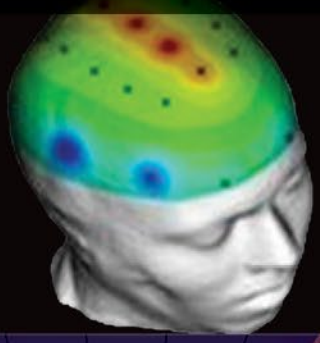
BRAIN RESOURCE DATABASE OVERVIEW 2017

ASSESSMENT

TRAINING NEW HABITS

GENETICS

EEG



MRI

DATA ANALYTICS

BRAIN RESOURCE DATABASE OVERVIEW 2017

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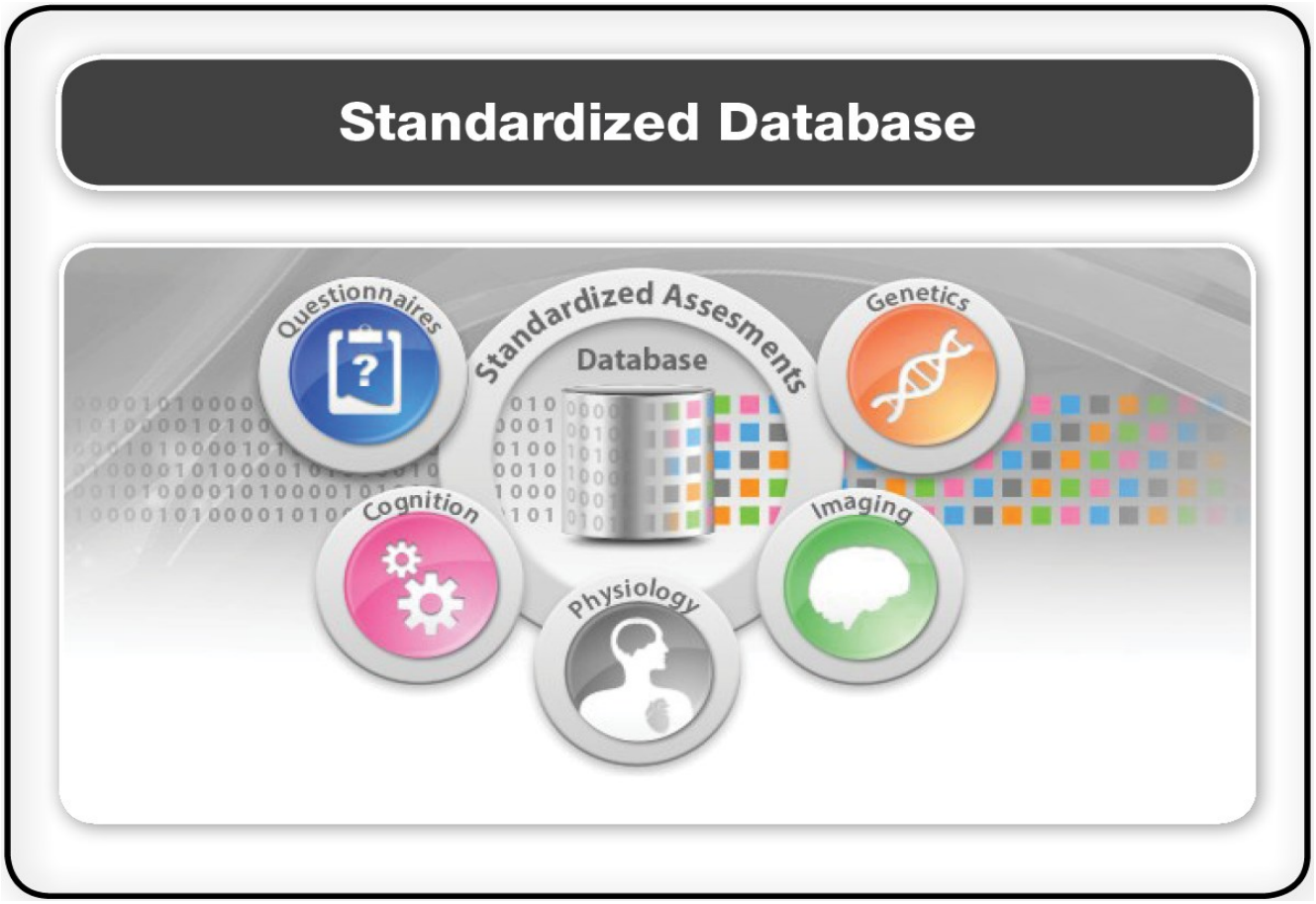
DATABASE SNAPSHOT

The Brain Resource International Database contains over 1,000,000 standardized datasets.

In addition, users have engaged in over 16 million online brain training exercises and games.

This is likely to escalate exponentially in 2017 as the current large clients (including Boeing; Kaiser; AARP) increase adoption and the mobile version goes live this month.

This includes cognitive performance, questionnaires, brain training, genomics, EEG, and structural and functional MRI. These come from a range of employees, over 20 clinical groups and matched controls.



Below is a snapshot of the datasets in the database. One dataset is equivalent to 1 cognitive battery (with several tests); 1 set of questionnaires done in a single sitting; or 1 of the any other assessments.

Database Cognition, Genetic and Brain Measures:

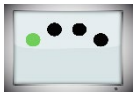
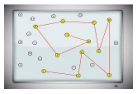
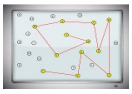
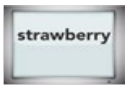
	TOTAL	Cognition (touchscreen)	Cognition (keyboard & mouse)	Questionnaires	Brain training	EEG	Genomic	MRI
Core seeding cohorts:								
Normative	**15,365**	3,333	1,317	4,889		3,563	1,788	475
Clinical	**4,094**	925	942	958		958	244	67
BRID additional:								
Normative	**736,937**	1,786	243,908	277,835	228,358			
Clinical	**208,222**	40,437	67,881	101,554	9,074			
EEG additional	**~100,000**	~35,000		~15,000		~50,000		
TOTAL:	**1,064,618**							

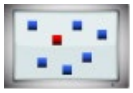
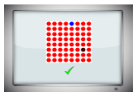
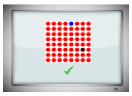
The approximately **100,000 additional datasets** of EEG recordings with accompanying cognitive and questionnaire data for a range of normative and clinical groups.

