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Does learning the Qur'an improve memory capacity?

Practical and theoretical implications

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Abstract

Our understanding of human memory has gained greatly from the study of individuals with impaired memory but rather less from outstandingly high levels of memory performance. Exceptions include the case of London taxi drivers whose extensive route learning over years has been shown to result in modification of their hippocampus. Our study involves a group whose extensive verbal learning potentially provides a similar natural experiment. The Muslim faith encourages followers to memorise the whole of the Qur'an, some 77,449 words in its classic Arabic form. Successful memorisers are known as 'Hafiz'. We tested 10 Hafiz, 12 background-matched Muslim controls and 10 non-Muslim participants, on their detailed knowledge of the Qur'an and on their performance on standard measures of verbal and visuo-spatial learning. We found no differences between the three groups in their capacity to memorise verbal or visuospatial material and hence no evidence of generalization of learning capacity in the Hafiz group. More surprisingly, however, half the Hafiz group did not understand Arabic but were equivalent in Qur'anic memory to those who did. Given the importance that meaning is typically assumed to play in long-term memory, this was unexpected. We discuss the practical and theoretical implications of these results for verbal memory and long-term learning.

Key words: Verbal memory, Exceptional Long-term Learning, Expertise, Qur'anic learning, Hafiz

Introduction

Most theoretical advances in the study of human memory have come from research using participants from the general population. However, a potentially important source of further evidence comes from participants whose memory performance lies at the extreme ends – both exceptionally poor and exceptionally good memory. The case can readily be made for the theoretical impact of neurological patients with specific deficits in working memory (Baddeley, Papagno, & Vallar, 1988; Shallice & Vallar, 1990; Shallice & Warrington, 1970), episodic memory (Baddeley & Warrington, 1970; Milner, 1996; Squire, Knowlton, & Musen, 1993) and semantic memory (Patterson, Nestor, & Rogers, 2007; Pobric, Jefferies, & Lambon Ralph, 2010; Shallice & Warrington, 1984) which have all strongly influenced basic memory theory. The case for studies of exceptionally good memory is however more complex. Broadly speaking, two somewhat different patterns of exceptionally good memory have emerged – firstly, a small number of individuals showing enhanced performance that appears to reflect a fundamental difference in basic memory capacities and, secondly, a larger number of cases of individuals whose performance reflects the development and training of specific capacities and/or strategies. Within both groups, there tends to be considerable variability.

In the first type of exceptional natural memory capacity, the mnemonist S studied by Luria (1968) showed memory capacity that appears to have been based on a remarkable degree of synaesthesia, apparently relying heavily on multidimensional imagery, while S.R., a case studied by Hunt and Love (1972), appeared to rely more on semantic coding. Exceptional memory for numbers tends to be associated with mathematical skill and mental calculation, although this can sometimes also be associated with a much wider range of memory skills as in the case of Aitkin, Professor of Mathematics at the University of

Edinburgh studied by Hunter (1977) who showed a remarkable memory for a wide range of material.

Rather more frequent are people whose outstanding memory performance results from the deliberate development of particular mnemonic strategies where extensive practice allows normal basic capacities to be used in such a way as to achieve performance that extends well beyond the norm. Wilding and Valentine (1997) studied participants in a World Memory Championship held in London in 1993 in which a range of mnemonists performed a series of specified tasks, including memorising over 1,000 randomly generated binary digits, learning 100 names and faces and remembering the order of cards in a newly shuffled pack. Participants were therefore required to have developed a range of skills, rather than focus on a single activity. These tasks were however known in advance, hence allowing relevant strategies to be developed and practiced.

Mnemonists of this type fit broadly into Ericsson's (1988) more general analysis of expertise and his concept of long-term working memory (Ericsson & Kintsch, 1995). This essentially refers to the use of frameworks developed in long-term memory to enhance the capacity of immediate memory. This characteristically involves first developing a suitable structure in LTM, followed by three steps, first the selection of a feature of the stimulus followed by the development of an associate that can then be linked into the existing structure (Ericsson, 1988). Ericsson provides examples where digit span was extended by extensive practice up to some 80 digits, based on a hierarchical structure using running times, something of direct interest to this particular learner. Other examples include memory for dinner orders in expert waiters and learning the first 1000 digits of pi (Ericsson, 1988). In general, studies of the performance of people with such well-developed skills have however, been more important in identifying strategies whereby existing capacities can be amplified

rather than influencing our understanding of the basic processes underlying memory performance.

Actors form another group who are required to learn considerable amounts of material with great accuracy. Their approaches to memorisation vary, though they rarely appear to choose a strategy of simple rote rehearsal (Noice & Noice, 2006) often breaking a play down into chunks based on meaning, intent and purpose, using a method known as "active experiencing" (Trabasso & van den Broek, 1985), based on taking the perspective of the character and the context. This method that can be highly effective and it was found that even when spatial and visual context cues were removed, actors could remember 85% of a play after relatively brief study (Schmidt, Boshuizen, & van Breukelen, 2002).

