching faces, randomly interleaved. The internal condition block was presented first, followed by the external condition block, similar to Megreya and Bindemann, (2009). For each pair, faces were presented simultaneously on the computer screen until participants responded. The decisions for the match and mismatch were made by pressing two labelled keys on a standard computer keyboard – L key for match and A key for mismatch. Participants were instructed to respond as quickly and accurately as possible.

Results

The dependent variables were the number of correctly identified matches (CH for correct hits), the number of correctly identified mismatches (CR for correct rejections), and the overall accuracy (CR + CH). These are presented in Tables 37, 38 and 39 for Arabic and English participants, and for the two conditions (internal and external features).

Table 37

	Arabic participants	English participants
	Mean (SD)	Mean (SD)
External features		
Arabic faces	24.3 (2.4)	22.3 (3.1)
English faces	22.4 (4.8)	21.5 (3.4)
Internal features		
Arabic faces	23.8 (2.5)	22.4 (2.3)
English faces	23.1 (2.9)	20.6 (2.7)

Table 37. Mean overall accuracy of Arabic and English participants for matching the internal and external features of Arabic and English faces.

Table 38

	Arabic participants	English participants
	Mean (SD)	Mean (SD)

External features		
Arabic faces	13.7 (1.1)	12.4 (1.7)
English faces	11.3 (3.9)	9.4 (2.8)
Internal features		
Arabic faces	13.6 (1.3)	11.8 (2.2)
English faces	11.6 (2.9)	7.9 (2.8)

Table 38. Mean correct hits of Arabic and English participants for matching the internal and external features of Arabic and English faces.

Table 39

	Arabic participants	English participants
	Mean (SD)	Mean (SD)
External features		
Arabic faces	10.5 (2.2)	9.9 (2.4)
English faces	11(2.4)	12.1 (1.7)
Internal features		
Arabic faces	10.2 (1.8)	10.6 (1.8)
English faces	11.5 (2.1)	12.6 (1.7)

Table 39. Mean correct rejections both Arabic and English participants for matching the internal and external features of Arabic and English faces.

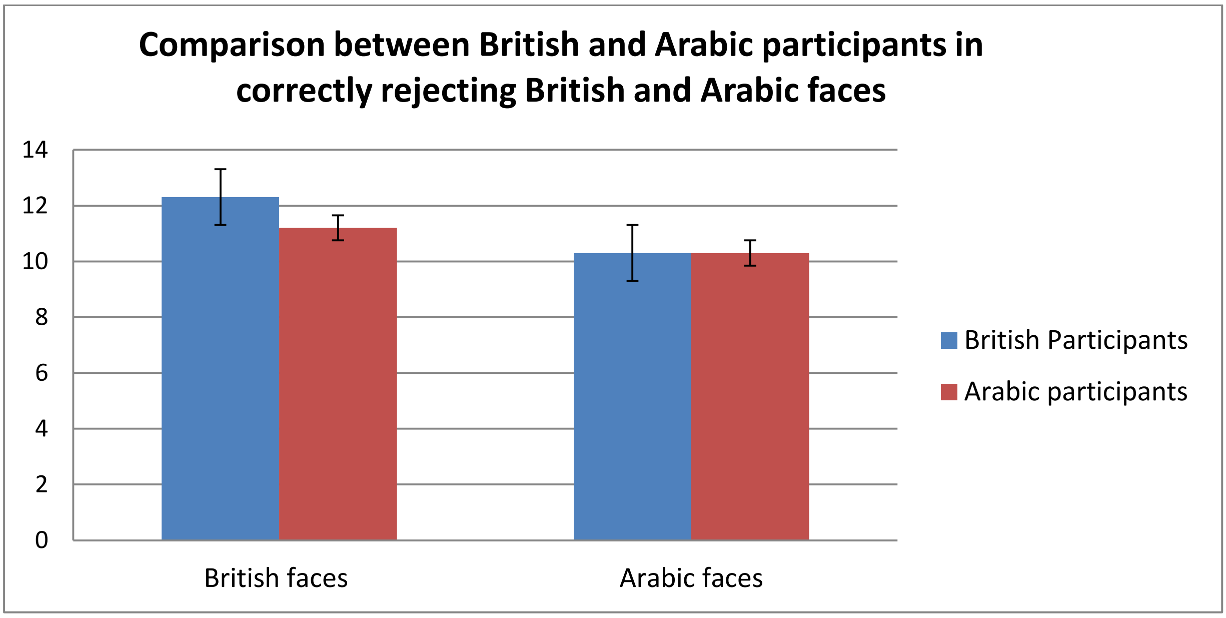
For each of these dependent variables, a 2 x 2 x 2 ANOVA was conducted with participant nationality (Arab versus British) as a between-participant factor, face nationality (Arab and British) and feature condition (internal and external features) as within-participant factors.

For overall accuracy, there was no main effect of feature condition ($F(1,33) < 1$), and no interaction between feature condition and any other variable. Participants were as accurate in the external feature condition (mean = 22.6, SD = 1.0) than the internal feature condition (mean = 22.5, SD = 0.3). There was a main effect of face nationality ($F(1,33) = 9.67$, $p = 0.004$), due to Arabic faces being more accurately recognised (mean = 23.2 SD = 0.26) than English faces (mean = 21.9, SD = 0.45); no interaction was found between face nationality and other variables. There was a main effect of group ($F(1,33) = 7.61$, $p = 0.009$) due to Arabic participants recognising faces overall better (mean = 23.3 SD = 0.41) than English participants (mean = 21.7, SD = 0.45). No interaction was significant.

For correct hits (CH), there was no main effect of feature condition ($F(1,33) = 2.05$, $p = 0.161$), and no interaction between feature condition and any other variable. Again participants were as accurate in the external feature condition (mean = 11.3., SD = 1.2) than the internal feature condition (mean = 11.2, SD = 0.7). As for overall accuracy, there was a main effect of face nationality ($F(1,33) = 48.35$, $p = 0.000$), due to Arabic faces being more accurately matched (mean = 12.9, SD = 0.19) than English faces (mean = 10.1, SD = 0.45), and no interaction between face nationality and any other variable. There was a main effect of group ($F(1,33) = 15.14$, $p = 0.000$) due to Arabic participants outperforming (mean = 12.6, SD = 0.38) English participants (mean = 10.4, SD = 0.41). No interaction was significant.

Finally, for correct rejections (CR), there was no main effect of feature condition ($F(1,33) < 1$), and no interaction between feature condition and other variables. Participants were as accurate in the internal feature condition (mean = 11.2, SD = 0.2) than the external feature condition (mean = 10.9, SD = 0.3). There was a main effect of face nationality ($F(1,33) = 35.12$, $p < 0.001$), due to mismatching English faces being more accurately rejected (mean = 11.8, SD = 0.26) than Arabic faces (mean = 10.3, SD = 0.26), but no interaction between face nationality and any other variable. There was no main effect of group ($F(1,33) = 1.33$, $p = 0.256$), English participants (mean = 11.3, SD = 0.34) were as accurate as Arabic participants (mean = 10.8, SD = 0.25). There was an interaction between participants nationality and faces nationality ($F(1,33) = 5.65$, $p = 0.023$), due to British participants (mean = 12.3, SD = 0.38) being better than Arabs (mean = 11.2, SD = 0.35) at rejecting British faces ($t(33) = 8.9$, $p = 0.0001$); in contrast, British participants (mean = 10.3, SD = 0.36) were no different than Arabs (mean = 10.3, SD = 0.33) at rejecting Arab faces ($t(33) < 1$); see figure 3.

Figure 3



We also analysed reaction times, which are summarised in Table 40.

Table 40

	Arabic participants	English participants
	Mean (SD)	Mean (SD)
External features		
Arabic faces	4432.9 (1627.1)	2488.8 (1692.4)
English faces	4429.918 (1577.5)	2568.8 (1867.5)
Internal features		
Arabic faces	5076.2 (7385.2)	2626.8 (1602.7)
English faces	5663.7 (4437.1)	2599.3 (1510.8)

Table 40. Mean reaction times for Arabic and English participants as a function of feature condition.

There was no main effect of feature condition (F(1,33) = 1.72, p = 0.199), and no interaction between feature and any other variable. There was no main effect of face nationality (F(1,33) = 3.42, p = 0.073), and no interaction between face nationality and any other variable. There was a main effect of group (F(1,33) = 9.208, p = 0.005) due to Arabic participants taking longer to accurately recognise faces (mean = 4900.7 ms, SD = 519.1) than English participants (mean = 2570.8 ms, SD = 566.0). No further interaction was significant.

Further, we conducted regression analyses to examine whether the length of stay in the UK or the amount of time spent back abroad could modify the type of feature cues used by Arabic participants. In the regression model, as the DV we used for each Arabic participant the difference between their accuracy in the internal feature condition minus external feature condition (referred to as internal feature advantage). Then we conducted a stepwise regression with the following variables: length of stay in the UK, age, time back home since immigration, and type of women clothing in home country. In order to normalise the variables, we log-transformed length of stay in the UK and time back home. However, these two variables could not be entered in the same model as they were highly correlated ($r = .850$, $p < .0000$), so two separate models were constructed.

A regression model on the internal feature advantage with length of stay, age and women dress, retained age as a significant predictor $F(1,17) = 7.024$, $p = .017$): the older Arabic participants are, and the more internal advantage for UK faces ($\beta = 0.39$, $p = .017$). Length of stay in the UK was not a significant predictor, see figure 4. However, a model with time back home, age and women dress retained age $F(1,17) = 7.024$, $p = .017$) and time back home $F(1,17) = 4.537$, $p = .048$ as significant predictors: the more Arabic participants spent time back home and the more of an internal advantage they showed for face recognition ($\beta = 2.85$, $p = .048$); see figure 5, and again the older Arabic participants are, and the more internal advantage for UK faces ($\beta = 0.39$, $p = .017$), see figure 6. The overall model fit was $R^2 = 0.211$.

Figure 4

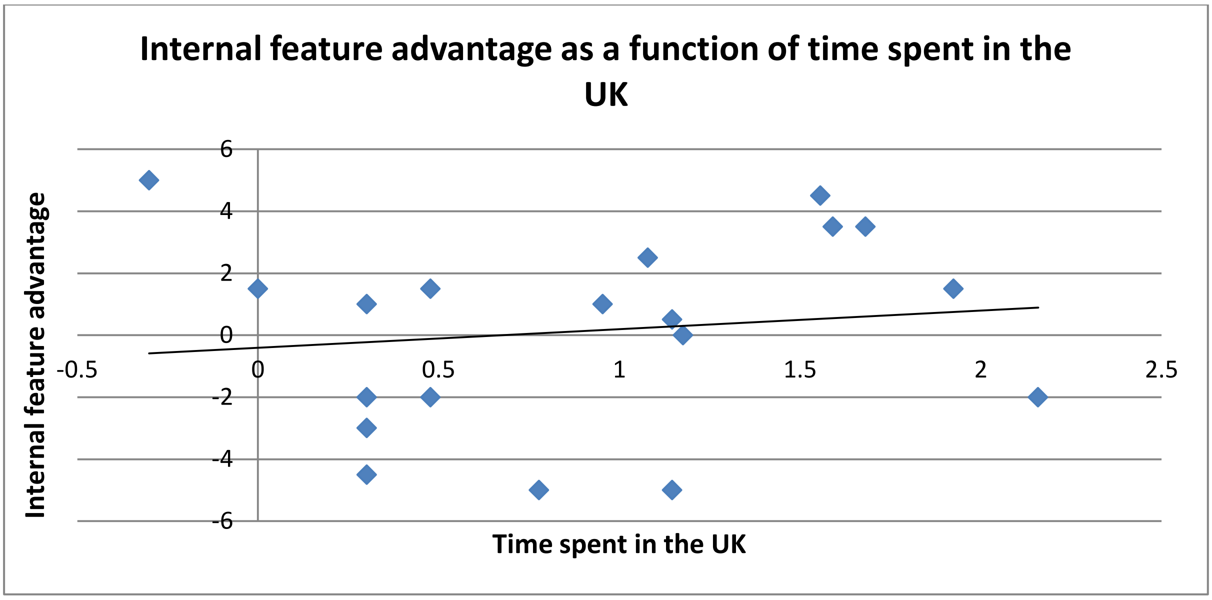


Figure 5

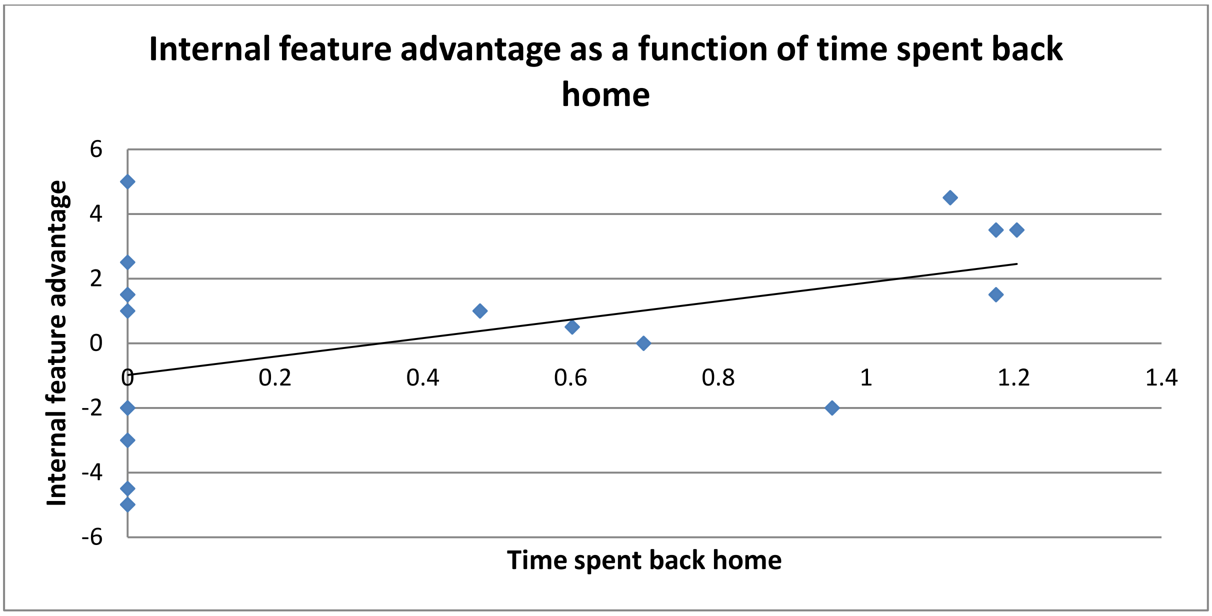
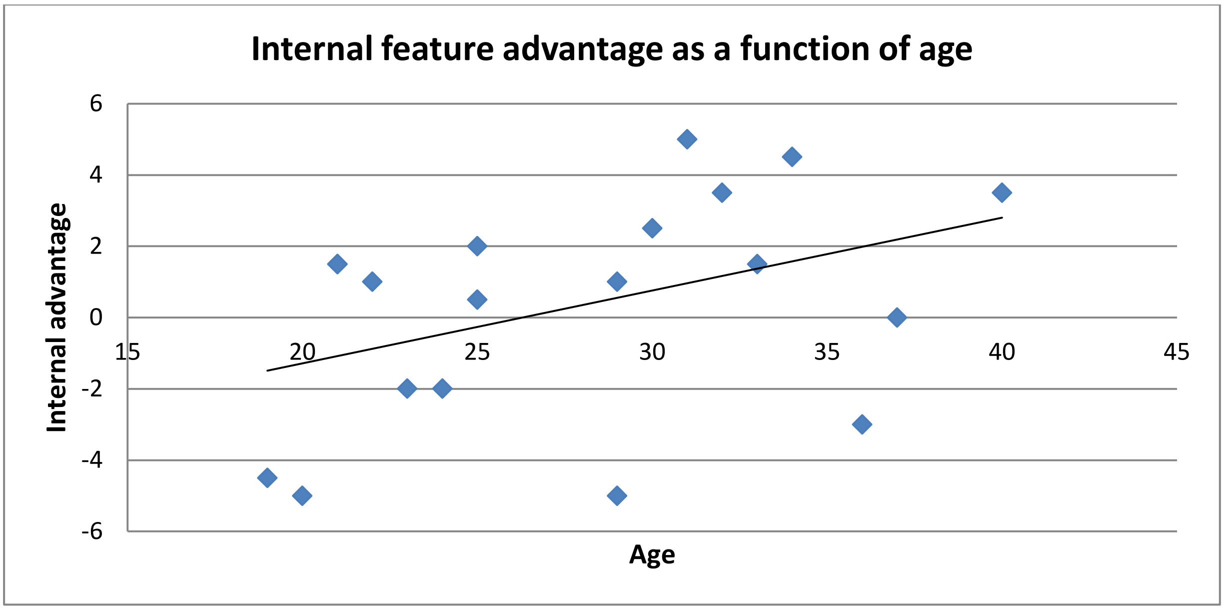


Figure 6



Finally, a post-hoc statistical power calculation for multiple regression was conducted. Our sample size (n = 35) yield a power of around 0.61 in testing hypotheses concerning both the length of stay in the UK variable and the time back home variable.