DATA TYPES

DATA TYPES

Cognition tests detail

Capacity assessed	What is measured	Equivalent traditional tasks	Computer: Toucshcreen console	Computer: Keyboard & mouse	Mobile devices
Motor Coordination Psychomotor response speed	Total number of taps Variability of pauses between taps	Finger tapping			
Processing Speed Speed of sensori-motor function and information processing	Average response time Variability of response times	Corsi Blocks			
Time Estimation Accurate estimation of time duration	Proportional bias (difference between estimated and real time			-	-
Sustained Attention Sustained attention and concentration	Accuracy Type of errors Response time	n-back, TOVA, Adaptive Rate Continuous Performance Test			
Controlled Attention Inhibiting one piece of well-learned information in order to focus on another or new aspect	Total number of correct 'color' responses (e.g. selecting 'blue') Total number of incorrect 'word' responses (e.g. selecting 'red')	Stroop Test			
Flexibility Information processing efficiency	Completion time Errors	Trails Making			
Inhibition Balance between impulsivity and response inhibition	Accuracy Type of errors Response time				
Working Memory Short-term working memory capacity (Numeric)	Total number of digits recalled (forwards and reversed recall task versions)	WAIS-III Digit Span			
Verbal Memory Verbal learning, immediate and delayed memory recall	Number of words remembered Number of intrusions (incorrect words selected); Learning rate	Rey Auditory Verbal Learning Test, California Verbal Learning Test			

Visual Memory Short-term working memory capacity (Visuo-spatial)	Total number of locations recalled			-	-
Spot the Word Estimated IQ	Accuracy		 		-
Word Generation Verbal and Semantic Fluency	Number of words generated	FAS; Controlled Oral Word Test (COWAT)		-	-
Maze Monitoring and using feedback to adjust and organize responses	Total and overrun errors Completion time Total trials	Austin Maze	 		
Emotion Identification Explicit identification of expressions of facial emotion	Accuracy for each emotion Response time for each emotion	Penn Emotion Test	 		
Emotion Bias Automatic encoding of basic facial expressions	Accuracy for each emotion Response time for each emotion		 		

Core questionnaires

In addition to the main aspects of cognition (thinking and emotion), a short set of questionnaires are presented as part of the cognitive test battery, to assess core aspects of feeling and self-regulation assessed.

Main Assessment Markers			
Thinking	***Emotion***	***Feeling***	***Self Regulation***
Motor Coordination	Emotion Identification	Depressed Mood	Negativity Bias
Processing Speed	Emotion Bias	Anxiety	Resilience
Sustained Attention		Stress	Social Capacity
Controlled Attention			
Flexibility			
Inhibition			
Working Memory			
Recall Memory			
Executive Function			

The statistical reliability and validity of these assessments has been established in several studies.

Test-retest reliability

Test-retest reliability has been established in three separate study samples. For the computer touchscreen delivery, in 336 participants across 8 weeks for the iSPOT-D healthy control sample, and in a separate study of 148 healthy participants across an average of 8 weeks (iSPOT-D study sample statics reported here). For the computer keyboard and mouse version, in a naturalistic sample 1,980 participants across an average of 8 weeks, as part of its embedding within the employee health programs of corporate organizations.

Cross-platform reliability

The tasks show cross-platform reliability between the touchscreen and keyboard & mouse delivery platforms. 50 healthy participants (56% female; 18-55 years) completed both delivery platform versions of the cognitive assessment , in a counter-balanced design within a single testing session. Results are published in Silverstein et al. (2007). Analyses used Pearson correlations, with standard correction for restriction of range in the scores. Results indicated strong comparability across the two batteries, in terms of individual task scores as well as an overall performance score (overall r=0.86). Cross-platform reliability between the keyboard & mouse and mobile device versions has also been established in a study of 31 healthy participants (48% female; 21-66 years) who completed cognitive tasks on keyboard & mouse, touchscreen tablet and touchscreen smartphone platforms.

Parallel forms reliability

1. The cognitive assessment battery uses parallel forms of tasks as a built-in method of controlling for practice effects with repeat testing. Parallel forms have been established using standardized criteria and test rules. The test-retest reliability of 6 parallel forms of the assessment have been established in 32 healthy adult males, who were assessed across 6 days completing a different parallel form of the assessment on each day. Intra-class correlation coefficients demonstrate a high overall level of parallel forms reliability (0.84), with almost all individual measures above 0.80.

Construct validity

The cognitive assessment battery has been validated against previously established "paper and pencil" neuropsychological tasks in 50 healthy adults, and published in Paul et al., 2005. Tasks evaluating emotional functioning are more recent, and do not have available the equivalent established "pencil and paper" versions for validation. Instead, the construct validity of the emotion tests have been typically established by validating the content of the stimuli. The stimulus set used in the current test battery are taken from an independently validated and standardized set of facial emotion images (Gur et al., 2002). In addition, performance data from the two emotional cognition tests has been factor analyzed, the results of which confirm the internal construct validity of the task and the measure sets of accuracy and speed that are derived from it. The results show that 4 of the factors derived represent the accuracy and response time for the Explicit Emotion Identification and Delayed Emotion Recognition tasks across emotions (Mathersul et al.,2009).

References

Gur, R.C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., et al., (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods, 115,* 137-143.

Mathersul, D., Palmer, D.M., Gur, R.C., Gur, R.E., Cooper, N. Gordon, E., & Williams, L.M. (2009). Explicit identification and implicit recognition of facial emotions: II. Core domains and relationships with general cognition. *Journal of Clinical and Experimental Neuropsychology, 31*(3): 278-291.

Paul, R. H., Lawrence, J., Williams, L. M., Richard, C. C., Cooper, N., & Gordon, E. (2005). Preliminary validity of "integneuro": a new computerized battery of neurocognitive tests. *International Journal of Neuroscience, 115*(11), 1549-1567.