One example however in which the study of unusually high memory performance appears to have gone beyond strategy development and has influenced our basic concepts of learning and memory comes from the study by Maguire and colleagues of the memory performance of London taxi drivers (Maguire et al., 2000). In order to be licenced to drive a London cab, it is necessary for the driver to learn the layout of all the streets in London together with the optimal means of travelling from one point to the next. Given the size and complexity of London, acquiring "the knowledge" is a process that can take several years. Neuroimaging indicates that this leads to a structural change in the driver's hippocampus (Maguire et al., 2000), resulting in both increased posterior and decreased anterior hippocampi. Such a change does not occur in the case of London bus drivers who have driven for equivalent amounts of time, but on regular routes (Maguire, Katherine, & Hugo, 2006). This and a range of subsequent studies have played an important part in the abandonment of previous assumptions that the adult brain lacks plasticity, the capacity for new neural circuits to be formed (Fuchs & Flügge, 2014). However, while this effect has been well established, such intense and focused learning over a matter of years is rare and to the best of our

knowledge, has not been demonstrated for other capacities. The present study forms a preliminary exploration of another group who, like the taxi drivers, concentrate on a very specific type of learning over many years, namely people of the Muslim faith who have learned by heart the whole of the Qur'an, and who are known as Hafiz[1].

The Qur'an comprises over 77,000 words and is divided into 114 chapters (surah) which vary in length, a format somewhat similar to the Bible. Learning the whole Qur'an is therefore a major undertaking, typically extending over several years, in the case of our own sample between 2 and 26 years. The reason for memorising the Qur'an is reflected in the name Hafiz which means "guardian". The practice was adopted at a time when literacy was rare, and it is said that Prophet Mohammed himself relied on memory and recitation to preserve what became the Qur'an. Memory thus provided a means whereby the community could preserve the Qur'an in its original form, a form that was at that time able to be understood by the whole community. To avoid progressive distortion, it was seen as important that the original be reproduced accurately, hence the emphasis on being word perfect. Note that this differs from the Homeric and Bardic tradition, preserved in Eastern Europe into the last century, where the singer preserved the gist but recreated the detail on each performance based on rhyme and rhythm supplemented by a range of conventional phrases (Rubin, 1995).

Becoming a Hafiz, a guardian of the Qur'an, typically depends on an examination by the Hafiz teacher of a student. It takes place when the teacher deems the student to be ready and may take a number of different forms. These include recitation of the chapters verbatim with no errors, sometimes from the start of the Qur'an to the end whereas other methods may require the student to recite specified verses from different chapters. The process of testing is

[1] The term Hafiz applies to a single male. We have chosen not to use the plural huffaz or the feminine Hafiza for reasons of simplicity.

likely to extend for several sessions with a possibility of correcting errors and retaking the test. Perhaps surprisingly however, by no means all Hafiz understand (beyond a few frequently used words and phrases that are repeated regularly in prayers), read or speak Arabic (Saleem, 2015). Given the importance of meaning in most theoretical approaches to long-term memory since Bartlett (1932), the performance of Hafiz who do not understand Arabic is particularly interesting.

Our study focuses on the question of whether the extensive use of verbal memory involved in learning the Qur'an leads to enhanced verbal memory capacity and if so whether this extends to other aspects of cognition. While claims for the beneficial cognitive consequences of becoming a Hafiz have been made (Ghilan, 2012), concrete evidence appears to be limited. one study claiming extensive benefits (Nawaz & Jahangir, 2015) is based purely on self and parent reports in a study lacking a control group while a second study (Saleem, 2015) focusing on non-Arabic speaking Qur'anic memorisers found no effect of learning on their capacity to detect morphological patterns in Arabic. Scribner and Cole (1973) refer to work suggesting no difference between Hafiz and a control group on a standard verbal learning test, but do suggest enhanced learning on a specially designed task involving serial anticipation of nonsense syllables. Unfortunately, however, no reference is provided.

The assumption that practice at rote memorising will improve capacity to learn was educationally prominent during the 19th century, although rejected by William James (1890, p666), with subsequent experimental studies supporting James (Reed, 1917; Sleight, 1911). However, the amounts of training used in these and related studies was limited, extending for example over 15 days (Reed, 1917) or three weeks (Sleight, 1911) far less than the time needed to become a successful Hafiz. Claims to train working memory that have been prominent in recent years suggest that carefully developed regimes may enhance working

memory performance. However the balance of current evidence suggests that while training may generalise to other broadly similar laboratory tasks, it fails to generalise more widely to more practical cognitive activities (Melby-Lervåg, M., & Hulme, 2013; Shipstead, Redick, & Engle, 2012). However, unlike Qur'anic memorisation, these studies again typically extend over a matter of weeks at the most.

Our study attempts to explore this form of extended learning by testing three groups of participants all of whom had been educated to a university level. One comprised 10 Hafiz, a second comprised 12 participants from similar Muslim backgrounds but who had not trained to become a Hafiz. Both groups were recruited by word of mouth, principally from mosques within the UK cities of Leeds and London. A third group comprised age and education matched non-Muslim native English-speaking participants. All groups were tested on three aspects of knowledge of the Qur'an together with a range of cognitive tests. We assumed that performance on the Qur'anic tests would be very high in the Hafiz group, much lower in the non-Hafiz Muslim control participants and negligible in the non-Muslim group. Our principal question was whether the Hafiz group would prove superior on standard tests of verbal or visual learning and memory. A second question concerned possible differences between Hafiz who do and any who might not understand, read or speak Arabic, while differences between the Muslim and non-Muslim control groups might be expected to reflect possible differences in cultural and linguistic background. Finally, we wished to explore the strategies used by the Hafiz to memorise the Qur'an, to see if this could give some insight into effective learning strategies in general.