Discussion

Given that processing of unfamiliar faces appears to differ between Arabic and English people (Megreya & Bindmen, 2009; Megreya, Memon, & Havard, 2011; Wang et al., 2015), in this study we aimed at investigating the effect of length of stay in the UK on unfamiliar faces recognition, and comparing the use of internal versus external features between Arabic and British individuals. We conducted a face matching task similar to that used by Megreya and Bindemann (2009). We primarily expected to observe an external feature advantage for English participants, an internal feature advantage for the Arabic participants, and a correlation between length of stay in the UK and the use of external features in Arabs. We also expected an own-race effect, with participants being overall more accurate with faces matching their own ethnic background.

Contrary to our expectations, no internal/external feature bias was found for Arabic or English participants: participants were overall successful in the task, and equally so when having to match whole faces to internal features, or whole faces to external features. These null results could be due to the small statistical power of the experiment - we were aiming at 64 participants to reach Megreya and Bindeman's (2009) power, but due to experimental error, we had to reject half of the data.

Our results showed a hint of an own-race bias, as British participants were more accurate in identifying mismatching British faces than Arab participants. This result was expected as Caucasian people are generally better at recognising faces of individuals from own-race than faces from other race (Arizpe, Kravitz, Walsh, Yovel & Baker, 2016; Toseeb 2012). The absence of an own-race bias for the Arabic adults can be explained by the fact that Arabs have been in the UK for a while, as well as being used to watch Western faces in the media.

Despite the overall absence of internal/external feature biases in the two populations, we found that the expected internal feature advantage in Arabic participants was more likely to be found for those who spend more time back in their home country since their arrival in the UK, suggesting that visual processing biases can be modified with exposure in adulthood. This is in line with previous studies indicating that Arabs are likely to process unfamiliar faces from internal features rather than external features due to exposure to concealed faces with traditional clothing like a headscarf (Megreya & Bindemann, 2009; Wang et al., 2015). It goes a step further by suggesting that visual/attentional biases such as the internal feature advantage can be modified in adulthood depending on length of exposure. Besides, our findings showed that the older Arabic participants were those showing the more internal advantage for faces which implies that the internal feature advantage could develop with age, which is consistent with Megreya and Bindemann (2009) who reported that children at 5-8-years-old did not show an internal features advantage while it was found in adults.

Considering the findings above, the null effect of length of stay in the UK on the internal feature advantage could be due to the small statistical power of the experiment – again, half of the data was rejected. Our statistical power was not adequate to observe the expected effect which may have increased the risk of type II error (false negative). In addition, despite our use of a similar design to Megreya and Bindemann (2009), our findings are in agreement with Toseeb et al. (2012, 2014) for which South Asian and English participants similarly processed unfamiliar faces from internal features. Previous studies indicated that “prolonged experiences in a cultural context foster culturally specific patterns of cognition and perception across life span as adults age" (Reisberg, 2013, p.980). For instance, Blanchard-Fields, Chen, Horhota, and Wang (2007) found no cultural differences between younger Chinese and American adults in the degree of correspondence bias (judgment about the person's personality; Moskowitz, 2001), however, a stronger correspondence bias was shown in American older adults than Chinese older adults, suggesting that prolonged exposure to cultural contexts modulated cognitive styles in each culture. Additionally, Gutchess et al. (2006) found a similar pattern between American and Chinese adults for categorical clustering (participants required to recall words from different categories, i.e. fruits and mode of transportation): cultural differences were greater for older adults than for younger adults. Such results suggest that the impact of culture on cognition/perceptual processes is dynamic, with possible changes over the lifespan, with varying degrees of exposure.

General discussion

The central aims of this thesis were to assess cognitive functions in adult Arabic populations, and to examine cultural differences in cognitive performance between the Arabic and English speaking populations. The first study aimed to translate, cultural adapt, and validate the Cognistat (as a cognitive screening tool) for its use with Arabic speaking adults with acquired brain injury (ABI), alongside examining the cultural differences between the Arabic and English adults. Our results showed that the Cognistat is a valid and reliable tool for detecting cognitive deficits in those suffering from ABI. The performance of the Arabic adults on the Arabic Cognistat was compared to that of English adults in the original English Cognistat. Overall, cultural differences between healthy Arabs and healthy English adults were found in orientation and memory, but also extended to language (repetition and naming), construction, calculation and reasoning (similarities and judgment). These results were consistent with previous studies that adapted the Cognistat to different populations i.e. the Israeli (Katz, Elazar, & Itzkovich, 1996) and Chinese populations (Chan et al., 2002). The variations between Israeli and English populations were found in attention, naming and construction, whereas variations between Chinese and English individuals were identified in repetition, naming, construction and memory. It is difficult to determine whether these differences in cognitive tests are due to differences in cognitive processes, or to differences in strategies in test situations. Extension to this study would entail the testing of adults over the age of 60, the study of the impact of the severity of injury, and the validation of the Arabic Cognistat with patients with different neurological conditions such as multiple sclerosis or dementia.

This first study opened up the road to the culturally-adapted fine-grained evaluation of more specific cognitive processes, i.e. memory (Study 2) and face recognition (Study 3). Since memory deficits are commonly experienced in patients with ABI and no memory tests are available for assessing the full range of memory aspects in Arabic patients, we identified the need for the development of an appropriate tool. Therefore, our second study presented the development and validation of a memory test – the Plymouth Saudi Memory Test (PSMT) – for the Arabic speaking population with ABI, as well as the exploration of cultural differences in memory functioning in the Arabic and English individuals. Similar to the Cognistat, the PSMT was found to be a valid and reliable test, with patients expectedly underperforming the healthy control group in most memory domains (working memory, episodic memory, prospective memory, and recognition memory). An exception was found for semantic memory, in its three corresponding tasks: face recognition/ recognition, face recognition/ naming, and word recognition I. In the face recognition/ recognition task, and face recognition/ naming task, participants were presented with 10 faces, one by one, and were asked to tell whether they recognised the face (face recognition/ recognition task), and name it (face recognition/ naming task). For the word recognition I task, participants were read a mixture of 20 familiar and less familiar words and were required to tell whether they recognised the words and what they meant. Although the patient group scored lower than the healthy group in the face recognition/ recognition, and face recognition/ naming tasks, the results were not significant which are suggested to be due to the presence of contextual cues (e.g. a particular scarf associated with a well-known individual), and the fact that older adults might have a better knowledge of the selected faces. Again, the patient group underperformed the healthy group in the word recognition I task but no significant results were found due to an age effect in patients - the higher the age, the higher the word identification scores. This result is in line with Brickman and Stern (2009) who found that semantic knowledge related to words does increase with age. Thus, we suggest using an additional semantic memory test to further examine this type of memory, especially with elderly patients.

When comparing participants' performance in the Arabic PSMT and its British English version, expectedly we found variations between the Arabic and English healthy participants in working memory, semantic memory, and prospective memory. Arabic individuals scored worse than English participants in working memory and prospective memory principal domains, while they scored better than their English peers in the semantic memory principal domain. These variations were in agreement with previous research: Hedden et al. (2002) found variations between Chinese and American adults in verbal working memory tasks - forward and backward digit span – with Chinese participants outperforming Americans, whereas Gutchess et al. (2010) noted variations between East Asians and Americans in semantic memory skills. East Asians and Americans were reported to use different processing strategies of semantic knowledge, for which East Asians favoured a functional associations strategy to organise information in memory (i.e., cow-grass) while Americans favoured a categorisation-based strategy (i.e., cow-chicken). Further, Chang (2012) reported that prospective memory abilities can differ between Chinese and Canadian adults: Chinese adults outperformed Canadians in event-based, time-based and activity-based prospective memory tasks. The variations in working memory found in the current study were suggested to be due to linguistic differences between Arabic and English, as Arabic names for numbers are longer than in English. In speech production it is often found that the processing of longer words takes more time and generates more errors than shorter words (Levelt, 1999). For semantic memory, population differences could be due to semantic memory being subject to culture-specific learning and experiences, as suggested by Gutchess et al. (2011) and Yoon et al. (2004). Alongside the variations discussed above, we interpreted prospective memory differences in terms of a potential link between time orientation and prospective memory. Previous research indicated that Arabic individuals tend to be casual about time and are not accurate when it comes to appointments, while Americans as future time oriented are likely very time conscious and very accurate in regards to appointments (Wunderle, 2006). Cinan and Dogan (2013) acknowledged that there is an association between prospective memory and orientation to time, with prospective memory tends to be better in future-time oriented people (like Americans: Wunderle, 2006). Again, this association between orientation to time and prospective memory could justify the observed differences between the Arabic and English adults. Alongside the variations noted between Arabs and English adults in this second study, similar cultural differences were found in the first study in which Arabs scored lower than their English counterparts in memory and orientation.

In addition to the impact of culture, language is also suggested to influence our cognitive processes; the well-known Sapir-Whorf hypothesis proposed that speakers of different languages may think differently (Whorf, 1956) which could lead to variations in cognitive functioning. For example, Fausey et al. (2010) reported that memory, particularly describing past events, is predicted by patterns in language. More specifically, English speakers are likely to describe events in terms of people doing things (such as “John broke the vase”; Boroditsky, 2011, p. 64) even when the event accidently happened, whereas Japanese or Spanish speakers would tend to describe the same accidental event without mentioning the person who was involved (“the vase broke” or “the vase broke itself”; Boroditsky, 2011, p. 64). These findings suggest that speakers of English, Spanish and Japanese were equally able to remember previously encountered events but differed in the quality of details used to encode these memories (Fausey et al., 2010). Results like those make it difficult to determine whether the differences between Arabic and English speakers found in this thesis are due mostly to cultural differences, language differences, or a combination of both.

There are other factors that could influence our cognitive processes such as intelligence level and relative levels of familiarity. It is well-known that the person’s cognitive functions can be influenced by the intelligence level and that “general intelligence is responsible for much of the predictive validity of cognitive tests” (Deary, Penke, & Johnson, 2010, p. 201). With regards to the level of familiarity, some of the tasks that we used to measure the differences between the Arabic and English adults (i.e. faces or words recognition tasks: for semantic memory) could be influenced by the level of familiarity. More specifically, the faces or words we used might be more familiar to the Arabic participants than those chosen for the English adults. Again, such results tell us that the differences between the Arabic and English adults found in this thesis are not only due to cultural differences. Rather, the variations between the two populations could be due to the differences in intelligence, level of familiarity, language differences, or a combination of all.

In terms of limitations, similar to the first study, the normative PSMT profile did not include adults from the age of 60 years which limits the generalisability of the results to those from 18-59 years. Also, it could be argued that the notion of representativeness among the samples of both the first and second studies were problematic. The majority of Arabic participants were from Saudi Arabia: one could argue that such a sample is not a representative of all Arab countries. Thus, the results can only be generalised to the Saudi population and those from other Gulf countries who share a similar culture such as Kuwait, United Arab Emirates, Qatar or Oman. In addition, the clinical data lacked information regarding the severity of the injury. Further, it is likely that our results are confounded by the difference in intelligence between the patient group and the control group. Lastly, non-significant results in the semantic memory principal domain could result in type II error (false negative). Such a limitation has a clinical implication for which ABI patients might have a semantic memory deficit which was not detected using our semantic memory tasks.

Despite the identified limitations of the first and second studies, our results provide key solutions for the clinical assessment of Arabic populations: such cognitive tools could help improve the cognitive rehabilitation practice for the Arabic population by offering validated, reliable and culturally-adapted tests in the Arabic language. Further, our results should enhance practitioners' awareness of potential cultural differences in cognition and the importance of using culturally appropriate tools. This is because the person's culture could play a key role in modulating performance in cognitive tests, as we found in our studies and previously reported (i.e. Conway et al., 2005; Kastanakis & Voyer 2014; & Nisbett et al., 2001). In general, there are variations in values, needs, life expectations, and experiences between people from different cultures, as suggested by Kitayama, Duffy, Kawamura, and Larsen (2003), which may lead to variations in perception and cognition biases.

The cultural differences identified in the first two studies, especially in faces recognition, led to further investigation of the impact of exposure to a different culture on processing unfamiliar faces. The main aims of the third study were to investigate the effect of length of stay in the UK on unfamiliar faces recognition, and to compare the cultural differences in unfamiliar faces recognition between Arabic and British adults through the use of a face matching task. There appears to be mixed views in the literature regarding the processing of faces, especially unfamiliar faces. Researchers suggested that all adults process unfamiliar faces relying mainly on external features (Johnston & Edmonds 2009; Lewin & Herlitz 2002; Sinha & Poggio 1996; Sinha & Poggio 2002; Wright & Sladden 2003), a finding challenged in a number of studies (Megreya & Bindemann, 2009; Megreya Memon, & Havard 2011; Wang et al., 2015) suggesting that unfamiliar faces can be processed from internal features after a life-long exposure to faces concealed with a head scarf. The results of our third study indicated that the expected internal feature advantage in Arabic participants was found primarily in older Arabic immigrants, and in those who spend more time back in their home country, suggesting that visual processing biases can be modified with prolonged exposure in adulthood. Once completed to produce a satisfying level of statistical power, this study would add to the growing body of knowledge concerning the impact of culture on unfamiliar faces recognition.