Silverstein, S. M., Berten, S., Olson, P., Paul, R., Willams, L. M., Cooper, N., & Gordon, E. (2007). Development and validation of a World-Wide-Web-based neurocognitive assessment battery: WebNeuro. *Behavior Research Methods, 39*(4), 940-949.

Additional questionnaires:

Several additional questionnaires form part of selected versions of the assessment battery. These include the following:

Disposition: Personal Details

- Demographics, (10 questions on DOB, sex, country of birth, marital status, height, weight, occupation, education x 2, ethnic origins)
- Handedness (Annett's Handedness Inventory, including items from Edinburgh Handedness Inventory, 15 questions)

Medical history and psychological measures
Medical

- Vision, hearing, mobility/dexterity, mobile phone use, learning/dyslexia, psychiatric/psychological, neurological, sleep x 2, eating, tobacco, alcohol, marijuana, recreational drugs, surgery, physical trauma) (16 trigger questions for optional sections 1 to 15)
- Axis-I symptoms (SPHERES and PHQ; 34 questions)
- Caffeine, Alcohol, Addictive Drugs (3 questions for harmful use)
- Prescription medications (5 questions x max. of 3 medications)

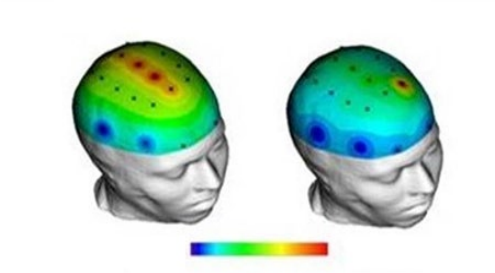
Feeling and Self Regulation: Wellbeing and Personality questions

- Depression Anxiety and Stress Scale-21 (21 questions, validated with PHQ-9, Beck Scales)
- Schizotypy Questionnaire (12 questions)
- Paranormal Belief (5 questions)
- BRIEF (Brain Resource Inventory of Emotional intelligence Factors; 14 questions)
- NEO-FFI (NEO-Five Factor Inventory, 60 item)
- BRISC (Brain Resource Inventory of Social Cognitions; 45 questions)

Environment: Stressors

- Early Life Stress (19 questions)
- Traumatic life events (11 trigger questions for optional sectional 16 on DSM trauma criteria)
- LifeStyle
- Nutrition
- WHOQoL
- PHQ-9

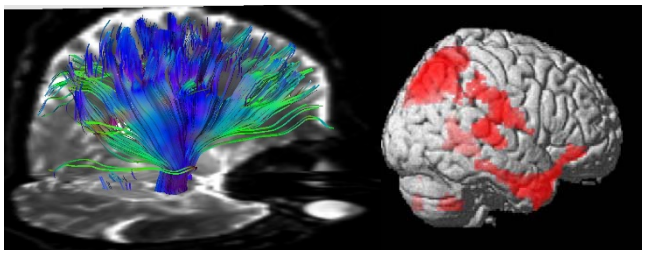
EEG recording types:



During the following 13 task conditions, EEG, startle response, heart rate and sweat rate data are recorded, as well as behavioral responses to the cognitive tasks:

1. Resting EEG (Eyes Open)
2. Resting EEG (Eyes Closed)
3. Auditory Habituation
4. Auditory Oddball
5. Go/No-Go
6. Visual Tracking
7. Letters Passive Primer
8. Continuous Performance Test (n-back)
9. Novelty task (embedded in #8)
10. Maze
11. Startle/Prepulse Inhibition
12. Emotion Processing (masked, nonconscious)
13. Emotion Processing (unmasked, conscious)

Structural and Functional MRI:

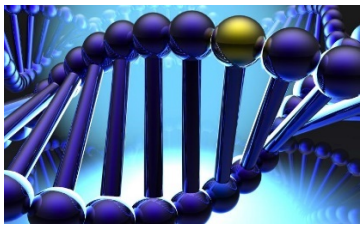


Structural scans include volumetric gray and white matter measures, as well as DTI connectivity.

The functional MRI test battery uses adapted versions of 4 of the same tasks as the EEG test battery. These tasks are also present in the standalone cognition batteries.

1. Go/No-Go
2. Continuous Performance Test (n-back)
3. Emotion Processing (masked, nonconscious)
4. Emotion Processing (unmasked, conscious)

Genomics:



Using saliva and blood collection, several hundred SNPs have been genotyped for subsets of both healthy normative and clinical cohorts.

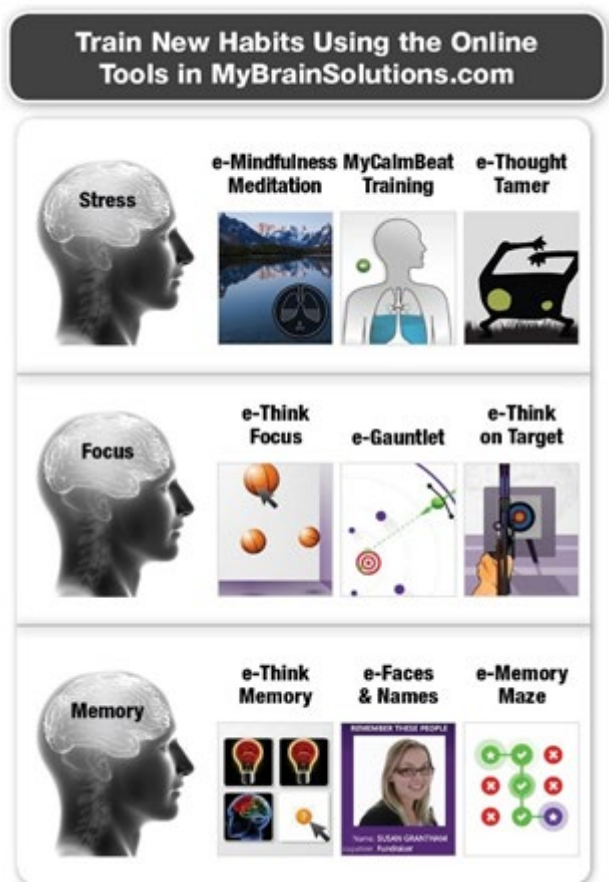
EXERICISES TO TRAIN NEW BRAIN HABITS

EXERCISES TO TRAIN NEW BRAIN HABITS

Brain training exercises and games:

Users have engaged in over 16 million games to date

MyBrainSolutions Personal Journeys



Association between Brain Health Score and Brain Training Exercises and Games:

●●● = very high, ●●○ = high, ●○○ = medium.

	e-Think Balance	Memory Maze	e-Think Focus	e-Think Memory	Gauntlet	e-Think On Target	e-Think Simon Says	e-Body Language Cues	Character Builder	Emotion Booster	Happy Seeker	Bubble Heads	e-Motion Wellbeing
	Thinking Games/Exercises							Emotion Games/Exercises					
Thinking													
Motor Coordination	●●○												
Processing Speed		●○○			●●●	●●●							
Sustained Attention	●●●	●●○	●●●	●●○	●●○	●●○	●●○	●○○	●○○	●○○			
Controlled Attention			●●○		●○○	●○○							
Flexibility	●●○												
Inhibition					●●●	●●●							
Working Memory		●●●		●●●	●○○	●○○	●●●						
Recall Memory				●●○			●●○						
Executive Function		●●○		●○○	●●●	●●●	●○○						
Emotion													
Identifying Emotions								●●●	●●●	●●●	●●○	●●○	●●○
Emotion Bias				●○○			●○○	●○○	●○○	●○○	●○○	●○○	●○○
Feeling													
Stress Level								●○○	●○○	●○○	●●○	●●○	●●○
Anxiety Level													
Depressed Mood Level											●○○	●○○	●○○
Self Regulation													
Positivity-Negativity Bias											●●○	●●○	●●○
Resilience													
Social Capacity								●●○	●●○	●●○			

	Bubble Topia	Word Smith	Emotion Match	e-Positive Spin	Expressions of Gratitude	Positive Affirmations	Relaxation Room	Thought Tamer	e-Faces and Names	Face Shifter	e-Positivity Puzzle	e-Self Regulate	e-EQ Tree of Life	MyCalmBeat Training	Positive Reflections
	Feeling Games/Exercises								Self Regulation Games/Exercises						
Thinking															
Motor Coordination															
Processing Speed														●○○	
Sustained Attention	●○○	●○○				●○○								●○○	●○○
Controlled Attention												●○○		●○○	
Flexibility												●○○		●○○	
Inhibition			●●○	●●○					●○○				●●○	●○○	
Working Memory									●●●						
Recall Memory									●●●						
Executive Function								●○○	●○○				●○○	●○○	
Emotion															
Identifying Emotions			●○○	●○○					●○○	●○○	●○○	●○○			
Emotion Bias	●○○														●○○
Feeling															
Stress Level	●●●	●●○	●○○	●○○	●●●	●●●	●●●	●●○				●○○		●●●	
Anxiety Level			●○○	●○○	●●○	●●○	●●○	●●●						●●●	
Depressed Mood Level	●●○	●●●	●●●	●●●	●●○	●●○	●●○	●●○		●●○	●●○	●●○		●○○	●●○
Self Regulation															
Positivity-Negativity Bias	●●●	●●●	●●○	●●○	●●●	●●●		●●●		●●●	●●●	●●●	●●●		●●●
Resilience	●●○	●●○			●●○	●○○	●○○	●●●		●○○	●○○	●●●	●○○	●●●	●●○
Social Capacity					●○○				●●●	●●○	●●○	●○○	●●○		