Methods

Participants

A total of 32 participants were recruited across the three groups. The first group included ten Muslims (9 males; mean age = 26.7 years, SD = 5.51 years) who had memorised the Qur'an in its entirety. While it would be desirable to have sampled equal numbers of male and female Hafiz , the predominance of males reflects the unequal distribution of Hafiz within the Muslim community. The second group comprised twelve Muslims (7 females; M = 24.0 years, SD = 4.16 years) who had not memorised the Qur'an but were familiar with the text due to early socialisation and religious obligations. We asked participants to self-report the number of years they had spent studying the Qur'an. The Hafiz group (M = 9.15 Years, SD = 9.51 Years, Range = 2-26 years) and the non-Hafiz (Mean age = 9.51 Years, SD = 8.29 Years, Range = 0.4-25 years) provided similar estimates (p = .64). This reflects the fact that Qur'anic learning forms part of the education for most practising Muslims, although very few attempt to achieve Hafiz status. The third group consisted of individuals who reported no familiarity with the Qur'an or Islam (7 females; Mean age = 23.7 years, SD = 3.65 years). Age and academic history (all participants had obtained at least an undergraduate degree) were matched across groups. The study received ethical approval from two UK University Psychology Department Research Ethics Committees. A participant information sheet containing the details of the research study was administered together with a consent form obtaining the participants' agreement and right to withdraw, followed by a questionnaire regarding age, gender, educational background and knowledge of Arabic.

Qur'an Knowledge

Two cued recall tasks and a recognition task were used. The recognition task involved participants being visually presented with three separated rows and thirty columns of text. One row contains an extract from the Qur'an, one from the Hadith which comprises reported sayings of the prophet from outside the Qur'an, and one involved on unrelated Arabic prose

passage. Participants were asked to indicate which of the three sentences they believed came from the Qur'an. All participants, including the control group, were asked to take part even though the stimuli for all tasks were provided in Arabic.

The task of cued recall comprised audio files of Surahs (Qur'anic verses) with participants asked to identify the Surah being played, specifying chapter and verse, and then to orally complete the subsequent part of the surah when the recording has stopped. Surahs vary in length and complexity with those encountered earlier in reading the Qur'an being typically shorter and simpler. Because of this, the longer surahs were played to participants for a longer period before being asked to recall, than the shorter surahs, with presentation time ranging from 15 to 40s in length.

Finally, to provide a more detailed understanding of Hafiz experience with the Qur'an and explore the strategies employed in learning and maintenance, we asked this group to complete a survey post-experiment (see Supplementary Information 1).

Cognitive Measures

The 'Spot the Word' vocabulary test (Baddeley, Emslie & Nimmo-Smith, 1993) was used as a measure of overall familiarity with English. It involves pairs of items, one a real English word and the other a nonword similar in structure, with the words ranging from common to very rare. Participants read a total of 60 pairs and were required to select which was the real word with performance was unpaced and was measured by number of correct responses. The Matrix Reasoning test from the Weschler Adult Intelligence Scale (Lazarević, Knežević, Mitić, & Jočić, 2018; Wechsler, 1981) was used to explore any potential differences in problem solving and cognitive processing. In this task, participants were shown a 26-page booklet in which each page contained problems based on a set of visual patterns, and participants had to select one from five possible solutions. This task was not timed but was stopped if

participants achieved a score of zero on four consecutive items, or four scores of zero on five consecutive items. The measure taken was the number of correct responses.

For learning, we chose to focus on two established tests that include measures of initial learning, the immediate effect of interference together with a delayed retention measure. As a test of verbal memory, we chose the relevant subtest from the Wechsler Memory Scale III (Wechsler, 1981). This involves presenting a list of 12 unrelated words (List A), for a total of four learning trials with recall required after each. This was followed by a single trial of List B, a further 12 words. Recall of List B was followed immediately by the recall of List A, and after a further delay of 30 min by a second test of List A, followed by a final yes/no recognition test.

Visual LTM was tested using the Design Recall and Recognition Test from the BIRT Memory and Information Processing Battery (Coughlan, Oddy, & Crawford, 2007). It comprises patterns created by joining dots within 4x4 array using nine component lines. Test A involved presenting the design for 10s after which the dot array was presented and recall of the design requested. This procedure was repeated for a further five trials, allowing a maximum total score of 45. This in turn was followed by Test B, a new design that was then tested after 10s. This was followed by a further recall of the Test A figure. In each case, performance is measured by number of designs successfully completed. As an additional procedure (not part of the standard test), after a further 30 m delay a final recognition test involved a sequence of 40 designs of which 10 had been presented previously, with participants required to decide whether each had been presented as Test A, Test B or were new. Performance in each case was indicated by number of correct categorisations.

Results

Language and Intelligence Measures

The Spot the Word Test was included to obtain an estimate of any differences between the groups in linguistic background. There was a statistically significant difference across groups in participant performance on this task, $F(2, 29) = 3.98$, $p = .03$, $\eta^2 = 0.23$), with the non-Muslim group of participants ($M = 47.6$, $SD = 4.12$) tending to slightly outperform both the Hafiz ($M = 36.6$, $SD = 12.94$; $t = 2.6$, $p = .037$), and the non-Hafiz ($M = 38.33$, $SD = 9.2$; $t = 2.29$, $p = .073$), with no difference between Hafiz and non-Hafiz ($p = .904$; Figure 1A). This suggests a possible cultural difference perhaps reflecting slightly less exposure to the ambient UK linguistic culture. There was, however, no difference, $F(2, 29) = 2.75$, $p = .081$, $\eta^2 = 0.16$, in non-verbal intelligence between the three groups, as indexed by the Matrix Reasoning Score (Control $M = 18.4$, $SD = 3.41$; Non-Hafiz $M = 18.6$, $SD = 4.58$; Hafiz $M = 14.5$, $SD = 5.23$).