In conclusion, we have generated new sets of data aimed at improving cognitive assessment in Arabic adult populations, and alongside, demonstrated the critical role of culture in shaping adults' performances in cognitive tasks. Most areas of cognition were found to differ amongst cultural groups: attention, orientation, language, construction, calculation, reasoning, memory (working, semantic, prospective) and face processing. Importantly we demonstrated how dynamics some cultural cognitive biases can be, as they can be modulated by age and length of exposure to different cultures. This thesis opens up the road to further, systematic investigation of the role of culture in the different cognitive processes such as executive functions and language processing.

Appendices

Appendix 1. English version of the Plymouth Saudi Memory Test (PSMT)

<table>
<tr><td colspan="2">1: Prospective memory (Comprehension score: score 3 points if patient repeated the three instructions correctly, 2 if repeated 2 instructions correctly, and 1 if repeated one instruction correctly).</td><td>Domain Total Score</td><td>/3</td></tr>
<tr><td>Subtest</td><td colspan="2">Administration Guide</td><td>Score Max</td></tr>
<tr><td>I. The Coins Task</td><td colspan="2">The examiner says to the patient: I am going to give you a box of coins (the examiner gives the box of coins to the patient) and I want you to keep it and when I say the word thank you give me the first coin from the box, when I say we are half way through the test hand me the second coin, and when I say we have finished the test hand me the third coin.

Now, tell me when you need to hand me the first coin, second and third. Instruction should be repeated if patient failed to repeat the instructions correctly. <u>Stop after 3 consecutive trials</u>.</td><td>/3</td></tr>
</table>

<table>
<tr><td colspan="2">2: Explicit (declarative) memory A. Episodic memory (Score 1 point for each correctly recalled idea, ½ point for partially recalled idea, 0 point for incorrect answer. If patient required prompting to remember the story 1 point should be deducted)</td><td>Domain Total Score</td><td>/22</td></tr>
<tr><td>Subtest</td><td colspan="2">Administration Guide</td><td>Score Max</td></tr>
<tr><td>I. Story task I (immediate recall)</td><td colspan="2">The examiner says to the patient: I am going to read you a short story and I want you to tell me as much as you can remember from the story. Listen carefully. (The examiner should read the story once).

Mark /said/ last week / I woke up early/ without any desire to work /, but I pushed myself to go / to the city council that I work in /, due to my need for money /. Before the end of my shift/ it was announced that there was a budget cut / and I lost my job /. On my return home / I discovered that the tire was flat/ I stopped to replace it /, and then I discovered that the spare tire was also in need of repair /. A young man stopped / his car / and offered me a ride to repair the tire/. I went with him and I told him about what happened to me at work /. The young man offered me a job/ in a retail shop nearby/ with a salary of up to 2000 pounds per month.</td><td>/22</td></tr>
</table>

<table>
<tr><td>3: Working memory (Scores are given based on the number of digits correctly repeated. For example, if the patient is able to repeat 2 digits correctly a score of two is given, and if 3 digits are repeated a score of three is given and so on. Discontinue after 2 misses at one level).</td><td>Domain Total Score</td><td>/18</td></tr>
</table>

Subtest		Administration Guide	Score	Max
I.	Forward Digit Span Task	The examiner says to the patient: I am going to read you a series of numbers and I want you repeat them exactly as they were given. Listen carefully. The examiner reads one digit at a time. 8–5 4–7–2 2–4–1–7 6–4 8–1–5 6–1–5–8 5–2–1–8–6 3–9–2–4–1–7 5–9–1–7–4–2–8 4–2–7–3–1 4–7–8–2–9–4 3–7–9–2–5–4–6 5–8–1–9–2–6–4–7 5–3–9–7–1–2–4–6–9 2–9–3–6–7–2–4–9 4–2–6–8–1–7–9–2–5		/9
II.	Reverse Digit Span Task	The examiner says to the patient: Now, I am going to read you a series of numbers and I want you repeat them backward. Listen carefully. The examiner reads one digit at a time. 8–3 8–2–9 6–2–4–1 8–4–1–3–2 2–8 1–3–2 2–3–5–9 6–2–1–4–3 5–8–7–2–6–1 2–9–4–1–5–7–8 2–6–1–3–7–4 1–2–7–5–3–9–4 2–7–8–1–4–6–5–9 2–3–1–7–9–4–6–5–2 4–9–6–7–5–2–1–3 4–1–5–7–8–6–9–2–1		/9

4: Explicit (declarative) memory A. Episodic memory		Domain Total Score		/0
Subtest	Administration Guide		Score	Max

I. Story task II	The examiner says to the patient: I am going to read you a short story and later in the test I want you to tell me as much as you can remember from the story. Listen carefully. (The examiner should read the story once). In today's newspaper / I read a story about /a 70 year old / man/ who just earned a Bachelor's degree / in Business Administration / from a major University/ located in one of the European countries. / This man works as a businessman / and has a number of companies / that specialise in export of food / to Arabic countries /. A reporter asked / "Why did you complete your studies / given that you are already a rich business man/ with success / and power?" / He replied/ "I worked hard and got the degree/ to fulfil a promise/ that I made to my mother / 50 years ago". Alternative story: Miss/ Sarah/ Jones/ is a 20 year old/ student/ in history/ at the University of Bangor / in Wales/ Sarah is a smart girl/, she is active/ and her favourite hobby/ is art/. On Monday/ the university announced/ a competition/ for the best drawing/. At the end of the week/ the results of the competition were announced/. Sarah had won / and received a trophy / written in it/ 'to the most talented artist'.	0

5: Explicit (declarative) memory B. Semantic memory (Recognition: Score 1 point for the correctly identified familiar face/word, 1 point for correctly saying that the face/non-word is not recognised, 0 point for incorrect answer). (Naming: Score 2 points for each correct answer, 1 point for correct answer with prompt, 0 point for incorrect answer)		Domain Total Score	/20
Subtest	Administration Guide		Score Max

I. Faces Recognition Task	The examiner says to the patient: I am going to show 10 faces, one by one, and I want you to tell me whether you recognise the faces, and then who is it. You will see each picture for 2 seconds, look at them carefully. The examiner starts to show the patient the pictures one at a time. Recognition Naming 1. Gorbachev 2. Unfamiliar face 3. Unfamiliar face 4. Yasser Arafat 5. Unfamiliar face 6. Obama 7. Tony Blair 8. Price William 9. Unfamiliar face 10. Unfamiliar face	/10 /10

6: Prospective memory (Score 3 points if one coin is handed without prompt, 2 point if more than one coin are handed at the same time or handed the whole box of coins, 1 point if one coin is handed with prompt, & 0 point if failed to hand in any coin).	Domain Total Score	/3
Subtest	Administration Guide	Score Max
I. The Coins Task I	The examiner says to the patient: Thank you. When you say this phrase the patient would need to hand you the first coin. If patient did not remember after 2 seconds, say: is there something that you needed to do.	/3

7: Explicit (declarative) memory B. Semantic memory (Recognition: Score 1 point for the correctly identified familiar word, 1 point for correctly saying that the non-word is not recognised & 0 point for incorrect answer).	Domain Total Score	/20
Subtest	Administration Guide	Score Max

I.	Words Recognition Task I	The examiner says to the patient: I am going to read you a mixture of 20 familiar and less familiar words, one by one, and I want you to tell me the words you recognise, and what they mean (ask the patient to descript the animals, For example, a sheep has four). Note: highlighted words only (6-15) will be examined later in the words recognition task II. 1. Sheep 2. Nelipot 3. Paroxysm 4. Rabbit 5. Gowpen 6. Chickens 7. Mouse 8. Sapient 9. Robins 10. Camlets 11. Gimlets 12. Scorpion 13. Wolves 14. Mullion 15. Ratoon 16. Gazelle 17. Horses 18. Lambent 19. Butterfly 20. Mungos	/20

8: Associative memory	Domain Total Score	/0

Subtest	Administration Guide	Score Max
I. Associative Recognition Task	The examiner says to the patient: I am going to read you 24 pairs of words. Listen carefully. The Examiner should allow 2 seconds only between each pairs of words. 1) Camel-Table 2) Church-Train 3) Banana- Necklace 4) Tooth-Policeman 5) Dress-Lion 6) Coffee - Door 7) Bed-Spoon 8) Tree- Ring 9) Doctor- trousers 10) Aeroplane- Ear 11) Garden- Cup 12) Apple-Child 13) Juice- Flower 14) Girl- Refrigerator 15) Drum- Tissue 16) Toy- Sun 17) Plastic- Flacon 18) Newspaper- Alarm 19) Sky-Pound 20) Television- Hammer 21) Button-Fish 22) Cloud-Camera 23) Rug- Telephone 24) Corkscrew- Bicycle	0

<table>
<tr><td colspan="2">9: Recall (Score 1 point for each correctly recalled idea, ½ point for partially recalled idea, 0 point for incorrect answer. If patient required prompting to remember the story 1 point should be deducted)</td><td>Domain Total Score</td><td>/22</td></tr>
<tr><td>Subtest</td><td colspan="2">Administration Guide</td><td>Score Max</td></tr>
<tr><td>I. story task II (delayed recall)</td><td colspan="2">The examiner says to the patient: Remember I read you a story earlier, can you recall it, and I am going to record you recalling the story if you do not mind (recording is recommended to help the examiner with scoring). If the patient did not remember the examiner says: the story I read you about the old man.

In today's newspaper / I read a story about /a 70 years old / man/ who just earned a Bachelor degree / in Business Administration / from a major University/ located in one of the European countries. / This man works as a businessman / and has a number of companies / that specialise in export of food / to Arabic countries /. A reporter asked / Why did you complete your studies / given that you are already a rich business man/ with success / and power? / He replied/ I worked hard and got the degree/ to fulfil a promise/ that I made to my mother / 50 years ago.</td><td>/22</td></tr>
</table>

<table>
<tr><td colspan="2">10: Prospective memory (Score 3 points if one coin is handed without prompt, 2 points if more than one coin are handed at the same time or handed the whole box of coins, 1 point if one coin is handed with prompt, & 0 point if failed to hand in any coin).</td><td>Domain Total Score</td><td>/3</td></tr>
<tr><td>Subtest</td><td colspan="2">Administration Guide</td><td>Score Max</td></tr>
<tr><td>I. The Coins Task II</td><td colspan="2">The examiner says to the patient: We are half way through the test. When you say this phrase the patient would need to hand you the second coin. If the patient did not remember after 2 seconds, say: is there something that you needed to do.</td><td>/3</td></tr>
</table>

<table>
<tr><td>11: Recognition memory (Faces recognition: score 1 point for each correctly identified familiar face and unfamiliar face, -1 point for each face which has been wrongly recognised as familiar i.e saying that King Hamad’s face had been presented before, 0 point if the patient says yes to everything).

(Words recognition: score 1 point for each correctly identified familiar and less familiar word (correct recognition and correct rejections), -1 point for each word which has been wrongly recognised as familiar or less familiar (incorrect acceptance and rejection) i.e saying that the word Crocodile was presented before).

(Associative recognition: score 1 point for each correctly identified pair of words, -1 point for each pair which has been wrongly recognised together i.e saying that Lion-Tree were together, 0 point if the patient says yes to everything).</td><td>Domain Total Score</td><td>/64</td></tr>
</table>

Subtest	Administration Guide	Score	Max
I. Faces Recognition Task	The examiner says to the patient: I am going to show you 20 faces, one by one, and I want you to identify the faces you have seen earlier in the test. I will ask you whether you have seen this picture earlier. You will see each face for 5 seconds, look carefully. The examiner starts to show the patient the faces one at a time. 1. Gorbachev √ 2. Obama √ 3. Unfamiliar face √ 4. Bill Clinton 5. Unfamiliar face√ 6. prince william √ 7. George bush 8. New unfamiliar 9. Unfamiliar face √ 10. David Cameron 11. New Unfamiliar 12. Tony Blair √ 13. Unfamiliar √ 14. New unfamiliar 15. New unfamiliar 16. Unfamiliar face √ 17. Yasser Arafat √ 18. Vladimir Putin 19. Prince Charles 20.New unfamiliar face		/20

II. Words Recognition Task II	The examiner says to the patient: I am going to read you a mixture of familiar and less familiar words, one by one. Some are the same as those I read you before and some are not. Some of the words I read were in a singular format and some were plural. I want you to tell me whether you have heard each word previously in the test. 1. Wolves √ 2. Snake (New familiar) 3. Camlets (less familiar) √ 4. Limerance (New less familiar) 5. Frogs (New familiar) 6. Scorpions (New familiar) 7. Sapient (new less familiar) √ 8. Mullions (new less familiar) 9. Sallow (new less familiar) 10. Robins √ 11. Chicken 12. Quire (new less familiar) 13. Cats (New familiar) 14. Ratoons (less familiar) 15. Zebra (New familiar) 16. Gimlets (less familiar) √ 17. Nihilarians (new less familiar) 18. Mice 19. Aughts (new less familiar) 20. Crocodile (new familiar) *Note: highlighted words presented earlier in the words recognition Task I.	/20

III. Associative Recognition Task	1) The examiner says to the patient: I am going to read you again pairs of words, and for each pair I want you to tell me whether you heard them together. 1) Camel-Table √ 2) Church -Necklace 3) Banana - Train 4) Tooth-Policeman √ 5) Dress- Ring 6) Coffee-Door √ 7) Bed-Spoon √ 8) Tree-Lion 9) Doctor-Cup 10) Aeroplane- Ear √ 11) Garden-Trousers 12) Apple-Child √ 13) Juice- Flower √ 14) Girl-Sun 15) Drum-Tissue √ 16) Toy-Refrigerator 17) Plastic-Falcon √ 18) Newspaper- Pound 19) Sky-Alarm 20) Television- Hammer √ 21) Button- Bicycle 22) Cloud- Camera √ 23) Rug- Telephone √ 24) Cockcrow- Fish		/24

12: Prospective memory (Score 3 points if one coin is handed without prompt, 2 points if one coin is handed with prompt, 1 point if 2 or 3 coins are handed at the same time & 0 point if failed to hand in any coin).	Domain Total Score	/3
Subtest	**Administration Guide**	**Score Max**
I. The Coins Task III	The examiner says to the patient: we have finished the test. When you say this phrase the patient would need to hand you the third coin. If patient did not remember after 2 seconds, say: is there something that you needed to do.	/3

List of References

Abdel Rahman, T. T., & El Gaafary, M. M. (2009). Montreal cognitive assessment Arabic version: reliability and validity prevalence of mild cognitive impairment among elderly attending geriatric clubs in Cairo. *Japan Geriatrics Society, 9*, 54–61.

