Norms for the Icelandic Version of the ACE-III: Effects of Age and Education

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Foreword

Submitted in partial fulfillment of the requirements of the BSc Psychology degree, Reykjavík University, this thesis is presented in the style of an article for submission to a peer-reviewed journal.

Abstract

Recently the much researched and validated cognitive test battery for dementia screening, Addenbrooke's cognitive examination (ACE-III) was translated into Icelandic. The aim of the study was to collect Icelandic norms for the elderly on the Icelandic version of the ACE (t-ACE) and evaluate whether age or education stratified cut-off scores should be used. The t-ACE was administered to 80 (46 women) cognitively healthy 65-85 year old volunteers with an average of 12.7 years of schooling. The results revealed little difference in performance between age groups. Participants with higher education did perform significantly better on the t-ACE with an average of 95.9 points compared to 90.2 and 90.6 points for those with secondary or elementary education. Furthermore, the correlation between years of schooling and t-ACE score was $R = 0.54$. The normative data were comparable to what had been seen in other countries and the Icelandic translation of the test appears to be adequate. The performance on the t-ACE was strongly influenced by the individual's education level, indicating that education stratified cut-off scores might be necessary.

Keywords: aging, Addenbrooke's Cognitive Examination, dementia, cognitive assessment

Útdráttur

Nýlega var Addenbrooke's Cognitive Examination prófið þýtt á íslensku. Markmið rannsóknarinnar var að safna normum meðal eldri borgara fyrir tölvu ACE (t-ACE) og meta hvort sérstök aldurs eða menntunar fráviksskor væru ákjósanleg. T-ACE prófið var lagt fyrir 80 (46 konur) heilbrigða einstaklinga, en meðallengd skólagöngu þeirra var 12.7 ár. Niðurstöður leiddu í ljós að lítill munur var á frammistöðu einstaklinga eftir aldri. Aftur á móti stóðu þeir sem voru með háskólapróf sig mun betur en fólk með framhaldskóla eða grunnskólapróf (95,9 stig samanborið við 90,2 stig og 90,6 stig). Ennfremur var fylgnin milli fjölda ára í skóla og frammistöðu á prófinu $R = 0,54$. Normagögnin voru sambærileg þeim normum sem söfnuð hafa verið í öðrum löndum og reyndist íslenska þýðingin fullnægjandi. Sterkt samband milli frammistöðu á t-ACE og menntunarstigs gefur til kynna að sérstök fráviksskor sem taka tillit til menntunar ættu að vera notuð.

Norms for the Icelandic Version of the ACE-III: Effects of Age and Education

With an ever increasing life expectancy and declining birth rate the proportion of senior citizens in the population is rising (Centers for Disease Control and Prevention (CDC), 2003). Although the world's population is living longer the brain still deteriorates at the same rate as before and the prevalence of geriatric conditions continues to increase (Wimo, Winblad, Aguero-Torres, & Strauss, 2003). Given that senior citizens are an expanding patient group, it is imperative that healthcare systems have good screening instruments to identify individuals in the early stages of dementia. Currently a small variety of dementia screening tests are available to clinicians (Hoops et al., 2009; Teng et al., 1994). One such test is the Addenbrooke's Cognitive Examination, which in the past years has gained considerable popularity and has been extensively investigated and undergone several revisions (Mioshi, Dawson, Mitchell, Arnold, & Hodges, 2006).

The Addenbrooke's Cognitive Examination (ACE) is an instrument that was created and developed by Mathuranath, Nestor, Berrios, Racowicz and Hodges (2000) as a screening test for Alzheimer´s disease (AD), frontotemporal dementia (FTD), progressive supranuclear palsy and other Parkinsonian syndromes. Mathuranath et al's aim was to create a sensitive yet inexpensive and brief test for accurate screening. There is a general consensus regarding the efficiency of the test and its third edition (ACE-III) has been found to have a reliability of 0.88 and for a cut-off score of 88 (maximum score is 100 points) the specificity is 0.96 and the sensitivity is as large as 1.0 (Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013). Whether and how the test is affected by spectrum bias will be discussed further in the next paragraphs in order to examine whether certain demographic stratified cut-off scores should be advised.

Numerous studies have found that those with greater educational resources are more resistant to cognitive decline (Tucker-Drob, Johnson, & Jones, 2009). Thus, the prevalence of dementia is greater amongst populations of lower educational status than amongst those that are well-educated (Plassman et al., 2007). This phenomena raises the notion of whether the same screening test is appropriate for populations of different educational backgrounds. The cut-off scores, currently relied on when using the ACE, have generally not taken education into account (Crawford, Whitnall, Robertson, & Evans, 2012; Mathuranath et al., 2007; Mioshi et al., 2006). However, there is emerging evidence suggesting that education specific cut-off scores might be beneficial. In 2007 the ACE was adapted in Malaysia (M-ACE) and administered to senior citizens of various backgrounds (Mathuranath et al., 2007). Education was the most efficient predictor of M-ACE scores and the authors concluded that education-stratified cut-off scores should be used for optimal efficiency. Since both educational inequality and class distinction are great in Malaysia (Ragayah, 2008) it cannot be assumed that a similar approach with different educational cut-offs would be equally applicable in more equal countries. However, in a recent study in the UK (Jubb & Evans, 2015) results similar to those observed in the Malaysian study were obtained, where the results indicated different cut-off scores for groups with higher vs. lower education. This suggests that a consideration of a patient's education might be necessary for optimal interpretation of test results.

Seeing the undeniable relationship between education and the prevalence of dementia surely the question is raised how much of an effect age has on the chances of developing a neurodegenerative disorder. It is generally accepted that a large aspect of an individual's cognition is adversely affected by age and that age is a non-modifiable risk factor for dementia (Kivipelto et al., 2006; Lustig et al., 2003). Therefore it would seem natural to use age specific

norms for an individual to be compared to. An aforementioned study, (Mathuranath et al., 2007) showed that education was the greatest predictor of a non-demented individual´s score on the ACE. However, age also significantly affected the score but to a lesser degree with an effect size of only 5.1%. Many studies assessing the ACE have found a similar pattern with scores declining significantly with age and some even recommended age-stratified cut-off scores (dos Santos Kawata et al., 2012; Pigliautile et al., 2011; Robben et al., 2010; Rotomskis et al., 2015; Stokholm, Vogel, Johannsen, & Waldemar, 2009; Yoshida et al., 2012). However, few studies have found little or no age effect (García-Caballero et al., 2006; Mioshi et al., 2006). Given the discrepancy between studies, it would be logical to assess the effect age has on test scores during the standardization of the test before deciding whether to develop age specific cut-offs or not.