Qur'anic Knowledge

Figure 1 shows performance on the three tests of Qur'anic Knowledge. Oral Completion (Figure 1A) of Qur'an Surahs differed across groups, $F(2, 29) = 69.46$, $p < .001$, $\eta^2 = 0.83$, with Quran Hafiz ($M = 12.6$, $SD = 2.5$), completing more than non-Hafiz (2.42, $SD = 3.48$; $t = 9.31$, $p < .001$ or the control group ($M = 0$, $SD = 0$; $t = 7.12$, $p < 001$;). The control and non-Hafiz group did not differ significantly ($t = 2.21$, $p = .086$).

-----INSERT FIGURE 1 HERE ----

Aa shown in Figure 1B, identification of chapter and verse of Qur'anic surahs showed similar results across groups, $F(2, 29) = 29.37$, $p < .001$, $\eta^2 = 0.67$. Unsurprisingly, the

control group were unable to correctly identify any Surah's (M = 0, SD = 0). On average The Hafiz (M = 7.3, SD = 3.53) outperformed both control (t = 7.3, p <.001) and the non-Hafiz (t = 5.73, p <.001).

As Figure 1C shows there was also a large difference in performance on the Qur'anic discrimination of visually presented Qur'anic surahs from those taken from the Hadith or from non-religious prose F (2, 29) = 34.48, p < .001, η^2 = 0.704). The Hafiz (M = 28.7, SD = 1.06) outperformed both the non-Hafiz (M = 16.00, SD = 8.3; t = 5.48, p < .001) and the control group (M = 8.9, SD = 2.96; t = 8.18, p < .001). We also found difference between non-Hafiz and the control group (t = 1.09, p = .013) who performed at chance level.

Memory

Verbal Memory

Next, we examined differences in performance in the four dimensions of the verbal memory tests (Word List I Total words correctly recalled, Word List II total recognised , Short Delay Recall and Long Delay Recall). The results are shown in Figure 2. We found no differences in List I total score F (2, 29) = 1.06, η^2 = 0.07, p = .359) List II Recognition Score, F (2, 29) = 0.635, η^2 = 0.042, p = 0.537), Short Delay Recall performance, F (2, 29) = .514, η^2 = 0.034, p = .603) or Long Delay Recall F (2, 29) = .412, η^2 = 0.03, p =.666).

-----INSERT FIGURE 2 HERE ----

Design Recognition

Results of the visual memory task are shown in Figure 3. ANOVA across the groups did not reveal significant differences in performance on any of the four measures. Specifically, we found no difference in Design Identification F (2, 29) = .367, η^2 = 0.025, p = .697), Design

Total Recognition F (2, 29) = .52, η^2 = 0.035, p = .6), Design A Recognition after presentation of Design B, F (2, 29) = .104, η^2 = 0.007, p = .902) or the total number of Design A lines recalled, F (2, 29) = .26, η^2 = 0.018, p = .773).

-----INSERT FIGURE 3 HERE ----

Qur'anic memory and knowledge of Arabic

We asked all our participants whether they could (a) understand Arabic; (b) speak Arabic; and (c) write in Arabic. None of the non-Muslim participants were able to understand, speak or write in Arabic. However, from our 22 Muslim participants in the Hafiz and non-Hafiz group, there was a mix of abilities. Of those who had achieved Hafiz status, two reported that, despite being able to memorise the Qur'an in its entirety, they were unable to understand, speak or write in Arabic. Three could write Arabic script but not speak or understand Arabic. Two could understand and write, but not speak, whilst the remaining three were able to understand, speak and write in Arabic. In our non-Hafiz group, five participants were unable to understand, speak or write in Arabic and seven were able to understand, speak and or write.

We then explored whether the ability to comprehend and communicate in Arabic might influence performance on the Qur'an knowledge tests and thus, separated participants into Ability (Yes vs. No) X group (Hafiz vs. non-Hafiz) for each level of understanding and performed exploratory analysis for each of the Qur'an tests- Passage Recognition, Passage Identification and Oral Completion. Given the small sample sizes, we opted against performing formal statistical analyses and provide descriptive analyses next.

Understanding Arabic

The principal question here is whether there is any difference between the performance of Hafiz who do and those who do not understand Arabic. It is clear from Figure 4 that the two groups of Hafiz entirely overlap on the Qur'anic tests. Overall, with the Hafiz group, performance on oral completion of surahs (Figure 4A) is high (Understanding Arabic: M = 12.8, SD = 2.68; No Understanding of Arabic: M = 12.4, SD = 2.61). Their capacity to identify chapter and verse of the relevant surahs (Figure 4B) is relatively low (Understanding Arabic: M = 7.4, SD = 3.36; No Understanding of Arabic: M = 7.2, SD = 4.08) but the capacity to recognise which of the three texts comes from the Qur'an is virtually perfect in both Hafiz subgroups (Figure 4C; Understanding Arabic: M = 28.8, SD = 0.45; No Understanding of Arabic: M = 28.6, SD = 1.52).