Abu Rabia, S., & Taha, H. (2004). Reading and spelling error analysis of native Arabic dyslexic readers. *Reading and Writing: An Interdisciplinary Journal*, 17, 651-689.

Adrados, H. P., Labra, J. G., Bernados, M. L. S., & Moreno. M. A. G. (2001). Evaluation battery for semantic memory deterioration in Alzheimer. *Psychology in Spain,* 5(1), 98-109

Alexopoulos, P. Mioshi, E. Greim, B. & Kurz, A. (2007). Brief assessment of cognitive mental status in German: The Addenbrooke's Cognitive Examination (ACE) and the Addenbrooke's Cognitive Examination Revised (ACE-R). *European Journal of Geriatrics*, 9(4), 175 – 180.

Al-Ghatani, A. M., Obonsawin, M. C., Binshaig, B. A., & Al-Moutaery, K. R. (2011). Saudi normative data for the Wisconsin card sorting test, Stroop test, test of non-verbal intelligence-3, picture completion and vocabulary (subtest of the Wechsler adult intelligence scale-revised). *Neurosciences, 16 (1)*, 29-41.

Al-Jadid, M. (2014). Disability trends in Saudi Arabia. *American Journal of Physical Medicine & Rehabilitation,* 93, S47-S49.

Almubark, B., Cattani, A., Floccia, C., submitted. Translation, cultural adaptation and validation of the Cognistat for its use in Arabic-speaking population with acquired brain injury.

Al-Muhtaseb H., & Mellish C. (1998). *Some differences between Arabic and English: a step towards an Arabic upper model.* The 6th International Conference on Multilingual Computing, Cambridge, UK. Cambridge University.

Al-Rajeh S, Ogunniyi A, Awada A, Daif A, Zaidan R. (1999). Preliminary assessment of an Arabic version of the Mini-Mental state examination. *Ann Saudi Med.* 19(2),150-2.

American academy of clinical neuropsychology (2007). American Academy of Clinical Neuropsychology (AACN) practice guidelines for neuropsychological assessment and consultation. *The Clinical Neuropsychologist*, 21, 209–231.

Anderson, J. R., & Bower, G. H. (2014). *Human associative memory.* New York: Psychology Press.

Andresen S, Sundet K. (1990). Basic neuropsychological assessment of stroke patients: factor structure and syndrome clusters. *J Clin Exp Neuropsychol*, 12: 415.

Antonuccia, S. M., & MacWilliama, C. (2015). Verbal description of concrete objects: a method for assessing semantic circumlocution in persons with aphasia. *American journal of speech-language pathology*, 24, 828–837.

Arciniegas, D. B., Kellermeyer, G. F., Bonifer, N., Bonifer , N. M., Anderson-Salvi, K. M., & Anderson, A. C. (2011). Screening for cognitive decline following single known stroke using the Mini-Mental State. *Neuropsychiatric Disease and Treatment, 7*, 189–196.

Ardila, A. (1995). Directions of research in cross-cultural neuropsychology. *Journal of Clinical and Experimental Neuropsychology, 17,* 143—150.

Ardila, A., & Moreno, S. (2001). Neuropsychological evaluation in Aruaco Indians: An exploratory study. *Journal of the international neuropsychological society*, 7, 510–515.

Ariza, M., Pueyo, R., Junqué, C., Mataró, M., Poca, M. A., Mena, M. P., Sahuquillo, J. (2006). Differences in visual vs. verbal memory impairments as a result of focal temporal lobe damage in patients with traumatic brain injury. *Brain injury,* 20(10), 1053-9.

Arizpe J., Kravitz D., J., Walsh V., Yovel G., Baker C., I. (2016). Differences in looking at own- and other-race faces are subtle and analysis-dependent: an account of discrepant reports. PLoS ONE, 11(2), 1-25.

Atkinson, R. C., & Kinchla, R. A. (1965). A learning model for forced-choice detection experiments. *Technical report, 70*, 1-37.

Atkinson, R. C., & Shiffrin, R. M. (1968). *Human memory: A proposed system and its control processes.* In K. W. Spence, & J. T. Spence, The psychology of learning and motivation: advances in research and theory, 2, 742-775. New York: Academic Press.

Atkinson, R. C., & Shiffrin, R. M. (1971). The control of short-term memory. *Scientific American*, 225, 82-90.

Awadh, F. H. R., Phénix, T., Antzaka, A., Lallier. M., Carreiras. M., & Valdois, S., (2016). Cross-language modulation of visual attention span: an Arabic-French-Spanish comparison in skilled adult readers*. Front Psychol,* 7, 307.

Ayres, J. G., Harrison, R. M., Nichols, Gordon L., Maynard, R. L. (2010). *Environmental Medicine*. U.S: Taylor & Francis Group.

Baddeley, A. D. (1968). How does acoustic similarity influence short-term memory? *Q. J. Exp. Psychol*, 20,249–64.

Baddeley, A. D., Emslie, H., & Nimmo-Smith, I. (1994). *The doors and people test: a test of visual and verbal recall and recognition*. Bury-St-Edmunds, UK: Thames Valley Test Company.

Baddeley, A. D., Hitch, G. J. (1974). Working memory. In *the psychology of learning and motivation: advances in research and theory*, ed., (pp.47–89). New York: Academic.

Bahrainian A., Bashkar N., Sohrabi A., Azad M. R, Majd S. A. (2013). Gender and age differences in time-based prospective memory (2013). J. *Appl. environ. biol. Sci,* 3(11), 111-116.

Balestreri, M., Czosnyka, M., Chatfield, D., Stein, L., Schmidt, E., Smielewski, P., et al. (2004). Predictive value of Glasgow coma scale after brain trauma:change in trend over the past ten years. *J Neurol neurosurg psychiatry, 75*, 161–162.

Bauer, R. M. (1984). Autonomic recognition of names and faces in prosopagnosia-a neuropsychological application of the guilty knowledge test. Neuropsychologia, 22(4), 457- 469.

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Lippincott Williams & Wilkins, 25*(24), 3186–3191.

Beaton, D., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2007). *Recommendations for the cross-cultural adaptation of the DASH & quickDASH outcome measures.* Ontario: CA: Institute for Work & Health 2002, 2007.

Benedict R. H. B. (1997). *Brief visuospatial test – revised: professional manual*. Lutz, PAR: Psychological Assessment Resources, Inc.

Benton A. L., Van Allen M. W. (1968). Impairment in facial recognition in patients with cerebral disease. *Cortex*, 4, 344–358.

Benton, A. L., & Vanallen, M. W. (1972). Prosopagnosia and facial discrimination. Journal of the neurological sciences, 15(2), 167.

Bernspng, & Fisher. (1995). Differences between persons with right or left cerebral vascular accident on the assessment of motor and process skills. *Archives of Physical Medicine and Rehabilitation, 76*(12), 1144-1151.

Berry, J. W. (1971). Ecological and cultural factors in spatial perceptual development. *Canadian Journal of Behavioral Sciences* 3: 324-336.

Berry, J. W. (1979). Culture and cognition style. In A. Mrsella, R. G. Tharp & T. J. Ciborowski (Eds.), *Perspectives in Cross-Cultural Psychology (*pp. 117-135). New York: Academic Press.

Berry, J. W., Poortinga, Y. P., & Segall, M. G. H. (1992). *Cross cultural psychology. Cambridge*: Cambridge University Press.

Blais, C., Jack, R. E., Scheepers, C., Fiset D., & Caldara R., (2008). Culture shapes how we look at faces. *PLoS ONE,* 3(8), 1-8.

Blake, H., McKinney, M., Treece, K., Lee, E., & Lincoln, N. B., (2002). An evaluation of screening measures for cognitive impairment after stroke. *Age Ageing,* 31(6), 451-6.

Blanchard-Fields, F., Chen, Y., Horhota, M., & Wang, M. (2007). Cultural differences in the relationship between aging and the correspondence bias. *Journal of Gerontology: Psychological Science*, 62B(6), 362–365.

Bleiberg, J. (2001). *The road to rehabilitation: part 3 guideposts to recognition: cognition, memory & brain injury.* America: brain injury association of America.

Bonner L, Burton A M, (2004). 7-11-year-old children show an advantage for matching and recognising the internal features of familiar faces: evidence against a developmental shift'' quarterly. *Journal of Experimental Psychology,* 57, 1019 -1029.

Bornstein, B., & Kidron, D. P. (1959). Prosopagnosia. Journal of Neurology, Neurosurgery, and Psychiatry, 22(2), 124-131.

Bornstein, M.H. et al. (1990) Mother and infant activity and interaction in Japan and in the United States II: a comparative microanalysis of naturalistic exchanges focused on the organization of infant attention. *Int. J. Behav. Dev,* 13, 289–308.

Boroditsky, L. (2011). How language shapes thought. *Sci Am,* 304(2), 62-65.

Bothwell, R. K., Brigham, J. C., & Malpass, R. S. (1989). Cross-racial identification. *Personality and Social Psychology Bbulletin,* 15(1), 19-25.

Bour, A., Rasquin , S., Boreas, A., Limburg, M., & Verhey, F. (2010). How predictive is the MMSE for cognitive performance after stroke? *Journal of Neurology, 257*, 630–637.

Bracewell, C., Gray, R., & Rai, G. S., (2010). *Essential facts in geriatric medicine.* Second edition. Oxford: Radcliffe Publishing.

Brain injury association of Queensland (2013). *Acquired brain injury: the fact. The practical guide to understanding and responding to acquired brain injury and challenging behaviours.* Queensland: Synapse.

Brant J., Benedict R. H. B. (2001). *Hopkins verbal learning test – revised: professional manual.* Lutz, PAR: Psychological Assessment Resources, Inc.

Brickman, A. M., & Stern, Y., (2009). Aging and memory in humans. *Encyclopedia of Neuroscience,* 1, 175-180.

Briley, D. A., Morris, M. W., & Simonson, I. (2005). Cultural chameleons: bicultural, conformity motives, and decision making. Journal of Consumer Psychology, 15(4), 351-362.

Broglio, S. P., Ferrara, M. S., Macciocchi, S. N., Baumgartner, T. A., & Elliott, R. (2007). Test-retest reliability of computerized concussion assessment programs. *Journal of Athletic Training*, 42(4), 509–514.

Brooks, B. M., Rose, F. D., Potter J., Jayawardena S. & Morling, A. (2004). Assessing stroke patients' prospective memory using virtual reality. *Brian injury, 18 (4),* 391-401.

Brooks, K. R., & Kemp, R. I. (2007). Sensitivity to Feature Displacement in Familiar and Unfamiliar Faces: Beyond the Internal/External Feature Distinction. *Perception, 36*(11), 1646-1659.

Bruce, V. (2012). Familiar face recognition. Cambridge. In C. Wilkinson & C. Rynn (Eds.), *Craniofacial Identification* (Chapter 1). Cambridge: Cambridge University Press.

Bruce, V., & Young, A. (1986). Understanding faces recognition. *The British Psychologial society, 77*, 305-327.

Bruce, V., Henderson, Z., Greenwood, K., Hancock, P. J. B., Burton, A. M., & Miller, P. (1999). Verification of face identities from images captured on video. Journal of Experimental Psychology: Applied, 5, 339–360.

Bruce, V., Young, A. W., (2012). *Face perception.* New York: psychology press.

Bruyer, R., Laterre, C., Seron, X., Feyereisen, P., Strypstein, E., Pierrard, E., & Rectem, D. (1983). A Case of prosopagnosia with some preserved covert remembrance of familiar faces. Brain and cognition, 2(3), 257-284.

Budson, A. E., & Price, B. H. (2005). Memory dysfunction in clinical practice. *Discov Med, 5(26),* 135-141.

Burgess P. W., Quayle A., Frith C. (2001). Brain regions involved in prospective memory as determined by positron emission tomography. *Neuropsychologia,* 39(6), 545–555.

Burgess P. W., Scott S., Frith C. (2003). The role of the rostral frontal cortex (area 10) in prospective memory: a lateral versus medial dissociation. *Neuropsychologia,* 41(8), 906–918.

Burgess, I. S., Dean, M., Lincoln, N. B., Pearce, M. J. (1996). *Salford objective recognition test.* Nottingham: Nottingham rehab.

Butler, J., (2008). Neuropsychology for occupational therapists: cognition in occupational performance. *The British journal of occupational therapy, 71*(11), 504-504.

Cabeza, R., Grady, C. L., Nyberg, L., McIntosh, A. R., Tulving, E., Kapur, S., et al. (1997). Age-related differences in neural activity during memory encoding and retrieval: a positron emission tomography study. *Journal of Neuroscience, 17,* 391–400.

Callahan C. D., Johnstone B. (1994). The clinical utility of the Rey auditory-verbal learning test in medical rehabilitation. *J clin psychol med settings*, 1(3), 261-8.

Campbell, R., Coleman, M., Walker, J., Benson, P., J., Wallace, S., Michelotti, J., Baron-Cohen, S., (1999). When does the inner-face advantage in familiar face recognition arise and why? *Visual cognition,* 6, 197 - 216.

Capruso, D. X., & Levin, H. S. (1992). Cognitive impairment following closed head injury. *Neurologic Clinics,* 10(4), 879–93.

Carlozzi, N., Grech, J., & Tulsky, D. (2013). Memory functioning in individuals with traumatic brain injury: an examination of the Wechsler Memory Scale–Fourth Edition (WMS–IV). *Journal of Clinical and Experimental Neuropsychology*, 35(9), 906-914.

Carlsson, G. E., Moller, A., & Blomstrand, C., (2004). A qualitative study of the consequences of 'hidden dysfunctions' one year after a mild stroke in persons <75 years. *Disabil Rehabil.* 26(23),1373-80.

Chan, C. C. H., Lee, T. M., Wong, V. et al., (1999). Validation of the Chinese version Neurobehavioral Cognitive Status Examination (NCSE). *Archives of Clinical Neuropsychology,* 14,71.

Chan, C. C., Chan, C. C. H., Yi Wu., Liu, K. P. Y., Xu, Y., (2016). Differentiating cognitive functions of post stroke patients with specific brain lesions: a preliminary study on the clinical utility of Cognistat-P. *Applied Neuropsychology: Adult*, 23(4), 274-283.

Chan, C. C., Lee, T. M., Fong, K. N., & Wong, V. (2002). Cognitive profile for Chinese patient with stroke. *Brain Injury, 16*(10), 873-84.

Chang, J. (2012). *Adult prospective memory and executive function performance: a cross-cultural comparison of Chinese and Canadian college students* (Master thesis). Retrieved from https://dspace.library.uvic.ca/bitstream/handle/1828/4352/Chang_Julie_MSc_2012.pdf?sequence=1&isAllowed=y.

Chao, L. L., Haxby, J. V., & Martin, A. (1999). Attributed-based neural substrates in temporal cortex for perceiving and knowing about objects. *Nature Neuroscience*, 2, 913–919.

Chatburn, R., L. (2011). *Handbook for Health Care Research (Second Edition).* USA, Boston: Jones and Bartlett Publishing.