Since the ACE was developed it has been in use in the UK and been translated to other languages and used clinically, for example in Spain, Japan, Germany and Belgium (Alexopoulos et al., 2010; Bier et al., 2005; dos Santos Kawata et al., 2012; García-Caballero et al., 2006). The test has proven to be easily adaptable to different languages and cultures and has been standardized in a variety of populations ranging from rural areas in Malaysia to urban Copenhagen (Mathuranath et al., 2007; Stokholm et al., 2009). The ACE seems robust to discrepancies between cultures and languages and the cut-off score has generally been in the range of 83 to 88 (Bier et al., 2005; Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013; Rotomskis et al., 2015; Stokholm et al., 2009; Yoshida et al., 2012). Numerous studies have confirmed that the ACE is effective in discriminating demented patients in general from controls for various syndromes, such as Alzheimer's disease, behavioral variant frontotemporal dementia (Bier et al., 2004; Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013), Parkinsonian syndromes (Reyes et al., 2009), and vascular dementia (Alexopoulos et al., 2006; Kwak, Yang, & Kim, 2010). The

current widespread use of the ACE underlines its quality and the test's reliability and validity has

been supported with research (Hsieh et al, 2013; Larner & Mitchell, 2014). The ACE is currently

in its 3rd edition and recently a mobile edition was created, reducing error in administration

("ACE-III Mobile," n.d.).

It is evident from the deliberations above, that the availability of a standardized

translation of the ACE-III is expected to be a valuable addition in any country to the measures

available to assess cognitive impairment. Currently, in Iceland, there is a need for good

standardized cognitive measures for early detection of dementia. The most used diagnostic tool

for dementia in Iceland today is the Mini Mental State Examination (MMSE) (Hoeltje, 2006),

which has been extensively criticized for numerous drawbacks (Mitchell, 2009). The ACE

successfully surpasses the MMSE and has fewer deficiencies (Devanand et al., 2008; Lonie et

al., 2010; P. S. Mathuranath, Nestor, Berrios, Rakowicz, & Hodges, 2000). In order for the ACE-

III to be useful in Iceland, it has to be standardized and tailored to the Icelandic population.

Although a screening test´s validity lies first and foremost in how well it discriminates between

affected individuals and controls, an analysis of the control group enables an exploration of

underlying differences between demographic groups that cannot be as readily identified in the

affected population. The aim of this thesis was to assess the adequacy of the Icelandic version of

the ACE by analyzing normative data. The norms collected here were compared to those

collected in other countries and Icelandic percentile norms were generated. Based on previous

research it was hypothesized that: 1) There is an age group difference concerning t-ACE

performance, with younger age groups performing better on the t-ACE than the older age groups;

2) Those with more schooling perform better on the t-ACE than those with less schooling.

Method

Participants

Eighty healthy senior citizens volunteered for this study, 46 females and 34 males. The inclusion criteria for participation were as follows: to be at least 65 years old, be independent in all activities of daily living (ADL), and to live independently. The exclusion criteria were being diagnosed with a neurological disorder, such as having suffered a head injury or stroke, or needing help with ADL. Participation in the study was relatively risk free, nonetheless, participation could have been stress provoking for individuals that feared being diagnosed with cognitive degeneration as well as for those who performed poorly. Distress was minimized by a supportive examiner who explained that slight errors in performance were normal. If the experimenter felt that the assessment caused too much distress on the participant, they were contacted by a neuropsychologist in order to reduce feelings of distress and inform participants if their performance indicated impairment. This only occurred in one case.

The youngest participant in this study was 65 years old and the oldest was 85 years old. The mean age of the sample was 73.5 years ($SD = 5.1$). Mean years of schooling was 12.7 years ($SD = 4.7$) with 33 participants (41.3%) having completed an education of an ISCED level over level 5 (university degree), 21 participant (26.3%) had an ISCED level 3 or 4 education (secondary education) and the remaining 26 (32.5%) had less education (elementary education). All participants were Icelandic citizens whose native language was Icelandic. Participants were recruited with advertisement and through word of mouth. Advertisements were placed in settings where healthy senior citizens were expected to spend their time, (e.g. choirs, bridge clubs and on Facebook pages for senior citizens). All participants signed a written informed consent form prior to participation.

Instruments and Measurements

The mobile edition of the Addenbrooke's cognitive examination, which was adapted from the third edition, was translated into Icelandic and adapted to Icelandic culture. The Icelandic version was named *tölvu-ACE* (t-ACE) (see Appendix A). The test largely remained the same but aspects that concerned language had to be changed and adapted. For measures of word-memorization, naming, reading and word-repetition, English words were exchanged for Icelandic words of similar difficulty and frequency of use according to the Leipzig word-frequency corpus (Quasthoff, Goldhahn, & Hallsteinsdóttir, 2013). For the delayed recall task, the English name and address was changed to an Icelandic name and address and for the episodic memory section, questions that were more appropriate for the Icelandic population were used (e.g. who is the prime minister of Iceland?). The test was translated by two experts and once the pilot translation had been made, the test was administered to 10 individuals in order to get feedback on the wording and possible aberrations. After pretesting the pilot version, minor changes were made. Scoring criteria remained identical to the scoring in the original version. In addition to the t-ACE, all individuals answered background questions concerning their age, education and previous occupations. No analysis was made concerning the participants occupations. Furthermore, an Icelandic version of the MMSE, which had been standardized and used in the AGES-Reykjavík Study, was administered (María K. Jónsdóttir, Pálmi V. Jónsson, Bylgja Valtýsdóttir, Vilmundur Guðnason & Lenore J. Launer, 2009).

Procedure

The study was approved by the Icelandic National Bioethics Committee (no. 15-084) and is a part of a larger standardization study of the ACE, conducted in collaboration by the Reykjavík University and Landspítali - The National University Hospital of Iceland**.** After

volunteering, all participants were contacted by a researcher and given further information

concerning the study and a visit was scheduled. When participants arrived they were briefed on

the procedure of the study as well as all participants signed an informed consent form (see

Appendix B and C). Participants answered questions about age, education and occupation. The t-

ACE and MMSE were administered in succession of one another. Questions that were identical

in both tests were not repeated during the administration but were added up to the total score in

both tests. The ACE was administered according to the guidelines provided in the mobile version

of the test ("ACE-III Mobile," n.d.) and the MMSE according to the guidelines used in the

AGES study (Harris et al., 2007). The average duration of the administration of the t-ACE was

15 minutes and 25 seconds (SD = 2 minutes, 6 seconds) and ranged from 11 minutes, 16 seconds

to 20 minutes, 17 seconds. No compensation was awarded for participation. Participants who

wished to be debriefed on their performance did receive such information. All data were

confidential and non-traceable.

Design and Data Analysis

The study was designed to collect normative data and to assess whether cognitively healthy

Icelandic senior citizens differed in how they performed on the ACE mobile edition according to

their education and age. Furthermore the study aimed at comparing the Icelandic normative data

to normative data collected in other countries and cultures and produce t-ACE percentile norms.

A Cronbach's alpha coefficient was calculated for the test in order to assess the tests reliability.