In the case of the non-Hafiz Muslim control group there is a suggestion that ability to understand Arabic may have some effect on the non-Hafiz/ Muslim group, with one participant performing at the same level as the Hafiz on oral completion (scoring 12/30), suggesting a high level of knowledge (Understanding Arabic: M = 3.71, SD = 4.11; No Understanding of Arabic: M = 0.6, SD = 0.89). Identifying chapter and verse is low for both non-Hafiz Muslim subgroups (Understanding Arabic: M = 2.57, SD = 1.62; No Understanding: M = 0.8, SD = 1.3), with a suggestion that understanding Arabic confers a small advantage. Four of the group who can understand Arabic perform relatively well at deciding which of three passages comes from the Qur'an and the group mean is higher as a result (Understanding Arabic: M = 19.57, SD = 9.03; No Understanding: M = 11, SD = 3.74). It should be pointed out here that learning the Qur'an is not limited to Hafiz and is seen as a desirable activity more generally for practising Muslims.

-----INSERT FIGURE 4 HERE ----

The pattern for *speaking* Arabic is somewhat similar to that for understanding, with no advantage to Arabic speakers (M = 11.67, SD = 3.05) over non-speaking Hafiz (M = 13, SD = 2.38; Figure 5 A) in the oral completion task. The capacity to speak Arabic does enhance performance of the non-Hafiz Muslim group (M = 3.71, SD = 4.11) relative to non-Arabic speaking participants (M = 0.6, SD = 0.89) again with one high performing participant (scoring 12/30). This pattern is repeated for chapter and verse identification (Hafiz: Speaking M = 7, SD = 3.6 vs. Non-Speaking M = 7.42, SD = 3.77; Non-Hafiz: Speaking M = 2.57, SD = 1.62 vs. Non-Speaking M = 0.8, SD = 1.30; Figure 5 B) and for source recognition (Hafiz: Speaking M = 29.0, SD = 0 vs. Non-Speaking M = 28.57, SD = 1.27; Non-Hafiz: Speaking M = 19.57, SD = 9.03 vs. Non-Speaking M = 11, SD = 3.74; Figure 5 C).

-----INSERT FIGURE 5 HERE ----

All but two of the Hafiz were able to write Arabic script, while in the non-Hafiz group again there was a tendency for the capacity to write Arabic to offer a slight advantage for oral completion (Able to Write: M = 3.71, SD = 4.11; Unable to Write: M = 0.6, SD = 0.89), chapter and verse identification (Able to Write: M = 2.57, SD = 1.62; Unable to Write: M = 0.8, SD = 1.30) and for source recognition (Able to Write: M = 19.57, SD = 9.03; Unable to Write: M = 11, SD = 3.74; Figure 6).

-----INSERT FIGURE 6 HERE ----

Considered overall, our data suggest that our 10 Hafiz participants are almost perfect at distinguishing between passages from the Qur'an and those from other sources, are excellent though not perfect at completing passages when cued by the first part of a given surah but are less good at quoting chapter and verse, a feature that could be regarded as less than central to mastering the Qur'an, and one that might well be given different degrees of emphasis by different teachers. Strikingly however, there is no apparent difference between those Hafiz who understand Arabic and those who do not understand Arabic, an issue we will return to in the discussion. A related question concerns how many years the Hafiz spent in learning the Qur'an. It is possible that both groups reached the same level of expertise but that the lack of Arabic led to slower learning. We only have broad self-report evidence on this with reported estimates varying hugely in both those who do and who do not understand Arabic. The five Hafiz who do understand Arabic reported taking 2, 3, 5, 5 and 25 years to learn and those who do not understand Arabic reported 2, 5, 5, 16 and 26 years, clearly not a reliable difference with groups of this size.

Strategies used by Hafiz

When questioned on methods of learning, six of the Hafiz reported practicing daily, typically in attendance at teaching classes, and one several times a day. One Hafiz mentioned they start to forget if they do not read and recall ten times a day. Four of the ten used recordings to aid pronunciation while two report using visualisation to maintain their place within the text. More generally, strategies varied across individuals typically tending to be imam-led, resulting in regular and frequent spaced learning and retrieval sessions

Discussion

The purpose of our study was to investigate the remarkable memory feat of learning the whole of the Qur'an, comparing the performance of Hafiz who have achieved this with a group of fellow Muslims who have a similar cultural background and a further non-Muslim control group. Our principle aim was to test the extent to which such learning generalises, using standard tests of verbal and visual memory. Our secondary concern resulted from the chance recruitment of five Hafiz who could and five who could not understand Arabic, a distinction that much of the research on human memory might suggest would have a major effect

First of all, it is clear that the Hafiz we studied do indeed have excellent memory for the whole of the Qur'an when measured by their capacity to complete verses taken at random, their capacity to distinguish between written passages, and to a lesser extent their capacity to quote chapter and verse. They perform at a consistently higher level than the non-Hafiz control groups, although understanding and speaking Arabic does allow some members of the Muslim control group to perform at a relatively high level in distinguishing Qur'anic from non-Qur'anic written passages.

Yet, when Hafiz are tested on their capacity for new learning, having learned the Qur'an provides no advantage on standardised verbal or visuo-spatial learning tasks. This reinforces conclusions derived from much older research on memory training conducted to test the widespread early belief that memory resembles a muscle which can be strengthened by repeated exercise, research that also found no evidence that practice at rote learning improves overall memory (James, 1890; Reed, 1917; Sleight, 1911). A similar conclusion has been drawn recently in the area of working memory, where claims were initially made that training programmes could develop working memory capacity. Later studies however typically indicate that training programmes covering a range of working memory tasks can lead to enhanced performance on broadly similar laboratory-based tasks, while more distant

generalisation to scholastic performance or improvement in performance on intelligence test measures typically fails to occur (Melby-Lervåg, M., & Hulme, 2013; Shipstead et al., 2012).