Chellappan, K., Mohsin, N. K., Islam M S, & Bin Md Ali. (2012). Post-stroke brain memory assessment framework. *Biomedical engineering and sciences (IECBES)* (pp. 189 - 194). Langkawi: IEEE.

Chen, A., Bushmeneva, K., Zagorsk, B., Colantonio, A., Parsons, D., & Wodchis, W. (2012). Direct cost associated with acquired brain injury in Ontario. *BMC Neurology, 12*(76), 1-12.

Chen, K. H, Chuah, L. Y., Sim, S. K., Chee, M. W. (2010). Hippocampal region-specific contributions to memory performance in normal elderly. *Brain Ccogn,* 72(3), 400-407.

Chen, Y., McAnally, M. M., & Reese, E. (2013). Development in the organisation of episodic memory in middle childhood and adolescence. *Front. Behav. Neurosci*, 7(84), 1-9.

Chiao, J., Li, S., Seligman R., & Turner, R., (2016). *The Oxford handbook of cultural neuroscience.* Oxford Library of Psychology.

Chua, H. F., Boland , J. E., & Nisbett, R. E. (2005). Cultural variation in eye movements during scene perception. *Proceedings of the National Academy of Sciences of the United States of America, 102*(35), 12629-12633.

Cinan, S., & Dogan, A. (2013). Working memory, mental prospection, time orientation, and cognitive insight. *Journal of Individual Differences*, 34(3), 159–169.

Clutterbuck ,R., Johnston, R., A., (2005). Demonstrating how unfamiliar faces become familiar using a face matching task. *European Journal of Cognitive Psychology,* 17, 97-116.

Clutterbuck, R., Johnston, R., A., (2002). Exploring levels of face familiarity by using an indirect face-matching measure. *Perception,* 312, 985 – 994.

Clutterbuck, R., Johnston, R., A., (2004). Matching as an index of face familiarity. *Visual Cognition*, 11, 857 – 869.

Cohen Kadosh, K. (2011). Differing processing abilities for specific face properties in mid-childhood and adulthood. *Front. Psychol.* 2, 400.

Cohen, G. (1996). *Memory in the real world*. Hove, UK: Psychology Press Ltd.

Cole, M., & Means, B. (1986). *Comparative studies of how people think*. San Diego, CA: University of California Press.

Cole, W. R., Arrieux, J. P., Schwab, K., Ivins, B. J., QashuSteven F. M., Lewis S. C. (2013). Test–Retest Reliability of Four Computerized Neurocognitive Assessment Tools in an Active Duty Military Population. *Archives of Clinical Neuropsychology,* 28(7), 732–742.

Connellana, J., Baron-Cohen, S., Wheelwrighta , S., Batkia, A., & Ahluwaliab, J. (2000). Sex differences in human neonatal social perception. *Infant Behavior and Development, 23*(1), 113–118.

Conway, A., Kane, M. J., Bunting M. F., Hambrick D. Z., Wilhelm, O., Engle R. W., (2005). Working memory span tasks: a methodological review and user's guide. *Psychonomic Bulletin and Review,* 12 (5), 769-786.

Conway, M. A., Wang , Q., Hanyu, K., & Haque, S. (2014). A cross-cultural investigation of autobiographical memory. *Journal of Cross-Cultural Psychology, 36*(6), 739-749.

Craik, F. I. M., Grady, C. L. (2002). Ageing, memory, and frontal lobe functioning. In D. T., Stuss & R. Knight (Eds.), *Principles of frontal lobe function* (pp.528–540). New York: Oxford University press.

Cumming, T. B., Marshall, R. S., & Lazar, R. M. (2013). Stroke, cognitive deficits, and rehabilitation: still an incomplete picture. *International Journal of Stroke, 8*, 38–45.

Cumming, T. B., Tyedin, K., Churilov, L., Morris, M. E., & Bernhardt, J. (2012). The effect of physical activity on cognitive function after stroke: a systematic review. *International Psychogeriatrics, 24*(4), 557–567.

Curtis, M. E., & Bharucha, J. J. (2009). Memory and musical expectation for tones in cultural context. *Music Perception*, 26(4), 365-375.

Deary, I. J., Penke, L., & Johnson, W. (2010). The neuroscience of human intelligence differences. *Neuroscience, 11, 201–211.*

D'Esposito, M., Aguirre, G. K., Zarahn, D., Ballard, D., Shin, R. K., & Lease, J. (1998). Functional MRI studies of spatial and nonspatial working memory. *Cognitive Brain Research,* 7, 1-13.

Dehaene, S., Bossini, S., & Giraux, P. (1993). The mental representation of parity and number magnitude. *Journal of Experimental Psychology: General,* 122, 371–396.

Deipolyi, A. R., Rankin, K. P., Mucke, L., et al. (2007). Spatial cognition and the human navigation network in AD and MCI. *Neurology*, 69(10), 986-997.

Delbecq-Derouesné, J., Beauvois, M. F., & Shallice, T. (1990). Preserved recall versus impaired recognition. A case study. *Brain: A Journal of Neurology, 113,* 1045–1074.

Delis, D., Kaplan, E., Kramer, J., & Ober, B. (2000). *California verbal learning test–II.* San Antonio, TX: The Psychological Corporation.

Denkova, E. J, Manning L. (2014). FMRI contributions to addressing autobiographical memory impairment in temporal lobe pathology. *World J Radiol*, 6(4), 93-105.

Dennis, C. Mittere, J., Talbot, S., & Vanchella, C. M. (2010). *Introduction to psychology: gateways to mind and behavior* (12th ed.). Canada: Wadsworth Cengage Learning.

Dikmen, S., Corrigan, J., Levin, H., Machamer, J., Stiers, W., & Weisskopf, M. (2009). Cognitive outcome following traumatic brain injury. *J Head Trauma Rehabil, 24*(6), 430–438.

Donders J., Tulsky D. S., Zhu J. (2001). Criterion validity of new WAIS-II subtest scores after traumatic brain injury. *J Int Neuropsychol Soc*. 7(7), 892-8.

Dong, Y., Sharma, V. K., Chan, B. P. L., Venketasubramanian, N., Teoh, H. L., Seet, R. C., Tanicala S, Chan YH, Chen C. (2010). The Montreal Cognitive Assessment (MoCA) is superior to the Mini-Mental State Examination (MMSE) for the detection of vascular cognitive impairment after acute stroke. *Journal of the Neurological Sciences, 299, 15–18.*

Drane D. L., Yuspeh R. L., Huthwaite J. S., Klingler L. K., Foster L. M., Mrazik M., Axelrod B. N. (2003). Healthy older adult performance on a modified version of the Cognistat (NCSE): demographic issues and preliminary normative data. *J Clin Exp Neuropsychol*. 25(1), 133-44.

Drane, D. L., & Osato, S. S. (1997). Using the Neurobehavioral Cognitive Status Examlnation as a screening measure for older adults. *Archives of Clinical Neuropsychology, 12*(2), 139-143.

Duff, K., Westervelt, H. J., McCaffrey, R. J., Haase. R. F. (2001). Practice effects, test-retest stability, and dual baseline assessments with the California Verbal Learning Test in an HIV sample. Archives of Clinical Neuropsychology, 16, 461–476.

Duffy, S., Toriyama, R., Itakura, S., & Kitayama, S. (2009). Development of cultural strategies of attention in North American and Japanese children. *Journal of Experimental Child Psychology*, 102, 351-359.

Echemendia R. J., Bruce J. M., Bailey C. M., Sanders J. F., Arnett P., Vargas G. (2012). The utility of post-concussion neuropsychological data in identifying cognitive change following sports-related MTBI in the absence of baseline data. *The Clinical Neuropsychologist*, 26 (7), 1077-1091.

Edwards D. F., Hahn M. G., Baum C. M., Perlmutter M. S., Sheedy C. & Dromerick A. W., (2006). Screening patients with stroke for rehabilitation needs: validation of the post stroke rehabilitation guidelines. *Neurorehabil Neural Repair,* 20(1), 42–48.

Efklides A., Yiultsi E., Kangellidou T., Kounti F., Dina F., & Tsolaki M. (2002). Wechsler Memory Scale, Rivermead Behavioral Memory Test, and Everyday Memory Questionnaire in healthy adults and Alzheimer patients. *European Journal of Psychological Assessment*, 18 (1), 63–77.

Ellis, H. D., Shepherd, J. W. and Davies, G. M. (1979). Identification of familiar and unfamiliar faces from internal and external features – some implications for theories of face recognition. Perception, 8, 431–439.

Emilien, G., Durlach, C., Antoniadis, E., van der Linden, M., & Maloteaux, J. M. (2004). *Memory: Neuropsychological, imaging, and psychopharmacological perspectives*. New York: Psychology Press.

Eviatar, Z. (2000). Culture and brain organization. *Brain and Cognition*, 42, 50–52.

Farid M., Grainger J. (1996). How initial fixation position influences visual word recognition: a comparison of French and Arabic. *Brain lang,* 53, 351–368.

Fausey, C. M., Long, B. L., Inamori, A. & Boroditsky, L. (2010). Constructing Agency: the Role of Language. *Frontiers in Cultural Psychology*, 1(162), 1-11.

Ferbinteanu, J. & Shapiro, M. L. (2003). Prospective and retrospective memory encoding in the hippocampus. *Neuron,* 40, 1227 – 1239.

Fernald A., & Morikawa H., (1993). Common themes and cultural variations in Japanese and American mothers' speech to infants. *Child Development,* 64, (3), 637-656.

Finn, A. S., Kalra, p. B., Goetz, C., Leonard, J. A., Sheridan, M. A., Gabrieli, J. D. E. (2016). Developmental dissociation between the maturation of procedural memory and declarative memory. *Journal of Experimental Child Psychology,* 142, 212–220.

Fiske, A. P., Kitayama, S., Markus, H. R., & Nisbett, R. E. (1998). The cultural matrix of social psychology. In D. T. Gilbert, S. T. Fiske & G. Lindzey (Eds.). *The Handbook of Social Psychology* (4th ed., pp. 915-981). New York and Oxford: Oxford University Press.

Fish, J., Wilson, B. A., & Manly, T. (2010). The assessment and rehabilitation of prospective memory problems in people with neurological disorders: a review. *Neuropsychological Rehabilitation, 20*(2), 161–179.

Fivush, R., & Nelson, R. (2004). Culture and language in the emergence of autobiographical memory. *Psychological Science*, 15(9), 573-577.

Foley J. A. (2007). *Retrospective and prospective memory in healthy and cognitively impaired older adults: Using subjective and objective assessment* (Doctoral thesis). Retrieved from https://www.researchgate.net/profile/Jennifer_A_Foley/publication/266864757_Retrospective_and_prospective_memory_in_healthy_and_cognitively_impaired_older_adults_Using_subjective_and_objective_assessment/links/568aade308aebccc4e1a13ba/Retrospective-and-prospective-memory-in-healthy-and-cognitively-impaired-older-adults-Using-subjective-and-objective-assessment.pdf.

Folstein, M., Folstein, S., & Mchugh, P. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12(3),* 189–198.

Fountoulakis K. N., T. M. (1998). Epidemiological dementia index: a screening instrument for Alzheimer’s disease and other types of dementia suitable for use in populations with low education level. *Dementia and Geriatric Cognitive Disorder, 9*, 329-38.

Friedman, T. w., Yelland , G. W., & Robinson , S. R. (2012). Subtle cognitive impairment in elders with mini-mental state examination scores within the 'normal' range. *International Journal of Geriatric Psychiatry, 27*, 463–471.

Fuhrman, O., & Boroditsky, L., (2010). Cross-cultural differences in mental representations of time: evidence from an implicit nonlinguistic task. *Cognitive Science,* 34,1430–1451.

Gambrel, P. A., & Cianci, R. (2003). Maslow's hierarchy of needs: does it apply in a collectivist culture. *Journal of Applied Management and Entrepreneurship, 8*(2), 143-161.

Godefroy, O., Roussel, M., Leclerc, X. & Leys, D. (2009). Deficit of episodic memory: anatomy and related patterns in stroke patients. *European Neurology*, 61(4), 223-229.

Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 11, 501-518.

Grieve, J., & Gnanasekaran, L. (2008). *Neuropsychology for occupational therapists: cognition in occupational performance* (Third ed.). Oxford, UK: Blackwell Publishing.

Grober, E., & Buschke, H. (1987). Genuine memory deficits in dementia. *Developmental Neuropsychology,* 3,1, 13-36.

Groot, Y. C. T., Wilson, B. A., Evans, J., & Watson, P. (2002). Prospective memory functioning in people with and without brain injury. *Journal of the International Neuropsychological Society*, 8, 645–654.

Guillemin, F., Bombardier, C., & Beaton, D. (1993). Cross-cultural Adaptation of Health-related Quality of Life Measures: literature review and proposed guidelines. *Journal of Clinical Epidemiology, 46*(12), 1417-1432.

Gupta, A., & Kumar, N. K. (2009). Indian adaptation of the Cognistat: psychometric properties of a cognitive screening tool for patients of traumatic brain injury. *Indian Journal of Neurotruma, 6*(2), 123-132.

Gururaj, G. (2002). Epidemiology of TBI injuries: Indian scenario. *Neurological Research, 24*, 24-28.

Gutchess, A. H., Yoon, C., Luo, T., et al. (2006). Categorical organization in free recall across culture and age. Gerontology, 52, 314–23.

Gutchess, A. H., Hedden, T., Ketay, S., Aron, A., & Gabrieli, John, D. E., (2010). Neural differences in the processing of semantic relationships across cultures. *Soc Cogn Affect Neurosci,* 5(2-3), 254–263.

Gutchess, A., Schwartz, A., & Boduroğlu, A., (2011). The influence of culture on memory foundations of augmented cognition. Directing the future of adaptive systems. In D. Schmorrow & C. Fidopiastis (Eds.), (Vol. 6780, pp. 67-76). Berlin / Heidelberg: Springer.

Hachinski, V., Iadecola, C., Petersen, R. C., Breteler, M. M., Nyenhuis, D. L., Black, S. E., et al. (2006). National institute of neurological disorders and stroke-Canadian stroke network vascular cognitive impairment harmonization standards. *American Heart Association, 37*, 2220-2241.

Hasan A., A., Al-Sammerai, N., S., M., & Abdul Kadir F., A. (2011). How colours are semantically construed in the Arabic and English culture: a comparative study. *English Language Teaching,* 4, 3, 206 - 213.

Hawkins, K. A., & Bender, S. (2002). Norms and the relationship of Boston naming test performance to vocabulary and education: a review. *Aphasiology*, 16(12), 1143-1153.

Hedden, T., Park, D. C., Nisbett, R., Jing, Q., Jiao, S., Ji, L., (2002). Cultural variation in verbal versus spatial neuropsychological function across the life span. *Neuropsychology,* 16 (1), 65–73.

Hedge, A. (2013). *Human information processing - II: human memory.* Retrieved January 01, 2015, from http://ergo.human.cornell.edu/studentdownloads/DEA3250pdfs/memory.pdf

Hernandez, Cardenache, R., Burguera, L., Acevedo, A., Curiel, R., & Loewenstein, D. (2014). Evaluating different aspects of prospective memory in amnestic and nonamnestic mild cognitive impairment. *ISRN Neurology*, 2014, 1-7.