The difference in performance between the sexes was assessed with an independent sample t-test

and one way ANOVA and ANCOVA were used to compare the performance of different age

and educational groups. Multiple linear regression was used to assess the relationship between

years of schooling, age and gender and the t-ACE score. The percentile norms were calculated

according to guidelines provided by Baumgartner (2009). All data analysis was carried out with the SPSS 20.

Results

Descriptive Statistics

All 80 participants (46 females, 34 males) completed both the t-ACE and MMSE. The sample's demographic information can be found in Table 1 below. The sample of the study was a little skewed from the distribution in the Icelandic population with an overrepresentation of women and people with a university degree and an underrepresentation of men and individuals with secondary or elementary education (Statistics Iceland, n.d.-b). Furthermore the age groups varied in size, with fewer participants in the older age groups. Individuals between the ages 71 and 80 were overrepresented but the youngest and oldest age groups were underrepresented (Statistics Iceland, n.d.-a).

The MMSE ranged from 22-30 with an average score of 28.6 ($SD = 1.4$), a little higher average than was observed in the standardization of the MMSE conducted for the AGES Reykjavík Study ($M = 27.0$, $SD = 2.0$) (María K. Jónsdóttir et al., 2009). Thus, it is likely that inclusion/exclusion criteria were useful in selecting the appropriate participants.

The ACE-score can potentially vary from zero to 100 and here ranged from 76-100 with a mean score of 92.68 ($SD = 5.09$) (see Figure 1). Skewness and kurtosis indices were within the acceptable range between negative one and one and Cronbach´s alpha showed acceptable reliability ($\alpha = 0.73$).

Table 1.

Gender, age and educational level of the participants compared to the general Icelandic population.

		Age					% in study/
	Education	65-70	71-75	76-80	81-85	Total	% in population
Male	Elementary school	2	1	3	2	8	24/31
	Secondary school	3	6	0	1	10	29/48
	University degree	4	1	10	1	16	47/21
	Total	9	8	13	4	34	
	% in study/ % in population	26/45	24/24	38/17	12/14		
Female	Elementary school	5	11	1	1	18	39/60
	Secondary school	4	4	2	1	11	24/22
	University degree	7	6	3	1	17	37/18
	Total	16	21	6	3	46	
	% in study/ % in population	34/37	46/27	13/20	7/17		
Total	Elementary school	7	12	4	3	26	33/46
	Secondary school	7	10	2	2	21	26/35
	University degree	11	7	13	2	33	41/21
	Total	25	29	19	7	80	
	% in study/ %in population	31/41	36/26	24/18	9/15		
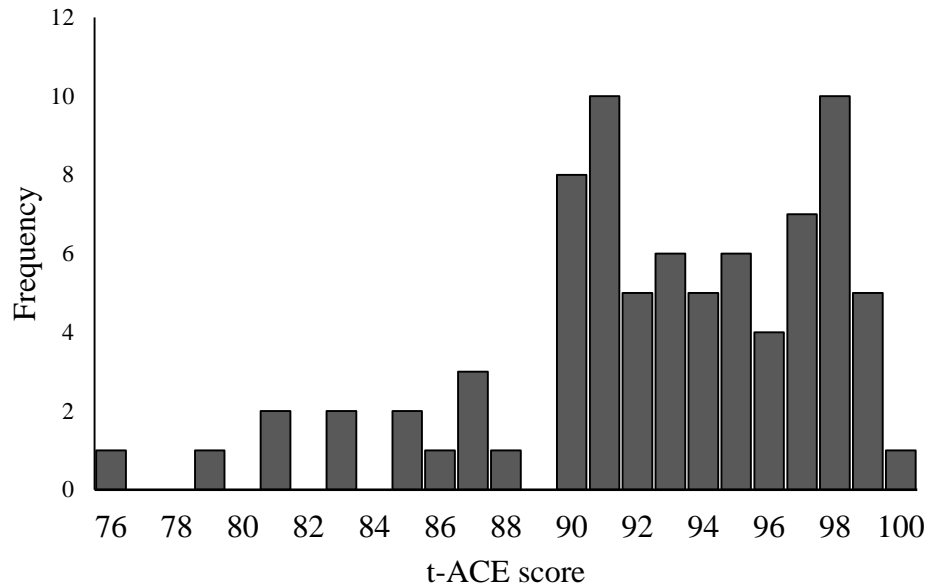
Figure 1. Distribution of the total scores on the t-ACE.

Age and Gender

As seen in Table 2 below, total t-ACE scores varied between age groups. This effect was significant, $F (3, 79) = 2.89$, $p = 0.041$, $\eta_p^2 = 0.10$. However, a Games-Howell post hoc analysis revealed that none of the age groups differed significantly from one another, $p > 0.05$. The age groups did not differ on any of the t-ACE subtests, $p > 0.05$, except for a significant relationship between age groups and scores in the attention subtest of t-ACE on which the youngest age group performed significantly better than the oldest age group, $F (3, 79) = 5.07$, $p = 0.003$. When education was controlled for using ANCOVA the relationship between age and t-ACE score was insignificant, $F (3, 79) = 2.06$, $p = 0.11$. When the relationship between gender and t-ACE was assessed using an independent sample t-test the difference between the sexes was insignificant $t(79) = -0.73$, $p = 0.47$

Table 2.

Age-specific data for the total t-ACE scores, ACE sub-scores and MMSE scores (M ± SD).

Age	n	t-ACE	Attention	Memory	Fluency	Language	Visuospatial
65-69	25	93.8 ± 3.8	17.9 ± 0.3	23.9 ± 2.1	11.4 ± 2.1	25.4 ± 1.0	15.1 ± 1.0
70-74	29	92.0 ± 4.3	16.9 ± 1.4	23.4 ± 2.6	11.4 ± 1.7	25.4 ± 1.0	14.9 ± 1.3
75-9	19	94.0 ± 5.7	17.3 ± 1.1	24.4 ± 1.8	12.0 ± 2.3	25.3 ± 1.2	15.0 ± 1.2
80+	7	88.3 ± 8.3	16.6 ± 1.3	22.6 ± 3.4	10.0 ± 3.8	24.7 ± 1.1	14.4 ± 1.7
Total	68	92.7 ± 5.1	17.3 ± 1.2	23.7 ± 2.4	11.4 ± 2.2	25.3 ± 1.1	15.0 ± 1.2

Note. Possible scores: t-ACE 0-100; attention 0-18; memory 0-26; fluency 0-14; language 0-26; visuospatial 0-16.