However, neither of these sources of evidence involves the many hours of training that occurs in becoming a Hafiz. A better comparison here is with the previously described studies on London taxi drivers for whom the evidence for anatomical modification of the hippocampus is strong (Maguire et al., 2000). The extent to which it extends to other cognitive and memory capacities however is rather more limited. In addition to their better knowledge of London routes and landmarks, they were also better at learning the layout of a new town as tested both by drawing and by route following (Woollett & Maguire, 2010) while being significantly worse at remembering the location of objects on a table top (Woollett & Maguire, 2009) together with a suggestion they might also be impaired on verbal paired associate learning. However, this was not consistently observed (Woollett & Maguire; 2009, 2012), suggesting that the advantage from their years of spatial learning does not generalise at all widely, with the most reliable effect being negative transfer to a simple location memory task. Broadly speaking therefore, the data from London taxi drivers are in line with our own findings and those of earlier studies involving more modest amounts of training in suggesting a lack of broad generalisation beyond the specific practice domain. The anatomical implications of our study are unclear. Despite the lack of clear behavioural effects, structural changes implying learning-based neuroplasticity have been observed in London taxi drivers and appear to be more clearly established than behavioural generalisation (Maguire et al 20000; 2006), suggesting further anatomically-based research may be worth pursuing.

A more surprising feature of our study is the fact that half of our group of Hafiz do not understand Arabic, a situation that we subsequently learned is not uncommon (Saleem, 2015). To our surprise, non-Arabic speakers appear to have memorised the Qur'an achieving

a broadly similar level of expertise to the Arabic speakers in the group. This finding should however be treated with caution, given that it was unexpected, based on two groups of five Hafiz that were not balanced for sex ratio to the control groups. As such, it merits further investigation with a larger sample and more carefully matched control groups. Our result is however of general interest given that the approach taken within the study of long-term memory from Bartlett (1932) onwards has emphasised the central importance of meaning in memory for verbal material (e.g. Baddeley, 1966; Baddeley, Eysenck & Anderson, 2015), leading us to expected that failure to understand the language in which the Arabic language would present a major handicap to a prospective Hafiz. We were apparently wrong although we do not have a reliable measure of total time taken to learn the Qu'ran

A possible clue as to how such learning might occur is offered by listening to the method in which the Qur'an is typically recited as illustrated by the following recording of a spoken verse from the Qur'an:
(https://www.tvquran.com/en/selections/category/5/beautiful-quran-recitation).
Although spoken, its rhythmic and melodic line makes performance much closer to music than to simple recitation of prose, suggesting similarities with Rubin's (1995) analysis of memory within oral traditions which emphasises the potential importance of rhythm and rhyme. While most of Rubin's examples involve combining meaning with these more prosodic features, it seems plausible to assume that memory for music in the absence of verbal content may well have a very large capacity, as reflected in the ability to hear a fragment of a melody and spontaneously complete it. We know of no work that investigates this, but suggest that it should perhaps be pursued as part of an aim to extend our knowledge of human memory beyond the fruitful, though limited, verbal domain on which so much existing theory has been developed.

Interviews concerning the methods used by the Hafiz to memorise the Qur'an suggested a range of strategies broadly similar to those typically used by individuals on less demanding memory tasks such as distributed practice and spaced retrieval. although they are used more consistently and intensively. Other methods include routinely memorising text before sleeping as a means of memory consolidation of material, which is then again rehearsed the following morning. Reading and recalling the text typically occurs daily either with the auditory assistance within imam-led teaching classes or by themselves (sometimes using recordings of imams). So, what should the prospective Hafiz conclude from our study? We would not recommend it as a means of improving memory and concentration as suggested by Ghilan, (2012) and Nawaz and Jahangir (2015). However, we suspect that most Hafiz did not undertake this onerous task as a memory training routine, and it may well yield social, emotional and perhaps spiritual benefits.

In conclusion, our results suggest that learning the Qur'an by heart is unlikely to lead to a general improvement in learning capacity, a result in line with earlier work on the failure of training of either long-term or working memory to generalise beyond the practiced domain. Somewhat surprisingly however, we find no evidence that failure to understand the language in which the learning takes place has any influence on performance level, a surprising and potentially theoretically important observation that would merit further investigation.

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Figures and Captions

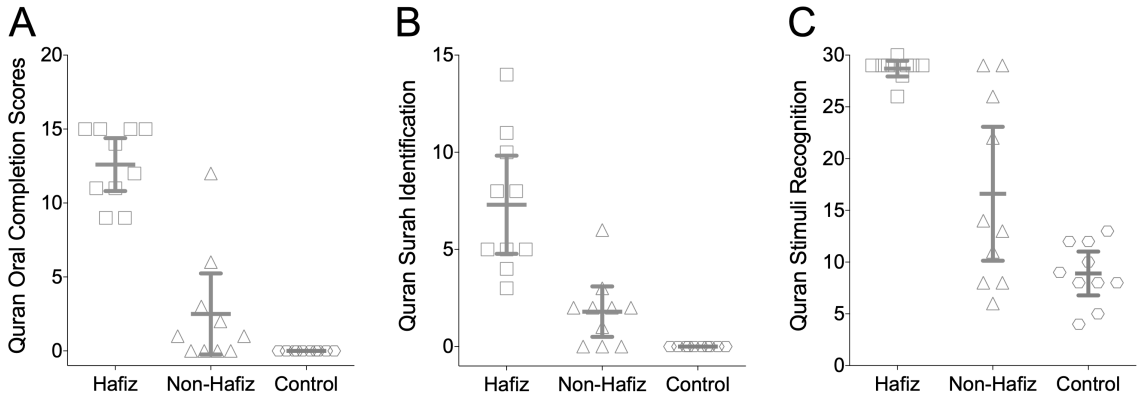

Figure 1. Qur'an tests. A comparison of scores by participant group on (A) the correct oral completion of Surahs following auditory presentation, (B) the correct identification of Surahs name and number and (C) correct recognition of Qur'an stimuli. Error bars represent the 95% confidence interval.