Hinkle, J. L. (2012). A descriptive study of cognitive status three years following motor stroke. *The Journal of Neurological and Neurosurgical Nursing, 1*(3), 97-102.

Hochstenbach , J., Anderson , P., van Limbeek , J., & Mulder, T. (2001). Is there a relation between neuropsychologic variables and quality of life after stroke? *Arch Phys Med Rehabil, 82*(10), 1360–1366.

Holmqvist, K. L., (2012). *Occupational therapy practice for clients with cognitive impairments following acquired brain injury-occupational therapists' prospective.* Orebro University, Repro.

Hommel, M., Miguel, S., Naegele , B., Gonnet, N., & Jaillard, A. (2009). Cognitive determinants of social functioning after a first ever mild to moderate stroke at vocational age. *Neurol Neurosurg Psych, 80*(8), 876–880.

Hung, Daisy L. and Ovid J. L. Tzeng (1981), Ortbographic Variations and Visual Infonnation Processing. *Psychological Bulletin,* 90(3). 377-414.

Hussein, B.-S. (2012). The Sapir-Whorf hypothesis today. *Theory and Practice in Language Studies, 2*(3), 642-646.

Ibrahim, R., Eviatar, Z., and Aharon-Peretz, J. (2002). The characteristics of the Arabic orthography slow its cognitive processing. *Neuropsychologia* 16, 322–326.

Ibrahim, R., Eviatar, Z., and Aharon-Peretz, J. (2007). Metalinguistic awareness and reading performance: a cross language comparison. *J. Psycholinguist. Res*. 36, 297–317.

Imbo, I., & LeFevre, J. (2008). Complex-arithmetic problem solving: differences among Belgian, Canadian, and Chinese participants. *The 30th annual meeting of the Cognitive Science* (pp. 2144–2149). Austin, TX: Cognitive Science Society.

Iracleous , P., Nie , J. X., Tracy , S. C., Moineddin, R., Ismail , Z., Shulman , K. I., et al. (2010). Primary care physicians' attitudes towards cognitive screening: findings from a national postal survey. *International Journal of Geriatric Psychiatry, 25*, 23-29.

Irvine, S. H., & Berry, J. W. (1988). *Human abilities in cultural context*. New York: Cambridge University Press.

Ismail, Z., Fajji, T. K., & Shulman, K. I. (2010). Brief cognitive screening instruments: an update. *International Journal of Geriatric Psychiatry, 25*, 111–120.

IstiZada. (2017). *Complete List of Arabic Speaking Countries 2017*. Retrieved August 23, 2017 from http://istizada.com/complete-list-of-arabic-speaking-countries-2014/.

Jacobs J., W., Bernhard M., R., Delgado A., Strain J., J. (1977). Screening for organic mental syndromes in the medically ill. *Ann Intern Med*, 86(1), 40-6.

Janowsky, J. S., A. P. Shimamura, M. Kritchevsky, & L. R. Squire. (1989). Cognitive impairment following frontal lobe damage and its relevance to human amnesia. *Behavioral Neuroscience,* 103 (3), 548-60.

Jasskelainen I. P., (2012). *Introduction to cognitive neuroscience*. Ventus Publishing ApS.

Ji, L., Peng, K., & Nisbett, R. (2000). Culture, control, and perception of relationships in the environment. *Journal of Personality and Social Psychology, 78*, 943-955.

Ji, L.J., Peng, K. P., Nisbett, R. E. (2000). Culture, control, and perception of relationships in the environment. *J. Pers. Soc. Psychol*. 78, 943–955.

Johnston, R. A., & Edmonds, A. J. (2009). Familiar and unfamiliar face recognition: a review. *Memory, 17*(5), 577-596.

Johnstone, B., Hexum, C. L., & Ashkanazi, G. (1995). Extent of cognitive decline in traumatic brain injury based on estimates of premorbid intelligence. *Brain Injury,* 9(4), 377-84.

Jones, K. (2011). *Neurological assessment.* Edinburgh: Elsevier.

Kamalakannan, S., Gudlavalleti, A., Gudlavalleti, V., Goenka, S., & Kuper, H. (2015). Challenges in understanding the epidemiology of acquired brain injury in India. *Ann Indian Acad Neurol, 18*(1), 66–70.

Kaplan E. F., Goodglass H., Weintraub S. (2001). *The Boston naming test* (2nd ed.). Philadelphia: Lippincott Williams & Wilkins.

Kastanakis, M., N., & Voyer, B. G. (2014). The effect of culture on perception and cognition: a conceptual framework cognition: a conceptual framework. *Journal of Business Research, 67*(4), 425-433.

Katz N., Itzkovich M., Averbuch S., Elazar B. (1989). Loewenstein Occupational Therapy Cognitive Assessment (LOTCA) battery for brain-injured patients: reliability and validity. *Am J Occup Ther,* 43(3):184-92.

Katz, N., Elazar, B., & Itzkovich, M. (1996). Cognitive Status Examination (COGNISTAT) in assessing patients post CVA and healthy elderly in Israel. *The Israeli Journal of Occupational Therapy, 5*, E185-E198.

Keith, R., A., Granger, C., V., Hamilton, B., B., & Sherwin, F., S. (1987). The functional independence measure: a new tool for rehabilitation. *Advances in Clinical Rehabilitation, 1,* 6-18.

Kelly,D. J., Liu, S., Rodger, H., Miellet, S., Ge, L., & Caldara, R. (2011). Developing cultural differences in face processing. *Developmental Science,* 14(5), 1176–1184.

Kesner, R. P., (1989). Retrospective and prospective coding of information: role of the medial prefrontal cortex. *Experimental Brain Research*, 74, 163 – 167.

Kiernan, R., J., Mueller, J., Langston, J., W., Van Dyke, C. (1987). The Neurobehavioral Cognitive Status Examination: a brief but quantitative approach to cognitive assessment. *Annals of Internal Medicine, 107*(4), 481-5.

Kitayama, S., Duffy S., Kawamura T., Larsen J.T., (2003). Perceiving an object and its context in different cultures: a cultural look at new look. *Psychol Sci.* 14(3), 201-6.

Knapp, M. L., & Hall, J. A. (2009). *Nonverbal communication in human interaction*. (7th ed.). Boston: Wadsworth.

Kochunov, P., Fox, P., Lancaster, J., Tan, L. H., Amunts, K., Zilles, K., Mazziotta, J., & Gao J. H., (2003). Localized morphological brain differences between English-speaking Caucasians and Chinese-speaking Asians: new evidence of anatomical plasticity. *Neuroreport.* 14(7), 961-4.

Koekkoek, P., Rutten, G., van den Berg, E., van Sonsbeek, S., Gorter, K., Kappelle, L., et al. (2013). The "Test Your Memory" test performs better than the MMSE in a population without known cognitive dysfunction. *Journal of the Neurological Sciences, 328*, 92–97.

Koivisto, M. (1999). Semantic priming in the cerebral hemispheres. Brain asymmetries in automatic, expectancy-based, and postlexical processing. Turku: University of Turku.

Lachman, M. E., Agrigoroaei, Stefan., Murphy C., Tun P. A. (2010). Frequent cognitive activity compensates for education differences in episodic memory. *Am J Geriatr Psychiatry 18 (1),* 4-10.

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D. H. J., Hawk, S. T., & van Knippenberg, A. (2010). Presentation and validation of the Radboud Faces Database. *Cognition & Emotion*, 24, 1377–1388.

Lee, J., Lee , D. W., Cho, S., Na Jeon, H. J., Kim, S., Lee , Y. R., et al. (2008). Brief screening for mild cognitive impairment in elderly outpatient clinic: validation of the Korean version of the Montreal cognitive assessment. *Journal of Geriatric Psychiatry and Neurology, 21*, 104-110.

Levelt, W. (1999). *A Blueprint of the speaker*. In C. Brown & P. Hagoort (Eds.), *the neurocognition of language* (chapter 4). Oxford Press.

Leveroni, C. L., Seidenberg, M., Mayer, A. R., Mead, L. A., Binder, J. R., & Rao, S. M. (2000). Neural systems underlying the recognition of familiar and newly learned faces. *Journal of Neuroscience, 20*(2), 878-886.

Levin, H. S., Shum, D., Chan, R.C. K. (2014). *Understanding traumatic brain injury: current research and future directions*. The United State of America: Oxford University Press.

Lewin, C., & Herlitz, A. (2002). Sex differences in face recognition - women's faces make the difference. *Brain and Cognition, 50*(1), 121-128.

Lezak, M. D., (1995). *Neuropsychological assessment*. New York: Oxford University Press.

Lezak, M. D., Howieson, D. B. &, Loring, D. W. (2004). Neuropsychological assessment. New York: Oxford University Press.

Lincoln, N. B., Drummond, A. E. R., Edmans, J. A., Yeo, D., & Willis, D., (1998). The Rey figure copy as a screening instrument for perceptual deficits after stroke. *British Journal of Occupational Therapy*, 61(1), 33-35.

Lo, A. H. Y., Humphreys, M., Byrne G. J., & Pachana, N. A. (2012). Test–retest reliability and practice effects of theWechsler Memory Scale-III. *Journal of Neuropsychology. 6 (2),* 212-31.

Logue, P., Tupler, L., D’Amico, C., & Schmitt, F. (1993). The Neurobehavioral Cognitive Status Examination: psychometric properties in use with psychiatric inpatients. *Journal of Clinical Psychology, 49*, 80–9.

Loring, D. W. (1999). *INS Dictionary of Neuropsychology*. Oxford: Oxford

Luis, C. A., Keegan , A. P., & Mullan , M. (2009). Cross validation of the Montreal Cognitive Assessment in community dwelling older adults residing in the Southeastern US. *International Journal of Geriatric Psychiatry, 24*, 197–201.

Lum J., A., G. and Conti-Ramsden, G. (2014). Long-term memory: a review and meta-analysis of studies of declarative and procedural memory in specific language impairment. *Europe PMC Funders Group,* 1, 33(4), 282–297.

Maas, A., Stocchetti, N., & Bullock, R. (2008). Moderate and severe traumatic brain injury in adults. *Lancet Neurology, 7*, 728–41.

MacDonald, S., Uesiliana, K.,& Hayne, H.(2000). Cross-cultural and gender differences in child- hood amnesia. *Memory*, 8, 365–376.

MacPherson S. E., Turner M. S., Bozzali M., Cipolotti B. L., Shallice T., (2016). Recognition memory in subjects with hypoxic brain injury. *Neuropsychology, 30(3)*, 332–337.

Maddux, W. W., & Yuki, M. (2006). The “ripple effect”: cultural differences in perceptions of the consequences of events. *Personality and Social Psychology Bulletin*, 32(5), 669-683.

Mandler, G. (1980). Recognizing: the judgment of previous occurrence. *Psychol. Rev.* 87, 252–271.

Manns, J. R, Hopkins, R. O, Reed, J. M., Kitchener, E. G., & Squire, L. R. (2003). Recognition memory and the human hippocampus. *Neuron* 37(1), 171-80.

Marcotte, T. D., van Gorp, W., Hinkin, C. H., & Osato, S. (1997). Concurrent validity of the neurobehavioral Experimental Neuropsychology cognitive status exam subtests. *J Clin Exp Neuropsychol,* 19(3), 386-395.

Maril, A, Davis, P. E., Koo, J. J., et al. (2010). Developmental fMRI study of episodic verbal memory encoding in children. *Neurology*, 75(23), 2110-2116.

Martin A. (1998). The organization of semantic knowledge and the origin of words in the brain. In N. G. Jablonski & L. C. Aiello (Eds.), The origin and diversification of language memory of the California academy of sciences, (Vol. 24, pp.69-88). San Francisco: California Academy of Sciences.

Martin, A. (2001). Functional neuroimaging of semantic memory. In *functional neuroimaging of semantic memory.* Cabaza, R, Kingstone, A. Cambridge, Massachusetts: MIT Press, (pp.153-186).

Matsuda, O., & Nakatani, M. (2004). *The manuals for the Japanese version of the Neurobehavioral Cognitive Status Examination.* Tokyo: World Planning (in Japanese).

Masuda, T., Ellsworth, P, C., Mesquita, B., Leu, J., Tanida, S., Van de Veerdonk, E., (2008). Placing the face in context: cultural differences in the perception of facial emotion. *Journal of Personality and Social Psychology,* 94 (3), 365–381.

Masuda, T., Nisbett, R. E. (2001). Attending holistically versus analytically: comparing the context sensitivity of Japanese and Americans. *J. Pers. Soc. Psychol*. 81, 922–934.

Matis, G., & Birbilis, T., (2008). The Glasgow coma scale – a brief review past, present, future. *Acta neurol. belg.,* 108, 75-89.

Matsumoto, D., Consolacion, T., Yamada, H., Suzuki, R., Franklin, B., Paul, S., Ray, S., Uchida, H. (2002). American-Japanese cultural differences in judgements of emotional expressions of different intensities. *Cognition and Emotion*, 16 (6), 721–747.

Matthews, B. (2015). Memory dysfunction. Continuum: Lifelong Learning in Neurology, 21(3), 613-626.

McDaniel, M. A. & Einstein G. O. (2011). The neuropsychology of prospective memory in normal aging: a componential approach. *Neuropsychologia*, 49(8), 2147–2155.

McDaniel, M. A., Glisky, E. L., Rubin, S. R., Guyunn, M. J. & Routhieaux, B. C. (1999). Prospective memory: a neuropsychological study. *Neuropsychology*, 13 (1), 103 – 110.

McWilliams J., & Schmitter-Edgecombe M. (2008). Semantic memory organization during the early stage of recovery from traumatic brain injury. *Brain Injury.* 22 (3), 243-253.

Megreya, A. M., & Bindemann, M. (2009). Revisiting the processing of internal and external features of unfamiliar faces: The headscarf effect. *Perception*, 38, 1831–1848.

Megreya, A. M., & Burton, A. M. (2008). Matching faces to photographs: Poor performance in eyewitness memory (without the memory). *Journal of Experimental Psychology: Applied*, 14, 364–372.

Megreya, A. H., Memon, A., & Havard, C. (2011). The headscarf effect: direct evidence from the eyewitness identification paradigm. *Applied Cognitive Psychology*, 26, 308–315.

Miellet, S., Vizioli, L., He, L., Zhou, X., &Caldara, R., (2013). Mapping face recognition information use across cultures. *Frontiers in Ppsychology*, 4 (34), 1-12.

Millis, S. R., Dijkers, M. (1993). Use of the recognition memory test in traumatic brain injury: preliminary findings. *Brain injury*, 7(1), 53-8.

Milner, B. (1971). Interhemispheric differences in the localization of psychological processes in man. *British Medical Bulletin*, 27, 272–277.

Minear, M., & Park, D. C. (2004). A lifespan database of adult facial stimuli. *Behavioral Research Methods, Instruments, & Computers*, 36, 630–233.