Education

There was a relationship between education and performance on the t-ACE and many of its subtests. There was a statistically significant relationship between education levels and the total t-ACE score, $F(2, 79) = 15.98$, $p < 0.001$, $\eta_p^2 = 0.42$, attention subtest, $F(2, 79) = 3.75$, $p = 0.03$, $\eta_p^2 = 0.10$, memory subtest, $F(2, 79) = 5.86$, $p = 0.004$, $\eta_p^2 = 0.15$ and verbal fluency, $F(2, 79) = 14.67$, $p < 0.001$, $\eta_p^2 = 0.38$. The relationship between t-ACE score and educational groups remained significant when age was controlled for, $F(2, 79) = 18.99$, $p < 0.001$. Post hoc analysis revealed that the difference was significant between those with a university degree ($M = 95.9$, $SD = 3.5$) and the ones with secondary or elementary education ($M = 90.2$, $SD = 4.5$, $M = 90.5$, $SD = 5.2$), $p = 0.01$. There was not a significant difference in performance between participants with either secondary or elementary education, $p = 0.95$.

Regression analysis identified a correlation coefficient between years of education and t-ACE score of $R = 0.54$ (see Figure 2). Number of years in education significantly predicted t-ACE scores, $\beta = .54$, $t(79) = 5.66$, $p < .001$. Number of years in education also explained a significant proportion of the variance in t-ACE scores, $R^2 = .29$, $F(1, 79) = 32.08$, $p < .001$.
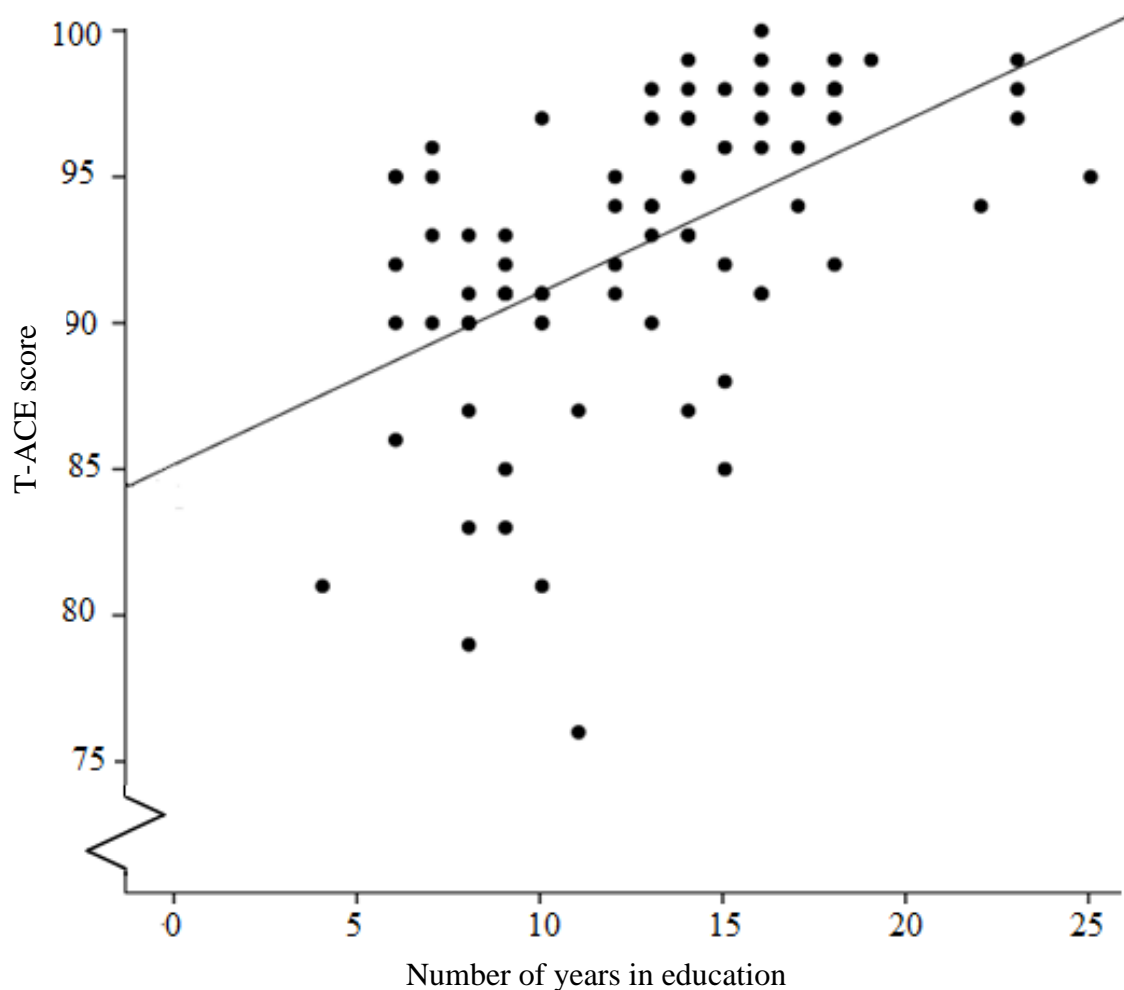

Figure 2. Relationship between numbers of years of education and total t-ACE-score.

Norms

Table 3 shows the percentiles of the performance on both the subtests of the t-ACE and total t-ACE score. Since there was a statistical difference in performance on the t-ACE between educational levels, education specific percentile norms are reported in Table 4.

Table 3.

Percentile norms for the total ACE scores and t-ACE subtests.

	Percentile						
	5	10	25	50	75	90	95
t-ACE	81.1	85.1	90	93	97	98	99
Attention	14.1	15	17	18	18	18	18
Memory	19	21	22	24	26	26	26
Fluency	7	8	10	12	13	14	14
Language	23	24	25	26	26	26	26
Visuospatial	12.1	13	15	15	16	16	16

Table 4.

Percentile norms for t-ACE scores by educational level.

	Percentile						
Education	5	10	25	50	75	90	95
Elementary school	79.7	82.4	90.0	91.0	93.0	95.0	96.7
Secondary school	76.5	81.8	87.5	92.0	94.0	96.6	97.9
University education	86.4	91.0	94.5	97.0	98.0	99.0	99.3

Discussion

The aim of the study was to analyze normative data on the Icelandic version of the ACE-III in order to assess the effect age and education had on performance in the test. The results revealed a slight difference in performance between age groups that became insignificant when education was controlled for. Those with higher education did perform significantly better on the

t-ACE compared to those with elementary or secondary education concluding that the second

hypothesis of how t-ACE score should be higher for those with more education was supported.

The primary hypotheses of how the t-ACE scores should be adversely affected by age was

neither supported nor rejected.

When the sample in this study was compared to normative data in other countries, similar

results were observed. A search through Web of Knowledge revealed that the ACE had been

standardized in at least 22 countries, of which the author of this study had access to 17 articles

(see Table 5). The average size of the studies' normative samples was 95.4 and the median was

69 participants, similar to the size in this study. The weighted average for the total ACE-score

was 81.1, which is surprisingly low for normative data. However, this average was severely

skewed by the low average and large sample in the Malayan standardization. When that study

was excluded, the weighted average was 89.0. Similar findings were observed when the

Icelandic normative data were compared to normative data in other countries. The age in all the

studies ranged from 41 to 93, with a weighted average of 68.77. The Icelandic sample, with a

mean age of 73.5 had a higher average age than the majority of previous studies. The Icelandic

sample was the fourth highest educated with an average of 12.7 years of schooling, a

considerably higher mean than the weighted average from all other studies of 10.7 years.