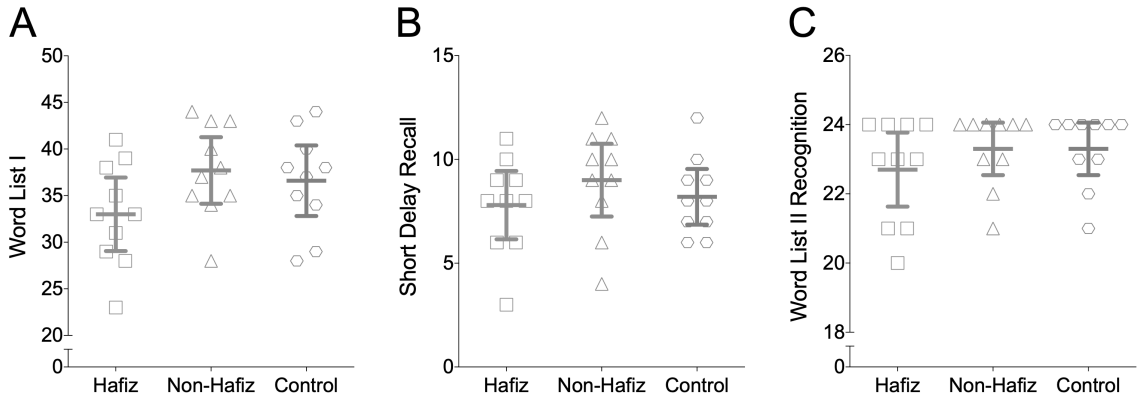

Figure 2. Word List Memory. A Comparison of the total mean scores by participant group on their performance on Word List Memory tasks, A List 1 learning score, B Recall following interference from List 2 and C Delayed recall. The error bars represent the 95% confidence interval.

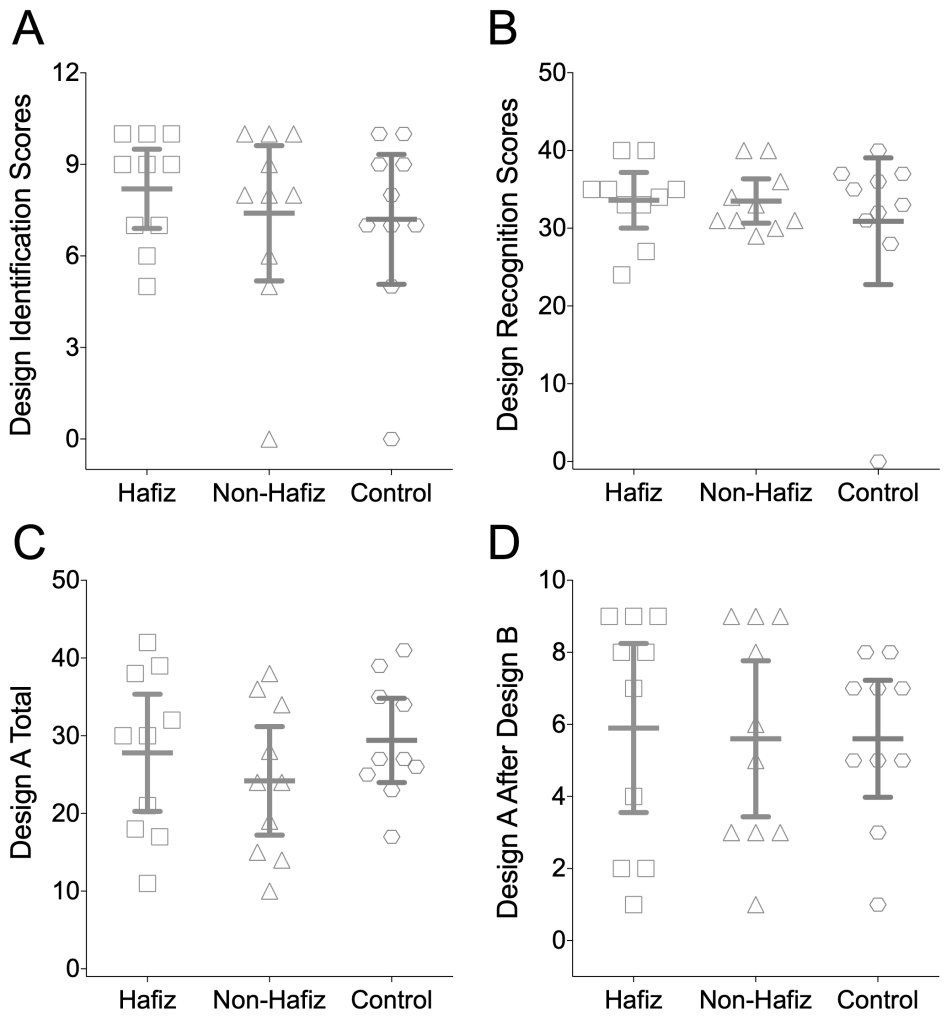

Figure 3: Mean scores by participant group on (A) Design Identification (B) Design Total Recognition (C) Total Number of Design A Lines Remembered and (D) the correct number of Design A lines recalled after a distractor presentation of Design B. Error bars represent the 95% confidence interval.