Mioni, G., Stablum, F., McClintock, S., M., & Cantagallo, A., (2012). Time-Based prospective Memory in severe traumatic brain injury patients: the involvement of executive functions and time perception. *Journal of the International Neuropsychological Society, 18,* 697–705.

Mitrushina, M., Abarat, J., & Blumenppld , A. (1994). Aspects of validity and reliability of neurobehavioral cognitive status examination (NCSE) in assessment of psychiatric patients. *Journal of psychiatric*, 28(1), 85-95.

Moscovitch, M., Nadel, L., Winocur, G., Gilboa, A., & Rosenbaum , R. S. (2006). The cognitive neuroscience of remote episodic, semantic and spatial memory. *Current Opinion in Neurobiology, 16*, 179–190.

Moser, R. S., Schatz P., Neidzwski K., Ott, S. D. (2011). Group versus individual administration affects baseline neurocognitive test performance, *American Journal of Sports Medicine*, 39(11), 2325-2330.

Moskowit, G. B. (2001). *Cognitive social psychology: The Princeton symposium on the legacy and future of social cognition.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Moss, M. B., & Albert, M. S. (1988). Alzheimer's disease and other dementing disorders. In M. S. Albert & M. B. Moss, (Eds.), *Geriatric Neuropsychology* (pp. 145-178). New York: Guilford Press.

Mueller, J., Kiernan, R., & Langston, W. J. (2014). *Cognistat paper, Cognistat active form, Cognistat assessment system, Cognistat five manual.* USA: Cognistat.

Mullen, M. K. (1994). Earliest recollections of childhood: a demographic analysis. *Cognition*, 52, 55–79.

Mullen, M., & Yi, S. (1995). The cultural context of talk about the past: implications for the development of autobiographical memory. *Cognitive Development*, 10, 407–419.

Murakami, H., Fujita, K., Futamura, A., Sugimoto, A., Kobayakawa, M., Kezuka, M., et al. (2013). The Montreal cognitive assessment and Neurobehavioral cognitive Status Examination are useful for screening mild cognitive impairment in Japanese patients with Parkinson's disease. *Neurology and Clinical Neuroscience, 1*, 103–108.

Nabors, N., Millis, S., & Rosenthal, M. (1997). Use of the Neurobehavioral Cognitive Status Examination (Cognistat) in traumatic brain injury. *Journal of Head Trauma Rehabilitation, 12*, 79–84.

Nachshon, I. (1985). Directional preferences in perception of visual stimuli. International Journal of Neuro-science, 25, 161–174.

Nachshon, I., Argaman, E., & Luria, A. (1999). Effects of directional habits and handedness on aesthetic preference for left and right profiles. *Journal of Cross-Cultural Psychology,* 30, 106–114.

Nair, R., & Lincoln, N. (2007). Cognitive rehabilitation for memory deficits following stroke (Review). *Cochrane Database of Systematic Reviews, 3*, 1-20.

Nasreddine, Z. S., Phillips, N. A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., et al. (2005). The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *The American Geriatrics Society, 53*, 695–699.

National clinical guidelines for Stroke (2012). *National clinical guidelines for stroke: the intercollegiate stroke working party.* Retrieved February 10, 2015, from National clinical guidelines for Stroke: https://www.rcplondon.ac.uk/sites/default/files/national-clinical-guidelines-for-stroke-fourth-edition.pdf

National institute for health and care excellence (2014). *Assessment and therapy in specific areas for people with stroke*. Manchester: national institute for health and care excellence.

National Stroke Association (NAS). (2006). *Recovery after stroke: thinking and cognition.* Retrieved January 02, 2015, from National Stroke Association: http://www.stroke.org/sites/default/files/resources/NSAFactSheet_ThinkingandCognition_2014.pdf

Nelson, K. (1993). The psychological and social origins of autobiographical memory. *Psychological Science*, 4, 7-14.

Nelson. T. O., Leonesio, R. J., Landwehr. R. S., & Narens. L. (1986). A comparison of three predictors of an individual's memory performance: the individual's feeling of knowing versus the normative feeling of knowing versus base-rate item difficulty. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 12, 279-287.

Ng A., H., Steele J., R. & Sasaki J., Y. (2016). Will you remember me? Cultural differences in own-group face recognition biases. *Journal of Experimental Social* Psychology, 64, 21-26.

Ngo, C. T., (2013). *Associative recognition memory and context effects using objects on natural backgrounds* (Doctoral thesis). Retrieved from http://scholarship.shu.edu/cgi/viewcontent.cgi?article=2867&context=dissertations.

Nisbett, R. E. (2003). *The geography of thought: How Asians and Westerners think Differently… and why.* New York: The Free Press.

Nisbett, R., & Masuda, T. (2003). Culture and point of view. *The National Academy of Sciences of the USA, 100*(19), 11163–11170.

Nisbett, R. E., & Miyamoto,Y. (2005). The influence of culture: holistic versus analytic perception. *Trends Cogn.Sci,* 9, 467–473.

Nisbett, R. E., Peng, K. P., Choi, I., Norenzayan, A. (2001). Culture and systems of thought: Holistic versus analytic cognition. *Psychol. Rev.* 108, 291–310.

Nokleby, K., Boland, E., Bergersen, H., Schanke, A., K., Farner, L., Wagle, J., et al. (2008). Screening for cognitive deficits after stroke: a comparison of three screening tools. *Clinical Rehabilitation, 22*, 1095–1104.

Nordin, K., Herlitz, A., Larsson, E., & Soderlund, H., (2017). Overlapping effects of age on associative memory and the anterior hippocampus from middle to older age. *Behavioural Brain Research, 317, 350-359.*

Nys , G., Van Zandvoort , M., De Kort , P., van der Worp, H., Jansen, B., Algra, A., et al. (2005). The prognostic value of domain-specific cognitive abilities in acute first-ever stroke. *Neurology, 64*(5), 821–827.

O'Craven KM, Kanwisher N (2000). Mental imagery of faces and places activates corresponding stimulus-specific brain regions. *J Cogn Neurosci*, 12, 1013-1023.

Oehlert M. E., Hass S. D., Freeman M. R., Williams M. D., Ryan J.J., Sumerall S.W. (1997). The Neurobehavioral Cognitive Status Examination: accuracy of the "screen-metric" approach in a clinical sample. *J Clin Psychol*, 53: 733–7.

Osborne, C., D., Stevenage, S., V., (2008). Internal feature salience as a marker of familiarity and configural processing. *Visual Cognition,* 16, 23 - 43.

Osmon, D.C., Smet, I.C., Winegarden, B., & Gandhavadi, B. (1992). Neurobehavioral Cognitive Status Examination: Its use with unilateral stroke patients in a rehabilitation setting. *Archives of Physical Medicine and Rehabilitation*, 73, 414–418.

Oudman, E., Postma, A., Van der Stigche, S., Appelhof, B., Wijnia, J, W., & Nijboer, T. C. W., (2014). The Montreal Cognitive Assessment (MoCA) is superior to the Mini Mental State Examination (MMSE) in detection of Korsakoff's syndrome. *The Clinical Neuropsychologist*, 28 (7), 1123-1132.

Oxford, R.L., & Anderson, N. (1995): State of the art: a cross cultural view of language learning styles. *Language Teaching*, 28, 201-215.

Oyserman, D., Markus, H. (1993). The sociocultural self. In J. Suls (Eds.), psychological *perspectives on the self: the self in social perspective* (pp.187–220). Mahwah, NJ: Erlbaum.

Park, D. C., Nisbett, R., & Hedden, T. (1999). Aging, culture, and cognition. *Journal of Gerontology: Psychological Sciences, 54*(2), 75-84.

Park, D., Smith, A., Lautenschlager, G., Earles, J., & et al,. (1996). Mediators of long-term memory performance across the life span. *Psychology and Aging*, 11(4), 621-637.

Pascalis, O., & de Haan, M. (2003). Recognition memory and novelty preference: what model? In H. Hayne, & J. Fagen, *Progress in Infancy Research* (pp. 95-120). New Jersey: Lawrence Erlbaum Associates.

Patel, M. D., Coshall, C., Rudd, A. G. and Wolfe, C. D. (2002). Cognitive impairment after stroke: clinical determinants and its associations with long-term stroke outcomes. *Journal of the American Geriatrics Society,* 50, 700–706.

Pelli, D. G., Burns, C. W., Farell, B., and Moore-Page, D. C. (2006). Feature detection and letter identification. *Vision Res.* 46, 4646–4674.

Pendlebury, Mariz, Bull, Mehta, & Rothwell, (2012). MoCA, ACE-R and MMSE versus the NINDS-CSN VCI Harmonisation Standards Neuropsychological Battery after TIA and stroke. *Stroke, 43(2):* 464–469*.*

Perfetti & Zhang, S. (1991). Phonological processes in reading Chinese characters. *Journal of Experimental Psychology Learning Memory and Cognition.* 17(4), 633-643.

Pergola G., Gunt O., Koch B., Schwarz M., Daum I., & Suchan B. (2012). Recall deficits in stroke patients with thalamic lesions covary with damage to the parvocellular mediodorsal nucleus of the thalamus. *Neuropsychologia*, 50, 2477–2491.

Pohjasvaara, T., Vataja, R., Leppävuori, A., Kaste, M., & Erkinjuntti, T. (2001). Depression is an independent predictor of poor long-term functional outcome post-stroke. *European Journal of Neurology: The Official Journal of the European Federation of Neurological Societies, 8*(4), 315-9.

Qutub, J. A., (2008). *A cross-cultural comparison of cognitive styles in Arabic and American adults learners using eye-tracking to measure subtle differences* (Doctoral thesis, George Mason University, Fairfax, VA). Retrieved from http://digilib.gmu.edu/jspui/bitstream/handle/1920/3075/Qutub_Jolin.pdf?sequence=1&isAllowed=y.

Rabinowitz, A., & Levin, H., (2014). Cognitive Sequelae of traumatic brain injury. *Psychiatr Clin North Am.,* 37(1), 1–11.

Rahman, T. T. (2009). Montreal cognitive assessment Arabic version: reliability and validity prevalence of mild cognitive impairment among elderly attending geriatric clubs in Cairo. *Japan Geriatrics Society, 9*, 54–61.

Raskin, S. A., Shum, D. H. K., Ellis, J., Pereira, A. and Mills, G. (2017). A comparison of laboratory, clinical and self-report measures of prospective memory in healthy adults and individuals with brain injury. *Journal of Clinical and Experimental Psychology. 1-14.*

Rasmussen, K. W., & Berntsen, D. (2014). Autobiographical memory and episodic future thinking after moderate to severe traumatic brain injury. *Journal of Neuropsychology*, 8, 34–52.

Reisberg, D. (2013). *The Oxford handbook of cognitive psychology*. United State of America: Oxford University Press.

Revlin, R. (2012). *Cognition: Theory and Practice*. The United State of America: Worth Publishers.

Rey, A. (1941). The psychological examination in cases of traumatic encephalopathy problems. *Archives de Psychologie*, 28, 215-285.

Rey, A. (1964). *L'examen clinique en psychologie*. Paris: Presses Universitaires de France.

Rice-Oxley, M., Turner Stokes L. (1999). Effectiveness of brain injury rehabilitation. *Clin Rehabil*, 13(1): 7–24.

Rogers, T. T., Lambon, Ralph, M. A., Garrard, P., et al. (2004). Structure and deterioration of semantic memory: a neuropsychological and computational investigation. *Psychol Rev*, 111(1), 205-235.

Rogoff, B., Mistry, J.. Goncii. A.. & Mosier, C. (1993). Guided participation in cultural activity by toddlers and caregivers. *Monographs of the Society for Research in Child Development,* 58(236).

Roper, B, B. L. (1996). Validity of the Mini-Mental State Examination and the Neurobehavioral Cognitive Status Examination in cognitive screening. *Neuropsychiat Neuropsychol Behavioral Neurol, 9*, 54-7.

Rosselli, M., & Ardila, A., (2003). The impact of culture and education on non-verbal neuropsychological measurements: a critical review. *Brain Cognition*, 52(3), 326-33.

Rosselli, M., (1993). Neuropsychology of illiteracy. Behavioural Neurology, 6, 107 - 112.

Sabe, L, J. L. (1993). Sensitivity and specificity of the Mini- Mental State Exam in the diagnosis of dementia. *Behavioral Neurol, 6*, 207-10.

Salari, S. (2002). Invisible in aging research: Arab Americans, Middle Eastern immigrants, and Muslims in the United States. *The Gerontologist, 42*, 580-5.

Salmon, D. P., Jin, H., Zhang, M., Grant, I., & Yu, E. (1995). Neuropsychological assessment of Chinese elderly in the Shanghai Dementia Survey. *The Clinical Neuropsychologist*, 9, 159–168.

Savani, K., & Markus , H. (2012). processing advantage associated with analytic perceptual tendencies: European Americans outperform Asians on multiple object tracking. *Psychology, 48*, 766-769.

Saxton, J., Morrow , L., Eschman, A., & Archer, G. L. (2009). Computer assessment of mild cognitive impairment. *Postgraduate Medicine, 121*(2), 177–185.

Schacter, D. L. (1987). Implicit Memory: History and Current Status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*(3), 501-518.

Schacter, D. L., Curran, T., Galluccio, L., Milberg, W. P., & Bates, J. F. (1996). False recognition and the right frontal lobe: A case study. *Neuropsychologia, 34,* 793– 808.

Schacter, D. L., Wagner, A. D., & Buckner, R. L. (2000). Memory systems of 1999. In E. Tulving & F. I. M. Craik (Eds.), *Oxford handbook of memory*, (pp.627–643). New York: Oxford University Press.

Schmitt, B. H., Pan, y., & Tavassoli (1994). Language and consumer memory: the impact of linguistic differences between Chinese and English. *Journal of customer research*, 21 (12), 419-31.

Schmitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment, 4*, 350-3.

Schouten E. A., Schiemanck S. K., Brand , N., & Post M. W. M. (2009). Long-term deficits in episodic memory after ischemic stroke: evaluation and prediction of verbal and visual memory. *Journal of Stroke and Cerebrovascular Diseases, 18 (2),* 128-138.

Schroeder, P. J., (2014). The effects of age on processing and storage in working memory span tasks and reading comprehension. *Experimental Aging Research, 40*, 308-331.

Schwamm, L., Van Dyke, C., Kiernan, R. J., Merrin, E. L., & Mueller, J. (1987). The Neurobehavioral Cognitive Status Examination: comparison with the Cognitive Capacity Screening Examination and the Mini-Mental State Examination in a neurosurgical population. *Annals of Internal Medicine, 107*, 486–491.

Schweinberger , S., R., Kaufmann, J. M., McColl A. (2002). Famous personal names and the right hemisphere: the link keeps missing. *Brain Lang.* 82(1), 95-110.

Sherer, M., Sander, A. M., Nick, T. G., High W. M., Jr., Malec, J. F., & Rosenthal, M., (2002). Early cognitive status and productivity outcome after traumatic brain injury: findings from the TBI model systems. *Arch Phys Med Rehabil.* 83(2),183-92.