Furthermore the Icelandic mean t-ACE score was in the highest quartile of ACE mean scores and

was comparable to what was observed in samples with a similar educational status. Although the

coefficient of the test ($\alpha = 0.73$) was lower than was observed in other ACE studies (García-

Caballero et al., 2006; Kwak, Yang, & Kim, 2010), according to Nunnally, a Cronbach's alpha

coefficient above 0.6 is sufficient during preliminary work with a scale or a test (as cited in

Field, 2013). Furthermore according to Neuendorf (2011), tests that assess a multidimensional

construct, such as the t-ACE, should not have an alpha coefficient that is too high since a high

Cronbach's alpha indicates unidimensionality.

Table 5.

Mean and standard deviation of age, numbers of years in education, MMSE score and ACE score for normative samples for the standardization of ACE in various countries.

Country	Reference	Age	Education	MMSE	ACE
Iceland $n = 80$	NA	73.5 ± 5.1	12.7 ± 4.7	28.6 ± 1.4	92.7 ± 5.1
Denmark $n = 63$	Stokholm et al., 2009	70.3 ± 6.2	12.9 ± 2.5	29.5 ± 1.2	93.1 ± 4.6
Malaysia $n = 488$	Mathuranath et al., 2007	68.5 ± 7.1	7.9 ± 5.4	22.5 ± 5.1	66.8 ± 17.4
Spain $n = 72$	García-Caballero, 2006	72.6 ± 6.0	13.4 ± 3.0	28.0 ± 1.5	83.5 ± 7.4
Japan $n = 73$	Yoshida et al., 2012	66.3 ± 10.0	12.7 ± 2.3	29.0 ± 1.2	93.3 ± 3.9
Korea $n = 84$	Kwak, Yang, & Kim, 2010	67.8 ± 9.3	10.1 ± 4.1	28.0 ± 1.5	80.7 ± 6.0
Italy $n = 264$	Pigliautile et al., 2015	72.9 ± 8.0	9.7 ± 4.8	NA	NA
China $n = 51$	Fang et al., 2013	68.2 ± 8.2	11.8 ± 3.5	28.8 ± 1.1	87.6 ± 7.7
Lithuania $n = 94$	A. Rotomskis et al., 2015	67.0 ± 10.3	11.9 ± 2.9	NA	85.1 ± 7.2
Brazil $n = 21$	Carvalho & Caramelli, 2007	75.4 ± 7.1	8.5 ± 4.3	26.9 ± 2.2	83.3 ± 10.0
UK $n = 63$	Mioshi et al., 2006	64.5 ± 5.7	12.7 ± 2.1	28.8 ± 1.3	93.7 ± 4.3
Peru $n = 70$	Herrera-Pérez et al., 2013	68	11	29	94
Chile $n = 45$	Muñoz-Neira et al., 2012	73.7 ± 7.5	13.1 ± 4.6	27.8 ±2.3	89.1 ± 9.1

Table 5.

Continued.

Country	Reference	Age	Education	MMSE	ACE
Belgium $n = 30$	Bier et al., 2005	60.9 ± 10.6	NA	29.2 ± 1.0	91.4 ± 5.5
Germany $n = 76$	Alexopoulos et al., 2010	69.6 ± 7.5	11.8 ± 2.5	29.0 ± 0.7	90.4 ± 5.0
Greece $n = 60$	Konstantinop oulou et al., 2011	66.2 ± 9.0	10.6 ± 4.2	NA	NA
Iran $n = 71$	Pouretemad et al., 2009	58.3 ±10.6	10.30 ± 3.8	27.8 ± 4.8	90.6 ± 4.8
Portugal $n = 38$	Gonçalves et al., 2015	77.0 ± 6.9	5.6 ± 2.8	28.7 ± 1.3	82.1 ± 1.3

Within the literature, findings differ on whether and how much of an effect age has on performance in the ACE. The findings of this study are in line with studies that did not detect a strong effect (García-Caballero et al., 2006; Mioshi et al., 2006) and only revealed a slight negative relationship between age and ACE score that became insignificant when education was controlled for. Although studies differ concerning this relationship a large majority of the studies reveal an age-effect (dos Santos Kawata et al., 2012; Pigliautile et al., 2015; Robben et al., 2010; Rotomskis et al., 2015; Yoshida et al., 2012) and therefore the findings of this study are not in line with what would be expected. The findings of the current study as well as those that did not reveal an age effect should be taken with caution. Both studies that revealed no age effect, did not specify the age range and a narrow age range poses limitation on the interpretation of the results. In this study, educational levels were not evenly distributed between the age groups and that might have skewed the results. It should be noted however, that the studies that identified an

age effect did not control for education which might have exaggerated the relationship between age and ACE-score.

The relationship between age and ACE is well acknowledged in the literature but the current study failed to detect a strong age effect. The study did however reveal a strong education effect, findings that contrast the general lack of discussion education has received in most previous research (Crawford et al., 2012). The findings of this study are however, not without a precedent and a few studies have indicated that education has a large effect on performance in the ACE (García-Caballero et al., 2006, Jubb & Evans, 2015, Mathuranath et al., 2007). The strength of the relationship gives rise to the notion that perhaps education stratified cut-off scores would be optimal. In this study there was not only a strong correlation between years of schooling and performance in the test but individuals with a university degree performed better than those less educated. Furthermore, the percentile norms for those with a university degree were considerably higher than the norms for the other groups. The large effect size of education on t-ACE score ($\eta_p^2 = 0.42$) highlights the importance of education stratified cut-off scores.

As mentioned above, education was not evenly distributed between age groups which posed limitations on the study. Other limitations were that individuals with elementary and secondary education were underrepresented and since the study used a convenience sample, selection bias posed a threat to external validity. The size of the sample puts constraint on the interpretation of the education stratified norms. However, this study is a part of an ongoing project and is only the first part of the normative data collection. Therefore the limitations of the study are expected to be minimized with a larger and more representative sample. Although the limitations must be taken into account the present study has several strengths. The sample size is

decent for a normative data analysis, the participants were older than seen in many other studies and the study gave a clear insight to the relationship between education and t-ACE performance. Furthermore these preliminary results give good promise for the ongoing validation of the t-ACE and confirm that the translation of the test is adequate.

The importance of the research lies first and foremost in its clinical and research value. The availability of normative data for the t-ACE will be beneficial to clinicians using the screening instrument as well as for those conducting geriatric research. The next steps would be to further examine the relationship between demographic factors, such as age and education, and performance on the t-ACE score, in pursuance of reducing ambiguity on the matter. In the upcoming months the normative data sample will be extended and compared to an affected population in order to develop Icelandic cut-off scores as well as education stratified cut off scores. The availability of an Icelandic standardization of the ACE-III is expected to be a valuable addition to the current measures available to assess cognitive impairment.