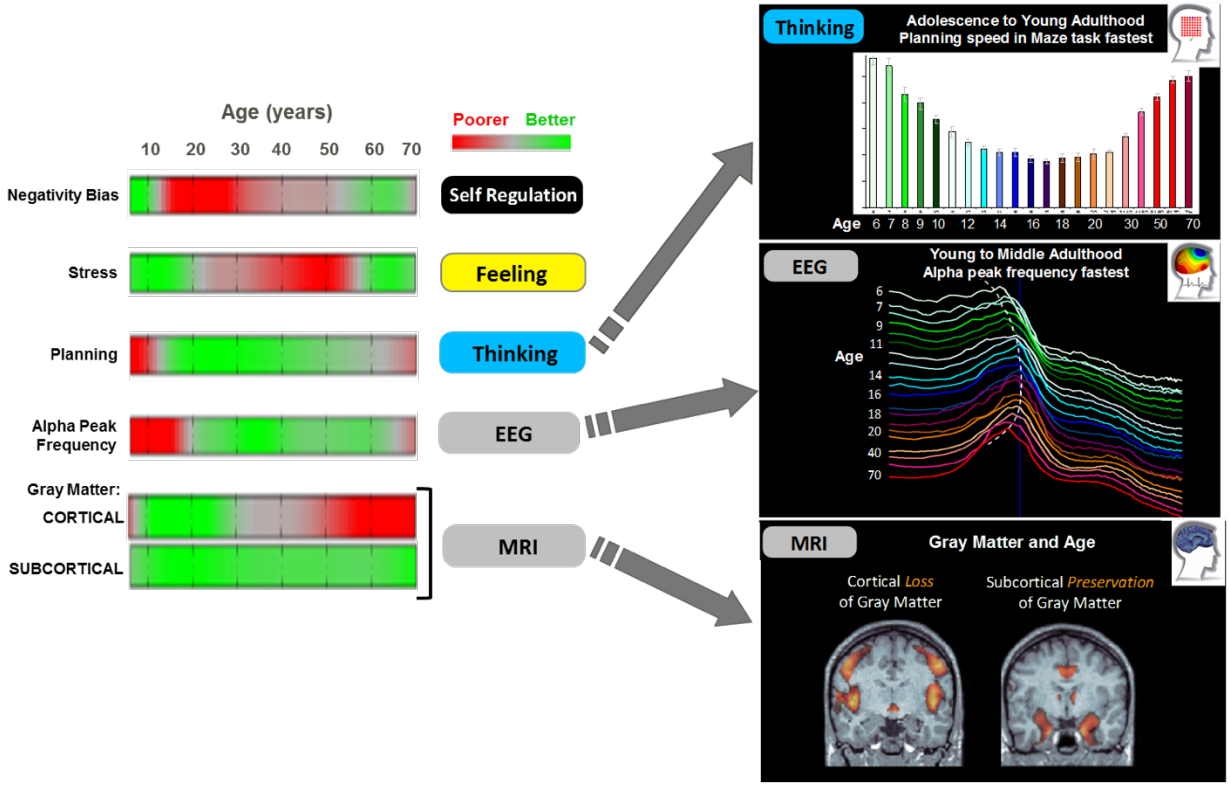
OUTCOME EXEMPLARS

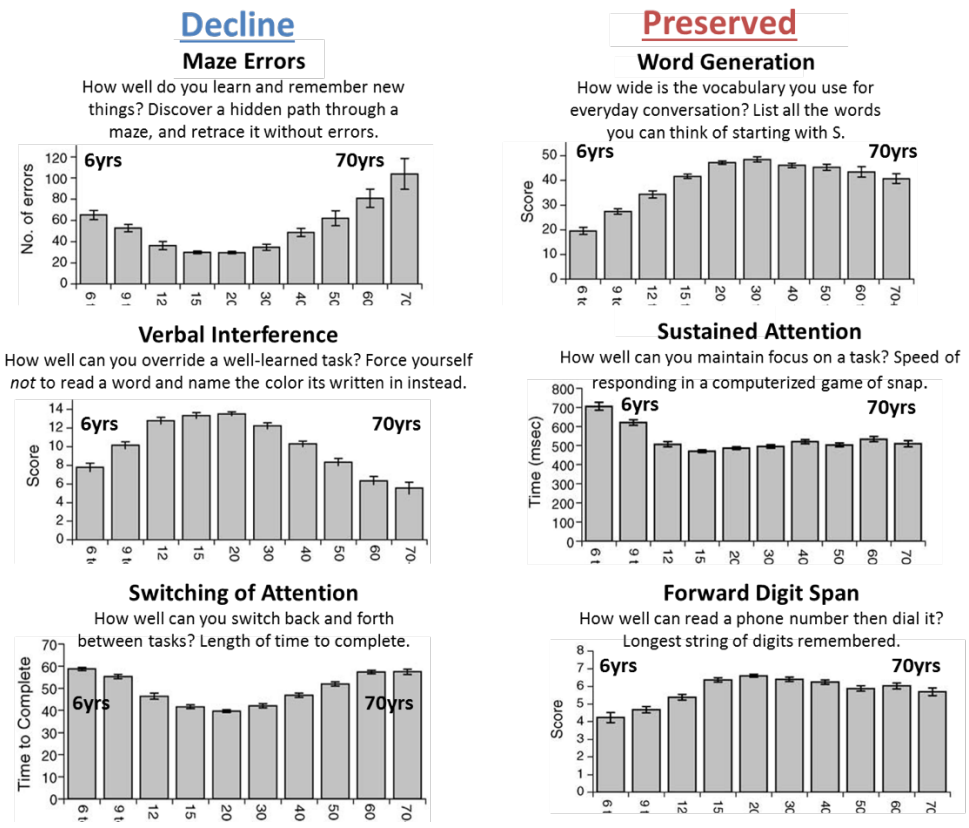
OUTCOME EXEMPLARS

Age-related changes across the lifespan

Many cognitive abilities improve with maturation and decline again with older age. Speed of electrical brain activity tends to show a similar trajectory.

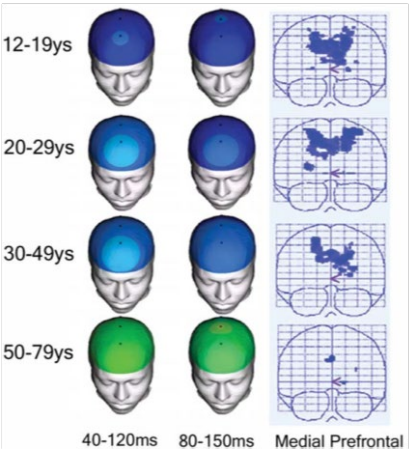
But that isn't the full picture. MRI shows gray matter to decline in only some regions, while remaining preserved in others. Some cognitive functions are also preserved along with emotional functioning, which tends towards a more positive bias and greater resilience.





Clark et al. (2006). Archives of Clinical Neuropsychology, 21: 449-467.

Progressive reduction in early frontal alerting activity to happy facial expressions

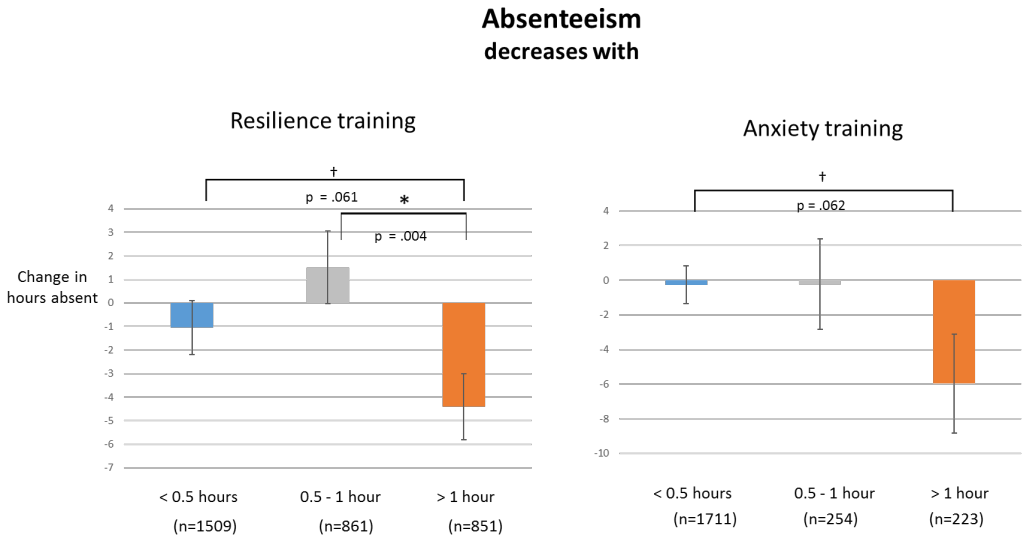


Williams et al. (2006). The Journal of Neuroscience, 26: 6422-30.