Shimamura, A. P., Janowsky, J. S., & Squire, L. R. (1991). What is the role of frontal lobe damage in memory disorders? In H. D. Levin, H. M. Eisenberg, & A. L. Benton (Eds.), *Frontal lobe functioning and dysfunction* (pp.173–195). New York, NY: Oxford University Press.

Shin, H., B. & Ortman, J. (2011). *Language Projections: 2010 to 2020*. The federal forecasters conference. Washington, DC, *2011. U.S. Census Bureau.*

Shiraev, E., & Levy, D., (2007). *Cross-cultural psychology*. (3rd ed.). Boston: Allen & Bacon.

Shulman K. I. (2000). Clock-drawing: Is it the ideal cognitive screening test? *Int J Geriatr Psychiatry*, 15, 548–61.

Shum, D., Valentine, M., & Cutmore, T. (1999). Performance of individuals with severe long-term traumatic brain injury on time-, event-, and activity-based prospective memory tasks. *Journal of Clinical and Experimental Neuropsychology, 21*, 49–58.

Siedlecki, K. L., Manly, J. J., Brickman, A. M., Schupf, N., Tang, M. X., & Stern, Y. (2010). Do neuropsychological tests have the same meaning in Spanish speakers as they do in English speakers? *Neuropsychology*, 24(3), 402-411.

Simonson, I., Carmon, Z., Dhar, R., & Drolet, A. (2001). Consumer research: in search of identity. *Annual Review of Psychology,* 52(1), 249.

Sinha, P., & Poggio, T. (1996). I think I know that face. *Nature, 384*(6608), 404-404.

Sinha, P., & Poggio, T. (2002). Last but not least: 'united' we stand. *Perception, 31*, 133-133.

Sodring, K., Laake, K., Sveen, U., Wyller, T., & Bautz-Holter, E. (1998). Validation of the screening instrument for neuropsychological impairment in stroke*. Physiotherapy Research International, 3(1),*15-26.

Soldatovic-Stajic, B., Misic-Pavkov , G., Bozic , K., & Gajic , Z. (2014). Neuropsychological and neurophysiological evaluation of cognitive deficits related to the severity of traumatic brain injury. *European Review for Medical and Pharmacological Sciences, 18*, 1632-1637.

Squire, L. R., & Zola-Morgan, M. (1991). The medial temporal lobe system. *Science*, 253, 1380–1386.

Squire, L. R., Clark, R. E., Knowlton, B. J. (2001). Retrograde amnesia. Hippocampus, 11, 50-55.

Stacey, P. C., Walker, S., & Underwood, J. D. M. (2005). Face processing and familiarity: evidence from eye-movement data. *British Journal of Psychology, 96*, 407-422.

Stone, C. P., & Wechsler, D. (1946). Wechsler memory scale: Form III. *The Journal of Psychology, 22,* 199–206.

Strub R. L., Black F. W. (2000). *The Mental Status Examination in neurology*, 4th edition. Philadelphia. F.A. Davis Company.

Sundet K. Nevropsykologisk grunntest (NPG). Nevropsykologiske funksjonsprofiler etter hjerneslag [in Norwegian]. *Tidsskr Nor Psykologforen* 1991; 28: 686–96.

Suzuki, W. A. (2005). Science Briefs: Associative Learning and the Hippocampus. Retrieved March 20, 2017 from http://www.apa.org/science/about/psa/2005/02/suzuki.aspx.

Tabish S. A., & Syed N., (2015). Recent advances and future trends in traumatic brain Iinjury. *Emerg Med (Los Angel).* 5(1), 1-21.

Tatemichi, T. K., Desmond, D. W., Stern , Y., Paik, M., Sano , M., & Bagiella, E. (1994). Cognitive impairment after stroke: frequency, patterns and relationship to functional abilities. *J Neurol Neurosurg Psych, 57(2), 202–207.*

Tavassoli, N. T. (1999). Temporal and associative memory in Chinese and English. *Journal of Consumer Research*, 26, 170-181.

Tayim F. M., Flashman L. A., Wright M. J., Roth R. M. & McAllister T. W. (2016). Recovery of episodic memory subprocesses in mild and complicated mild traumatic brain injury at 1 and 12 months post injury. *Journal of Clinical and Experimental Neuropsychology*, 38(9), 1005-1014.

Tennant, A. (2015). *Acquired brain injury: the numbers behind the hidden disability.* England and Wales: headway– the brain injury association.

Tham, D. S., Bremner, G. J., Hay, D. (2017). The other-race effect in children from a multiracial population: A cross-cultural comparison. *Journal of Experimental Child Psychology*, 155, 10, 128-137.

Thomas, J. (2013). *Psychological well-being in the Gulf States*. New York: Palgrave Macmillan.

Thornton, A. E., & Raz , N. (1997). Memory impairment in multiple sclerosis: a quantitative review. *Neuropsychology, 11*(3), 357–66.

Toseeb, U., Bryant, E. J., & Keeble, D. R. (2014). The muslim headscarf and face perception: ‘‘they all look the same, don’t they?’’. *PLOS one, 9*(2), 1-9.

Toseeb, U., Keeble, D. R., & Bryant, E. J. (2012). The significance of hair for face recognition. *PLoS One, 7*(3), 1-8.

Tranel, D., Damasio, A. R., & Damasio, H. (1988). Intact recognition of facial expression, gender, and age in patients with impaired recognition if face identity. *Neurology,* 38(5), 690-696.

Tranel, D., Damasio, H., & Damasio, A. R. (1997). A neural basis for the retrieval of conceptual knowledge. *Neuropsychologia*, 35, 1319–1327.

Triandis, H. C. (1989). The self and social behaviour in differing cultural contexts. *Psychol. Rev.* 96, 506–20.

Triandis, H. (1996). The psychological measurement of cultural syndromes. *American Psychologist*, 51(4), 407-415.

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247*, 301-306.

Tulving, E. (1985). Memory and consciousness. *Can. Psychol.* 26, 1–12.

Tversky, B., Kugelmass, S., & Winter, A., (1991). Cross-cultural and developmental trends in graphic productions. *Cognitive Psychology*, 23, 515-557.

Tyerman A., & King N., S. (2008). Community rehabilitation. In A. Tyerman & N. S. King (Eds.), *Psychological approaches to rehabilitation after traumatic brain injury (*pp.65-90). Oxford: BPS Blackwell.

UCSF memory and aging centre (2014). Episodic memory. Retrieved January 21, 2017, from http://memory.ucsf.edu/brain/memory/episodic.

Uysal-Bozkir, O., Parlevliet, J. L., & de Rooij, S. E. (2013). Insufficient cross-cultural adaptations and psychometric properties for many translated health assessment scales: a systematic review. *Journal of Clinical Epidemiology, 66 (6),* 608–618.

Vakil, E., (2005). The effect of moderate to severe Traumatic Brain Injury (TBI) on different aspects of memory: a selective review. Journal of Clinical and Experimental Neuropsychology. 27, 8, 977-1021.

Van der Schalk, J., Hawk, S. T., Fischer, A. H., & Doosje, B. (2011). Moving faces, looking places: Validation of the Amsterdam Dynamic Facial Expression Set (ADFES). *Emotion*, 11, 907–920.

Van Gorp, W. G., Marcotte, T. D., Sultzer, D., Hinkin, C., Mahler, M., & Cummings, J. L. (1999). Screening for dementia: comparison of three commonly used instruments. *Journal of Clinical and Experimental Neuropsychology, 21*(1), 29-38.

Van Heugten, C. M., Walton, L., & Hentschel, U. (2014). Can we forget the Mini-Mental State Examination? A systematic review of the validity of cognitive screening instruments within one month after stroke. *Clinical Rehabilitation*, 1-12.

Van Lancker, D. (1991). Personal relevance and the human right hemisphere. *Brain and Language*, 17, 64–92.

Walker, P. M., & Hewstone, M. (2006). A developmental investigation of other-race contact and the own-race face effect. *British Journal of Developmental Psychology,* 24, 451-463.

Wallesch C. W, Horbach H. J, Blanken G. (2003). The assessment of acquired spoken language disorders. In P. Halligan, U. Kischka and J.C. Marshall (Eds.), *Handbook of Clinical Neuropsychology*. Oxford: Oxford University Press.

Wang Q. (2009). Are Asians forgetful? Perception, retention, and recall in episodic remembering. *Cognition,* 111, 123–131.

Wang, Q. & Fivush, R. (2005). Mother-child conversations of emotionally salient events: exploring the functions of emotional reminiscing in European American and Chinese families. *Social Development*, 14, 473-495.

Wang, Y., Thomas, J., Weissgerber , S. C., Kazemini, S., Ul-Haq, I., & Quadflieg, S. (2015). the headscarf effect revisited: further evidence for a culture-based internal face processing advantage. *Perception,* 44, 328 – 336.

Wang,Q.(2006). Earliest recollections of self and others in European American and Taiwanese young adults. *Psychol. Sci,* 17, 708–714.

Wang, Q., Ross, M. (2007). Culture and memory. In K. D. Cohen (Eds.), *Handbook of Cultural Psychology* (pp. 645–67). New York: Guilford.

Want S C, Pascalis O, Coleman M, Blades M, (2003). Recognising people from the inner or outer parts of their faces: Developmental data concerning unfamiliar faces. *British Journal of Psychology* 21 125 -135.

Ward H., Shum D., Wallace G., & Boon J. (2002). Paediatric traumatic brain injury and procedural memory. *Journal of Clinical and Experimental Neuropsychology*, 24, 4, 458-470.

Warrington. E., K., (1984). *Recognition memory test: manual.* Berkshire, UK: NFER-Nelson.

Wechsler, D. (1945). A standardized memory scale for clinical use. The journal of Psychology: interdisciplinary and applied, 19(1), 87-95.

Wechsler, D. A. (1981). *Wechsler adult intelligence scale—revised*. New York: Psychological Corporation.

Wester, A. J., van Herten, C. J., Egger, J. I., & Kessels, R. P. (2013). Applicability of the Rivermead Behavioural Memory Test – Third Edition (RBMT-3) in Korsakoff's syndrome and chronic alcoholics. *Neuropsychiatric Disease and Treatment, 9*, 875–881.

Whorf, B. L. (1956). *Language, thought, and reality*. New York: John Wiley & Sons and The

Technology Press of M.I.T.

Whyte, E., Skidmore, E., Aizenstein, H., Ricker, J., & Butters, M. (2011). Cognitive impairment in acquired brain injury: a predictor of rehabilitation outcomes and an opportunity for novel interventions. *PM R, 3*(601), 1-12.

Wilson B. A. (1993). Ecological validity of neuropsychological assessment: do neuropsychological indexes predict performance in everyday activities? Appl Prev Psychol. 2,209–215.

Wilson, B. A., Emslie, H., Foley, J., Shiel, A., Watson, P., Hawkins, K., et al. (2005). *The Cambridge prospective memory test*. London: Harcourt Assessment.

Wilson B. A, Greenfield E., Clare L., et al. (2008). The Rivermead Behavioural Memory Test – Third Edition (RBMT-3). London, UK: Pearson Assessment.

Wilson, B., & Moffat, N. (1984). *Clinical management of memory problems* (1st ed.). Rockville, Md.: Aspen Systems Corp.

Wilson, B., & Moffat, N. (1992). *Clinical Management of Memory Problems* (Second ed.). Scotland: Chapman & Hall.

Wilson, B., Greenfield, E., Clare, L., Baddeley, A., Cockburn, J., Watson, P., et al. (2008). *The Rivermead Behavioural Memory Test – Third Edition (RBMT-3).* London, UK: Pearson Assessment.

Wilson R. R, Blades M., Pascalis O. (2007). What do children look at in an adult face with which they are personally familiar?. *British Journal of Developmental Psychology* 25 375 – 382.

Wittich, W., Phillips, N., Nasreddine, Z. S., & Chertkow, H. (2010). Sensitivity and Specificity of the Montreal Cognitive Assessment modified for individuals who are visually impaired. *Journal of Visual Impairment & Blindness, 104*(6), 360-368.

Woodford, H. J., & George, J. (2007). Cognitive assessment in the elderly: a review of clinical methods. *International Journal of Medicine, 100*, 469–484.

World Health Organization. (2001). *International classification of functioning, disability and health: ICF.* Geneva, Switzerland: World Health Organization.

Wright, D. B., & Sladden, B. (2003). An own gender bias and the importance of hair in face recognition. *Acta Psychologica, 114*(1), 101-114.

Wrobel, N. H., & Farrag, M. F. (2008). Preliminary validation of an Arabic version of the MMSE in the elderly. *Clinical Gerontologist, 31*(3), 75-93.

Wunderle, W. (2006). *Through the lens of cultural awareness.* Fort Leavenworth, KS: Combat Studies Institute Press.

YanHong , D., Vijay, K. S., Poon-Lap , B. C., Venketasubram, N., Teoh , H. L., Seet , R. C., et al. (2012). The Montreal Cognitive Assessment (MoCA) is superior to the Mini-Mental State Examination (MMSE) for the detection of vascular cognitive impairment after acute stroke. *Journal of the Neurological Sciences, 299*(1-2), 15–18.

Yeo, D., Lincoln, N.B., Burgess, I.S. & Pearce, M.J. (1996). SORT: A validation study with stroke patients. *Age & Aging, 25(2), 121-4.*

Yonelinas, A.P., Kroll, N.E.A., Quamme, J.R., Lazzara, M.M., Sauve, M.J., Widaman, K.F., and Knight, R.T. (2002). Effects of extensive temporal lobe damage or mild hypoxia on recollection and familiarity. *Nat. Neurosci.* 5, 1236–1241.

Yoon, C., Feinberg, F., Hu, P., Gutchess, A. H., Hedden, T., Chen, H. Y., et al. (2004). Category norms as a function of culture and age: comparisons of item responses to 105 categories by American and Chinese adults. *Psychology and Aging,* 19, 379–393.

Young, A. W., Newcombe, F., Dehaan, E. H. F., Small, M., & Hay, D. C. (1993). Face perception after brain injury - selective impairments affecting identity and expression. *Brain*, 116, 941-959.

Young, A., & Bruce, V. (1998). Pictures at an exhibition - the science of the face. *Psychologist, 11*(3), 120-125.

Zebian, S. (2005). Linkages between number concepts, spatial thinking and directionality of writing: The SNARC effect and the REVERSE SNARC effect in English and in Arabic mononitrates, biilliterates and illiterate Arabic speakers*. Journal of Cognition and Culture*. Special Issue: Psychological and Cognitive Foundations of Religiosity. 5(1–2), 165–190.

Zhang, H., Zhang, X., Zhang, H., Huang, L., Chi, Q., Zhang, X., & Yun, X. (2016). Differences in cognitive profiles between traumatic brain injury and stroke: a comparison of the Montreal Cognitive Assessment and Mini-Mental State Examination. *Chinese Journal of Traumatology, 19 (5)*, 271-274.