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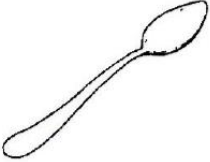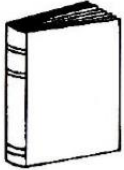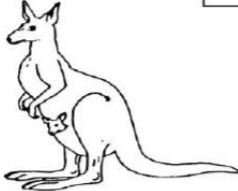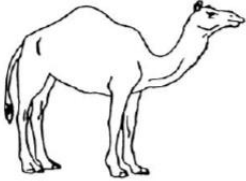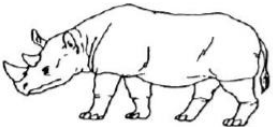
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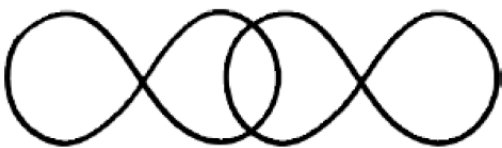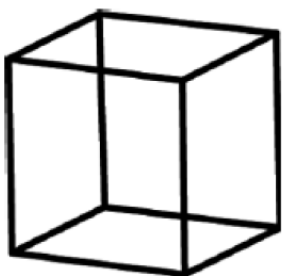
Appendix A
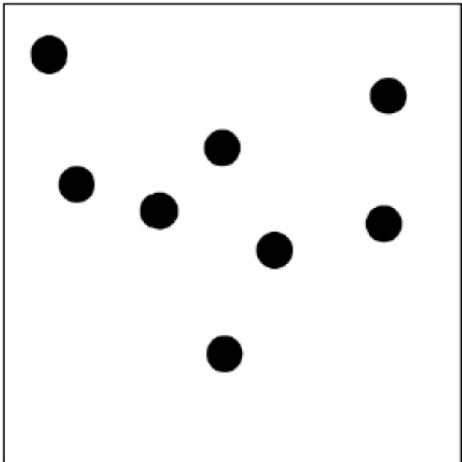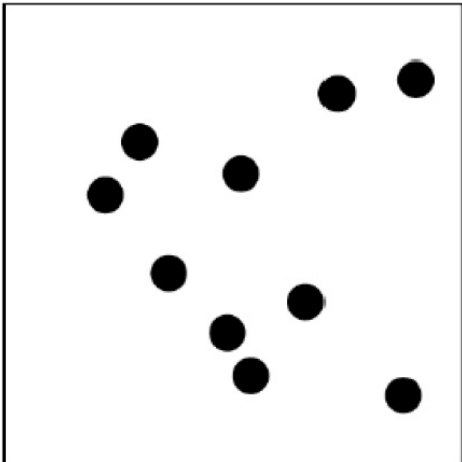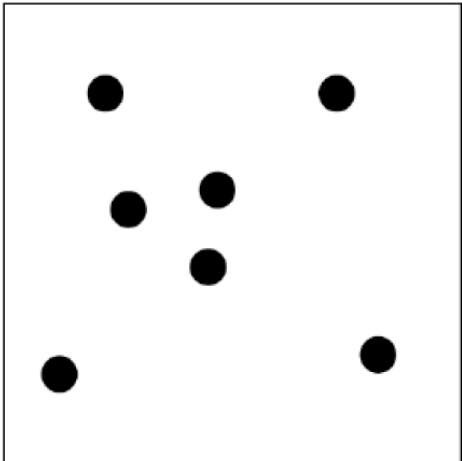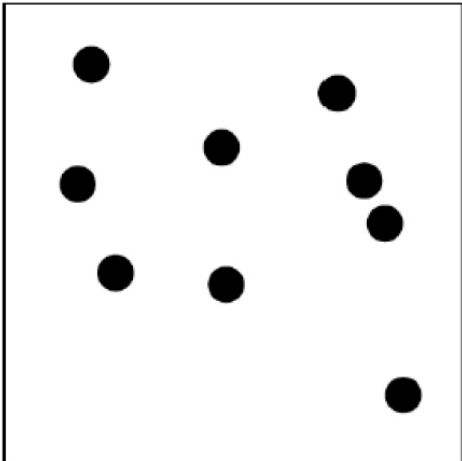
ADDENBROOKE: MAT Á HUGRÆNNI FÆRNI – ACE-III
(Íslensk útgáfa: María K. Jónsdóttir og Brynhildur Jónsdóttir, gerð með leyfi höfunda, 2015)

Nafn:	Prófunardagur:
Fæðingardagur:	Prófandi:
Deild / heimilisfang:	Aldur þegar hætti í skóla/í fullu námi:
	Starf:
	Ríkjandi hendi:

ATHYGLI   *(Legðu saman feitletruð atriði fyrir M-ACE)

➢ Spurðu: Hvaða	**vikudagur er?**	**mánaðardagur er?**	**mánuður er?**	**ár er?**	**árstíð er?**	Athygli (skor 0-5)* ☐
➢ Spurðu um:	Húsnúmer/hæð	Götu/spítala	Borgarhluta	Landshluta	Land	Athygli (skor 0-5) ☐

ATHYGLI

➢ Segðu: „ **Ég ætla að segja þrjú orð og ég ætla að biðja þig um að endurtaka þau þegar ég er búin að segja þau: epli, kvöld og bíll.**" ➢ Eftir að prótaki endurtekur skaltu segja: „ **Reyndu að muna þessi orð, ég ætla að biðja þig um að endurtaka þau síðar.**" ➢ Skoraðu *einungis* fyrstu tilraunina (endurtaktu þrisvar ef nauðsynlegt er). ➢ Skráðu fjölda tilrauna: _____	Athygli (skor 0-3) ☐

ATHYGLI

➢ Spurðu próftaka: „ **Dragðu 7 frá 100 og segðu mér svarið.** " Segðu svo: „ **Mig langar að biðja þig um að halda áfram að draga 7 frá hverri nýrri tölu þangað til ég segi þér að hætta.** " ➢ Ef próftaki gerir mistök skaltu ekki stoppa hann. Láttu hann halda áfram og gefðu fyrir næstu svör (t.d. 93, 84, 77, 70, 63 – gefðu 4 stig). ➢ Hættu eftir 5 frádrætti (93, 86, 79, 72, 65): _____	Athygli (skor 0-5) ☐

MINNI

➢ Spurðu: „ **Hvaða 3 orð bað ég þig um að endurtaka og muna?**" _____ _____ _____	Minni (skor 0-3) ☐