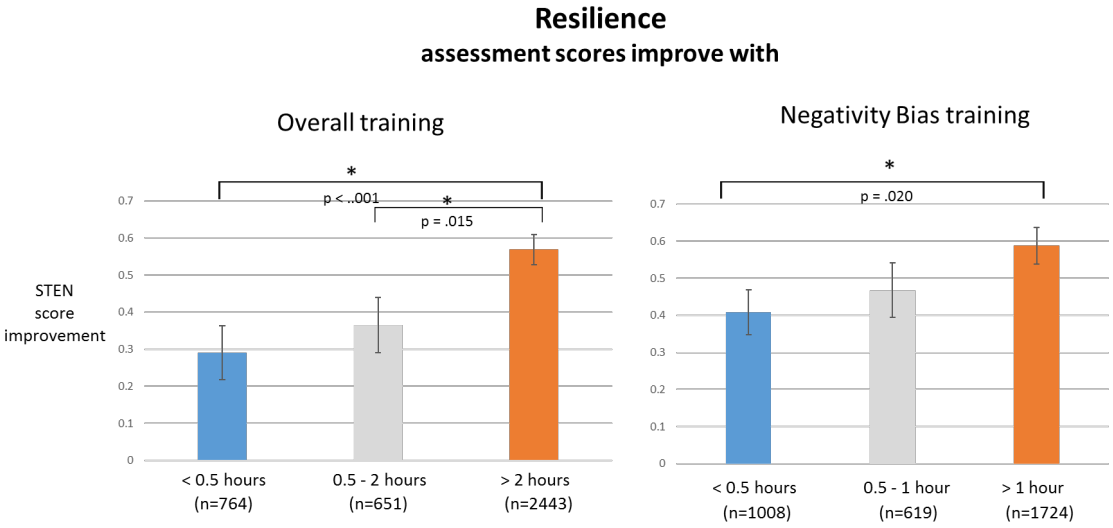
Beneficial outcomes of brain training

In a large group of employees, improvements in daily functioning, self-regulation, feeling, emotion and cognition were evaluated. Employees who did brain training exercises for less than half an hour were compared to those who trained for 1-2 hours or more Below are some exemplar outcomes from this study.

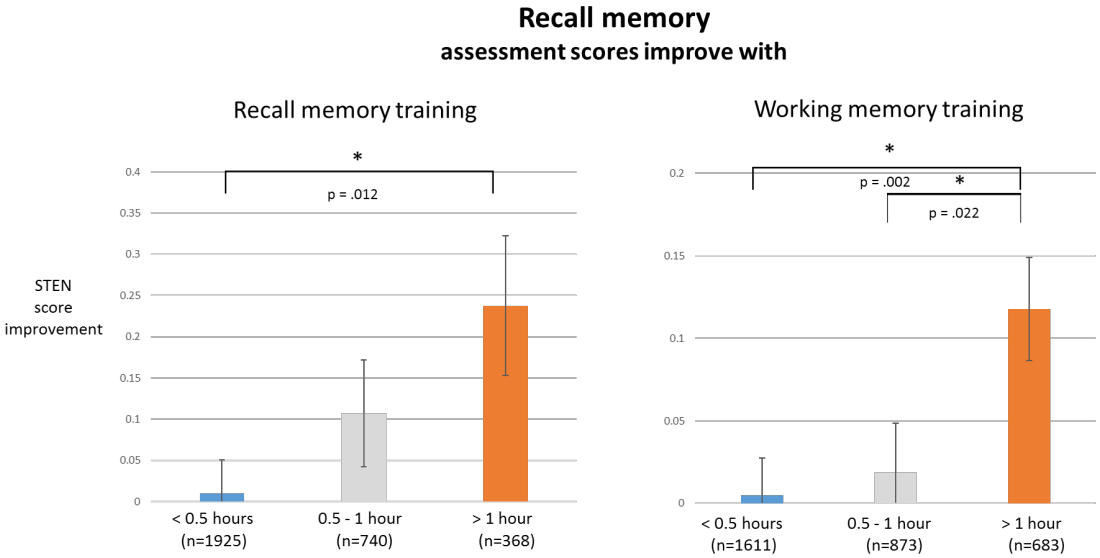
In the group who trained on exercises for resilience and anxiety for 1 hour or more, absenteeism decreased by up to 6 hours a month.



Resilience improved with overall training on MyBrainSolutions, as well as specific training on exercises designed to reduce negativity.



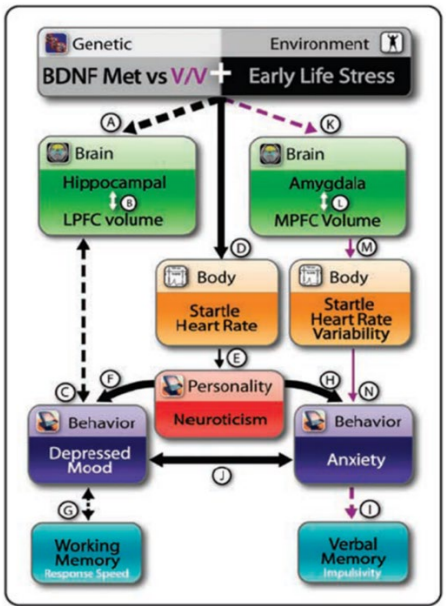
Recall memory improved with at least 1 hour of training on exercises designed to improve both recall memory and working memory.