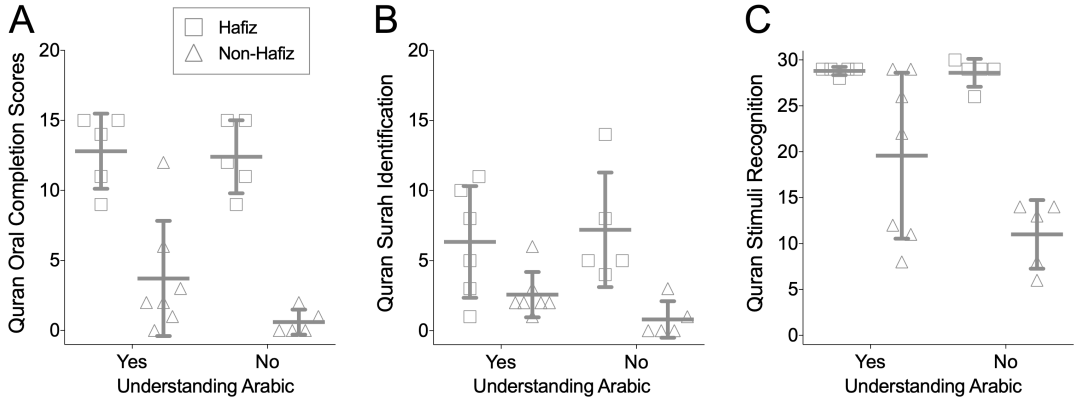

Figure 4. Understanding Arabic. Participants who could and could not understand Arabic were separated by level of scholarship (Hafiz vs Non-Hafiz) for the three Qur'an related measures of performance- (A) oral completion, (B) correct identification and (C) stimuli recognition. Error bars represent the 95% confidence interval.

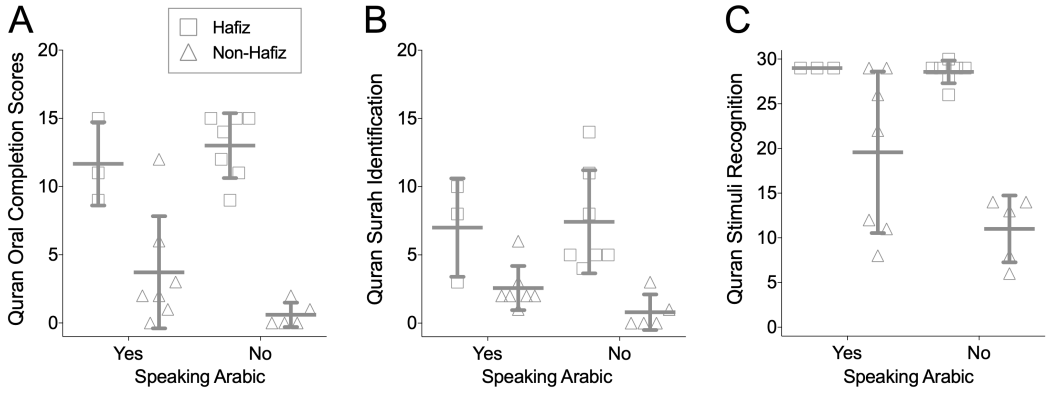

Figure 5. Speaking Arabic. Participants who could and could not speak Arabic were separated by level of scholarship (Hafiz vs Non-Hafiz) for the three Qur'an related measures of performance- (A) oral completion, (B) correct identification and (C) stimuli recognition. Error bars represent the 95% confidence interval.

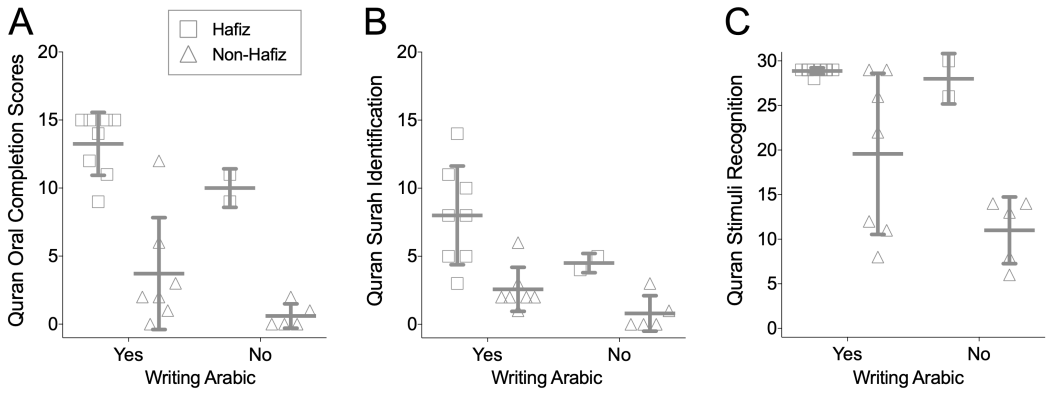

Figure 6. Writing in Arabic. Performance of participants who could and could not write in Arabic on (A) oral completion, (B) correct identification and (C) stimuli recognition. Error bars represent the 95% confidence interval.