ORÐAFLÆÐI

➢ **Stafir**
Segðu: „ **Ég ætla að segja bókstaf og biðja þig svo um að segja eins mörg orð og þú getur sem byrja á þessum bókstaf. Ekki segja mannanöfn eða nöfn á stöðum. Til dæmis, ef ég segi stafinn K gætirðu sagt köttur, kremja, klukka og svo framvegis. En þú mátt ekki segja orð eins og Katrín eða Kanada. Áttarðu þig á þessu? Ertu tilbúin(n)? Þú færð eina mínútu. Stafurinn sem ég vil að þú notir er S.**"

Orðaflæði (skor 0-7) ☐

Alls	Skor
≥ 18	7
14-17	6
11-13	5
8-10	4
6-7	3
4-5	2
2-3	1
0-1	0

➢ **Dýr**
Segðu: „ **Nú ætla ég að biðja þig um að nefna eins mörg dýr og þú getur. Þau mega byrja á hvaða staf sem er.**"

Orðaflæði (skor 0-7) ☐

Alls	Skor
≥ 22	7
17-21	6
14-16	5
11-13	4
9-10	3
7-8	2
5-6	1
< 5	0

MINNI				
➢ Segðu: „ Nú ætla ég að segja þér nafn og heimilisfang sem ég ætla svo að biðja þig um að endurtaka. Svo þú fáir tækifæri til að læra þetta, gerum við þetta þrisvar sinnum. Ég spyr þig svo aftur síðar um nafnið og heimilisfangið." Skoraðu bara 3. tilraunina.				Minni (skor 0-7) ▨ ☐

	1. tilraun	2. tilraun	3. tilraun
Helgi Bjarnason Hólsvegur 73 Eskifjörður Fjarðarbyggð	_____ _____ __ _____ _____ _____	_____ _____ __ _____ _____ _____	_____ _____ __ _____ _____ _____

MINNI	
➢ Hvað heitir núverandi forsætisráðherra? _____ ➢ Hvað heitir eina konan sem gegnt hefur stöðu forsætisráðherra?_+_____ ➢ Hvað heitir forseti Bandaríkjanna?_____ ➢ Hvað hét forseti Bandaríkjanna sem var myrtur árið 1963? _____	Minni (skor 0-4) ☐

MÁL	
➢ Segðu: „Ég ætla að gefa þér fyrirmæli varðandi blýantinn og blaðið. Hlustaðu vandlega á það sem ég segi og fylgdu svo fyrirmælunum nákvæmlega. Hlustaðu vel, ég má ekki endurtaka fyrirmælin." ➢ Settu blýant og blað fyrir framan próftaka. Sem æfingu segðu: „Taktu upp blýantinn og svo blaðið." Ef þetta er rangt skoraðu 0 og hættu við þessa spurningu. ➢ Ef próftaki gerir æfinguna rétt haltu áfram með fyrirmælin þrjú hér fyrir neðan. 　• Segðu við próftaka: „Settu blaðið ofan á blýantinn." 　• Segðu við próftaka: „Taktu upp blýantinn en ekki blaðið." 　• Segðu við próftaka: „Réttu mér blýantinn eftir að hafa snert blaðið." 　• Athugið: Settu blýantinn og blaðið fyrir framan prófaða fyrir hver fyrirmæli.	Mál (skor 0-3) ☐

MÁL	
➢ Segðu: „Ég ætla að biðja þig um að skrifa tvær setningar. Þær geta verið um hvað sem þú vilt. Skrifaðu fullgildar setningar og notaðu ekki skammstafanir." Ef próftaki veit ekki hvað hann á að skrifa um getur þú stungið upp á nokkrum efnum. „Þú gætir t.d. skrifað um nýlegt frí, um áhugamál þín, fjölskyldu þína eða barnæsku". Ef próftaki skrifar bara eina setningu, biddu um aðra. Setningar verða að hafa frumlag og sagnorð. Dregið er frá fyrir ranga stafsetningu og málfræði. Setningarnar þurfa ekki að vera um sama efni. Sjáið frekari upplýsingar í skorunarleiðbeiningum.	Mál (skor 0-2) ☐

MÁL	
➢ Segðu: „Nú ætla ég að biðja þig um að endurtaka orð." ➢ Biddu próftaka að endurtaka: **'ánamaðkur; 'svæðisskipulag; 'eftirsóknarverður; 'starfsmannafélag** Gefðu 2 stig ef allt er rétt, gefðu 1 stig ef 3 eru rétt og gefðu 0 stig ef 2 eða færri eru rétt.	Mál (skor 0-2) ☐

MÁL	
➢ Segðu: „Nú ætla ég að biðja þig um að endurtaka setningar.“ ➢ Biddu próftaka að endurtaka: „Ekki er allt gull sem glóir“	Mál (skor 0-1) ☐
➢ Biddu próftaka að endurtaka: „Ekki er ráð nema í tíma sé tekið“	Mál (skor 0-1) ☐

MÁL	
➢ Biddu próftaka að nefna eftirfarandi myndir:	Mál (skor 0-12) ☐

MÁL	
➢ Notaðu myndirnar hér fyrir ofan og biddu prófaða um að: • Benda á það sem tengist einveldi _____ • Benda á það sem er pokadýr _____ • Benda á það sem finnst á suðurskautinu _____ • Benda á það sem tengist sjómennsku _____	Mál (skor 0-4) ☐

MÁL

➤ Biddu prófaða að lesa eftirfarandi orð (gefa 1 stig einungis ef allt er rétt)

agi

tefla

töng

trylla

rigndi

Mál (skor 0-1)

☐

SJÓNRÝMDARGETA

➤ Áttur: Biddu prófaða að kópíera þessa teikningu.

Sjónrýmd (skor 0-1)

☐

➤ Kubbur: Biddu prófaða að kópíera þessa teikningu (sjá skorunarleiðbeiningar í leiðbeiningabækling).

Sjónrýmd (skor 0-2)

☐

➤ Klukka: Biddu prófaða að teikna klukkuskífu með tölustöfum. Biddu síðan prófaða um að setja vísana á 10 mínútur yfir 5. (Sjá skorunarleiðbeiningar í leiðbeiningabækling: Hringur = 1, tölustafir = 2, vísar = 2 ef allt rétt).

Sjónrýmd (skor 0-5)

☐

SJÓNRÝMDARGETA

Sjónrýmd (skor 0-4)

➢ Biddu prófaða að telja punktana án þess að benda á þá

SJÓNRÝMDARGETA

Sjónrýmd (skor 0-4)

➤ Biddu prófaða að tilgreina bókstafina

MINNI

➤ Segðu: „**Segðu mér hvað þú manst af nafninu og heimilisfanginu sem við endurtókum í byrjun.**"

		Minni (skor 0-7)
Helgi Bjarnason Hólsvegur 73 Eskifjörður Fjarðarbyggð	....	▢ ▢

MINNI

➤ Þetta próf á að gera ef prófaði mundi ekki eitt eða fleiri atriði hér fyrir ofan. Ef hann mundi allt á að sleppa þessu og gefa 5 stig. Ef hann mundi bara hluta byrjaðu á að merkja við þau atriði í skyggðu reitunum sem hann mundi og prófaðu síðan það sem ekki var munað með því að segja: „**Ég gef þér vísbendingar; var nafnið X, Y eða Z?**" og svo framvegis. Fyrir hvert atriði sem prófaði þekkir fæst eitt stig sem er lagt saman við það sem þegar var rifjað upp.