Scores include statistical correction for repeat testing sessions

Pathways to experienced anxiety and depressed mood in the normative population

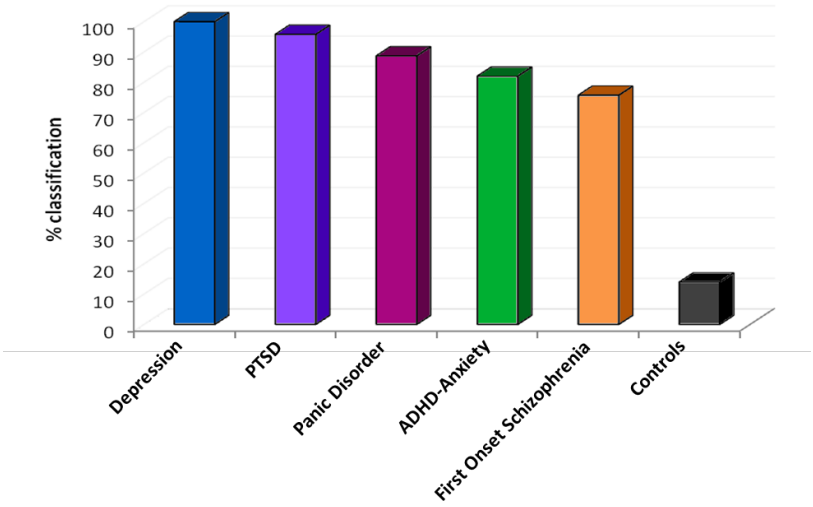
Pathways to experiencing sub-clinical anxiety and depressed mood have been identified from the database, combining genomic predisposition with early life stressful experiences, and additional influence of current brain and body functioning measures from functional MRI, EEG and autonomic arousal.



Gatt et al. (2009). Molecular Psychiatry, 14: 681-695.

Negativity Bias – A marker predictive of poor functioning

Negativity Bias is 95% accurate in discriminating depression from healthy control, and acts as a marker for 'case identification of poor functioning across the spectrum of clinical groups, especially when combined with low resilience.

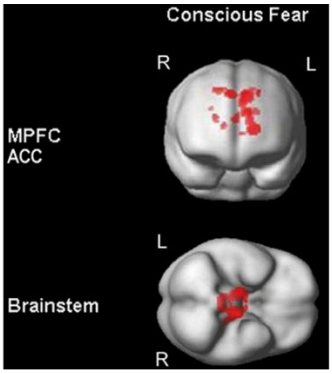


The underlying neural mechanisms of negativity bias have also been elucidated from genomic, functional MRI and EEG data from the database.

High Negativity Bias linked to:

Genomics and fMRI

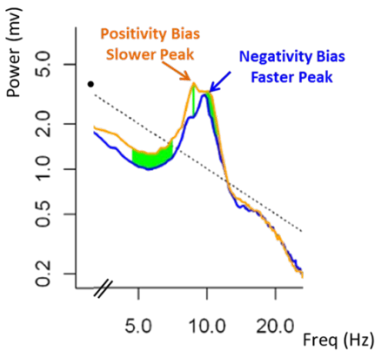
- COMT met alleles
- 5-HTT-LPR short allele
- Greater activation of frontal emotion brain networks to fear in these genomic groups



Williams et al. (2009). *NeuroImage, 47: 804-14.*

Resting EEG

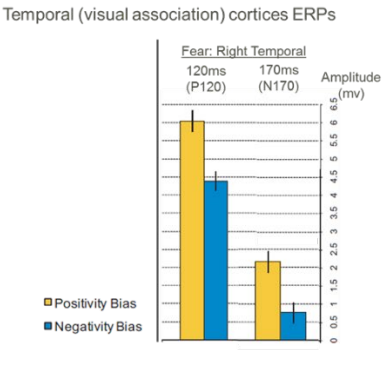
- Faster (more active) brain activity happening in the background while not performing a task



Gordon et al. (2008). *Journal of Integrative Neurocience, 7: 345-66.*

Task-related EEG (ERPs)

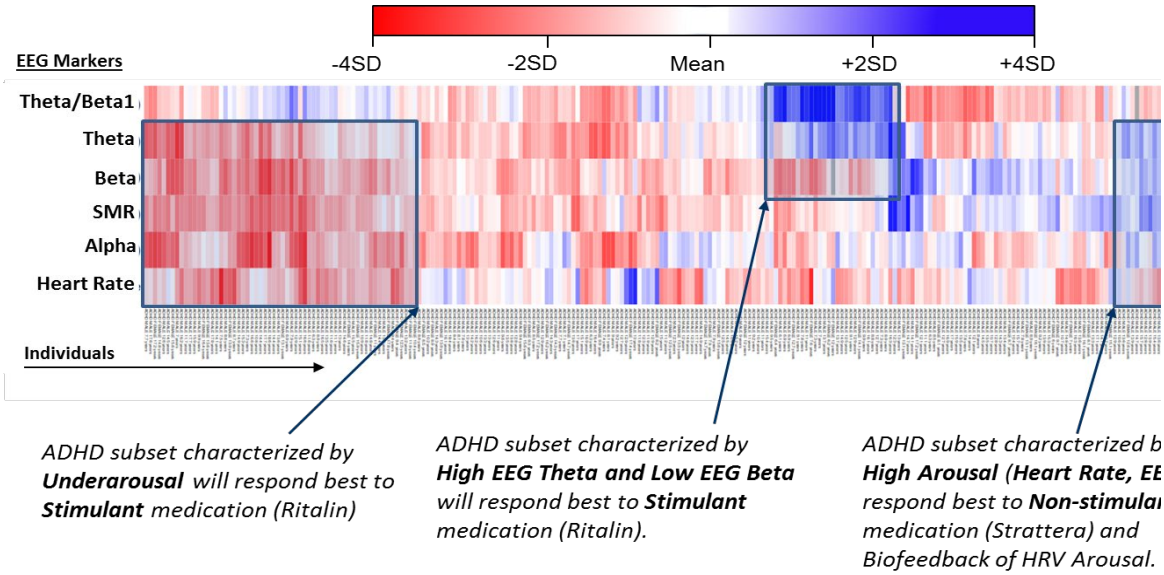
- Smaller amplitude early responses to fear stimuli in specialized visual association cortices