Minni (skor 0-5) ▢

Egill Björnsson	Helgi Bjarnason	Helgi Baldursson	Munað	
Hólsstræti	Hólsvegur	Hjallavegur	Munað	
37	76	73	Munað	
Reyðarfjörður	Eskifjörður	Stöðvarfjörður	Munað	
Fjarðabyggð	Breiðdalshreppur	Fljótdalshérað	Munað	

SKOR

	ACE-III alls	/100
	M-ACE sko alls	/30
	Athygli	/18
	Minni	/26
	Orðflæði	/14
	Mál	/26
	Sjónrýmd	/16

Appendix B

Samþykkisyfirlýsing

Addenbrook prófið fyrir iPad (*ACE-III mobile*): Íslensk þýðng, staðfæring og normasöfnun.

Þátttaka í rannsókninni felst í að taka ACE-III, sem er nýtt skimunarpróf fyrir hugræna getu á íslensku, og MMSE sem er það skimunarpróf sem nú er mest notað hérlendis. Í prófunum eru spurningar sem reyna á minni, athygli, mál og sjón. Kyn, aldur, menntun og aðalstarf verða skráð á svarblöð en engar persónugreinanlegar upplýsingar (s.s. nafn, heimilsfang og kennitala). Það tekur í mesta lagi 30 mínútur að svara spurningunum. Engin áhætta fylgir rannsókninni.

Ég staðfesti hér með undirskrift minni að ég hef lesið upplýsingarnar um rannsóknina sem mér voru afhentar og hef fengið tækifæri til að spyrja rannsakendur spurninga um rannsóknina og fengið fullnægjandi svör og útskýringar á atriðum sem voru óljós.

Ég hef af fúsum og frjálsum vilja ákveðið að taka þátt í rannsókninni. Mér er ljóst, að þó ég hafi skrifað undir þessa samstarfsyfirlýsingu, get ég hætt við þátttöku hvenær sem er án útskýringa og án áhrifa á þá læknisþjónustu sem ég á rétt á í framtíðinni.

_____

Dagsetning

_____

Nafn þátttakanda

Undirritaður, starfsmaður rannsóknarinnar, staðfestir hér með að hafa veitt upplýsingar um eðli og tilgang rannsóknarinnar, í samræmi við lög og reglur um vísindarannsóknir.

_____

Nafn ábyrgðarmanns: MARÍA K. JÓNSDÓTTIR

Nafn þess sem leggur samþykkisyfirlýsinguna fyrir: Una Sólveig Jóakimsdóttir / Brynhildur Jónsdóttir

Bréf þetta er í tvíriti, eitt fyrir þátttakanda og eitt fyrir rannsakanda.

Appendix C

Addenbrook prófið fyrir iPad (*ACE-III mobile*): Íslensk þýðng, staðfæring og normasöfnun.

Upplýsingar um rannsókn

Með auknum fjölda aldraðra í samfélaginu verður greining minnissjúkdóma meira aðkallandi og mikilvægt er að greining fari fram snemma. Þá er hægt að grípa inn í með meðferð og með því að veita sjúklingum og aðstandendum upplýsingar. Mikilvægur þáttur í greiningu er prófun á hugrænni getu.

Þessi rannsókn felst í að þýða og staðfæra hugrænt skimunarprófi sem heitir Addenbrooke skimunarprófið (ACE-III). Í því eru spurningar sem reyna á minni, athygli, mál og sjón. Prófið verður lagt fyrir 80 einstaklinga, 65 ára og eldri, til að safna íslenskum viðmiðunargildum. Þannig vitum við hvað telst vera eðlileg frammistaða á prófinu og hvað ekki og vitum hvað á að miða við þegar sjúklingar eru metnir.

Þátttaka í rannsókninni felst í að taka ACE-III og MMSE sem er það skimunarpróf sem nú er mest notað hérlendis. Kyn, aldur, menntun og aðalstarf verða skráð á svarblöð en engar persónugreinanlegar upplýsingar (s.s. nafn, heimilisfang, kennitala). Það tekur í mesta lagi 30 mínútur að svara spurningunum. Engin áhætta fylgir rannsókninni. Helsti ávinningur rannsóknarinnar er að læknar, hjúkrunarfræðingar og sálfræðingar fá til afnota próf sem er næmt fyrir byrjandi minnishrörnun meðal eldri borgara.

Ef þú ákveður að leggja okkur lið með því að taka þátt í rannsókninni skal tekið fram að þú getur hætt við hvenær sem er. Hvort sem þú ákveður að taka þátt eða ekki breytir það í engu þeirri meðferð sem þú eða aðstandandi þinn kann að fá á Minnismóttökunni á Landakoti. Ekkert er greitt fyrir þátttöku.

Þú þarft ekki að gefa upplýsingar um heilsufar þitt í þessari rannsókn en við viljum taka fram að þeir sem hafa fengið heilaáverka í slysi, hafa greindan heilasjúkdóm (t.d. MS, Parkinson) eða hafa fengið heilablóðfall geta ekki tekið þátt.

Rannsóknin var samþykkt af Vísindasiðanefnd þann 9. júní 2015 (nr. VSN-15-084).

Öll rannsóknargögn verða varðveitt leyndarmerkt á öruggum stað hjá ábyrgðarmanni á meðan á úrvinnslu þeirra stendur og unnin án persónuauðkenna. Öllum rannsóknargögnum verður eytt að lokinni úrvinnslu og eigi síður en fimm árum eftir rannsóknarlok.

Ábyrgðarmaður rannsóknarinnar er María K. Jónsdóttir taugasálfræðingur á Minnismóttöku Landakoti og dósent við sálfræðisvið Háskólans í Reykjavík. Aðrir rannsakendur eru Brynhildur Jónsdóttir, M.S. í sálfræði, sérhæfður starfsmaður í taugasálfræði á Landakotsspítala og Una Sólveig Jóakimsdóttir, sálfræðinemi við Háskólann í Reykjavík sem hefur starfað á Landakotsspítala. Starfsmenn rannsóknarinnar hafa þagnarskyldu um allt sem fram kemur.

Ef þú hefur spurningar skaltu ekki hika við að spyrja þeirra áður en þú ákveður þig. Það að spyrjast fyrir um rannsóknina með símtali eða tölvupósti, þýðir ekki að fyrirspyrjandi hafi ákveðið að taka þátt heldur er einungis verið að kynna sér rannsóknina.

Með von um góðar undirtektir,   María K. Jónsdóttir, ábyrgðarmaður