Gordon et al. (2008). *Journal of Integrative Neurocience, 7: 345-66.*

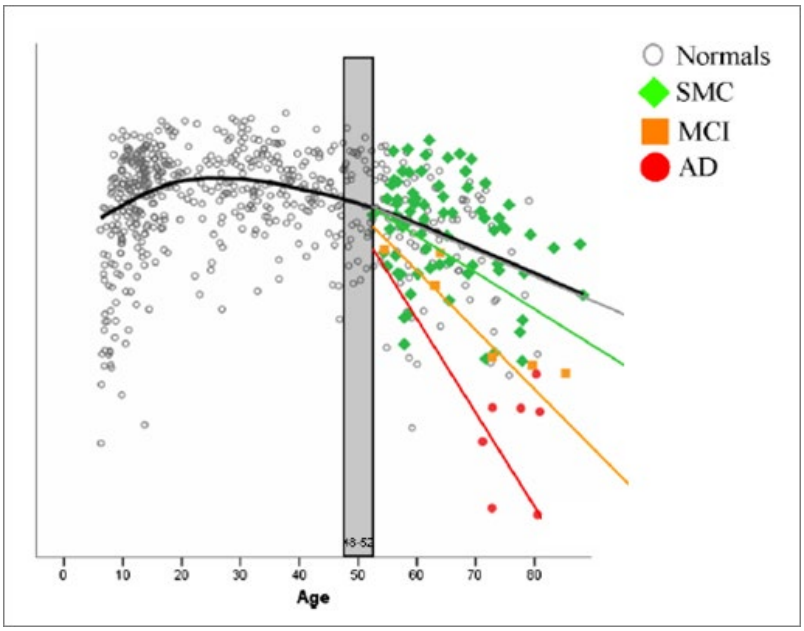
ADHD subtype profiles

EEG and heart rate measures reveal a diverse spectrum of subtypes in ADHD (in a group of N=345 young people with ADHD)



Distinguishing healthy aging from memory decline and cognitive impairment

The memory recall and recognition test shows distinguishing profiles between healthy aging, subject memory complaint (SMC), mild cognitive impairment (MCI) and Alzheimer's dementia

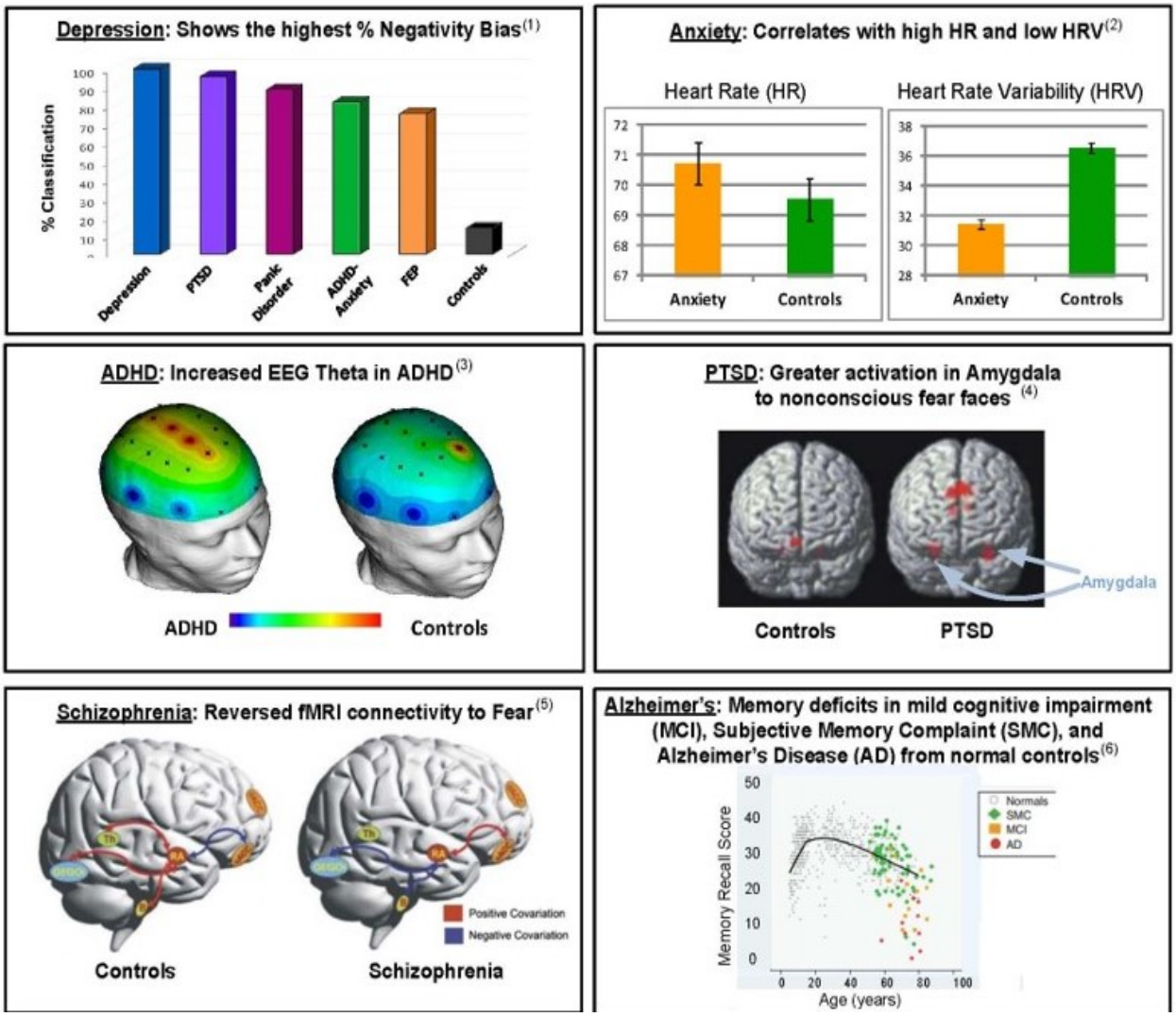


Liddell et al. (2007). Journal of Integrative Neuroscience, 6: 141-74.

Biomarkers findings in psychiatry

The power of standardization of assessment platforms in the database, means that outcomes across different psychiatric groups from dozens of different studies can be directly compared and integrated.

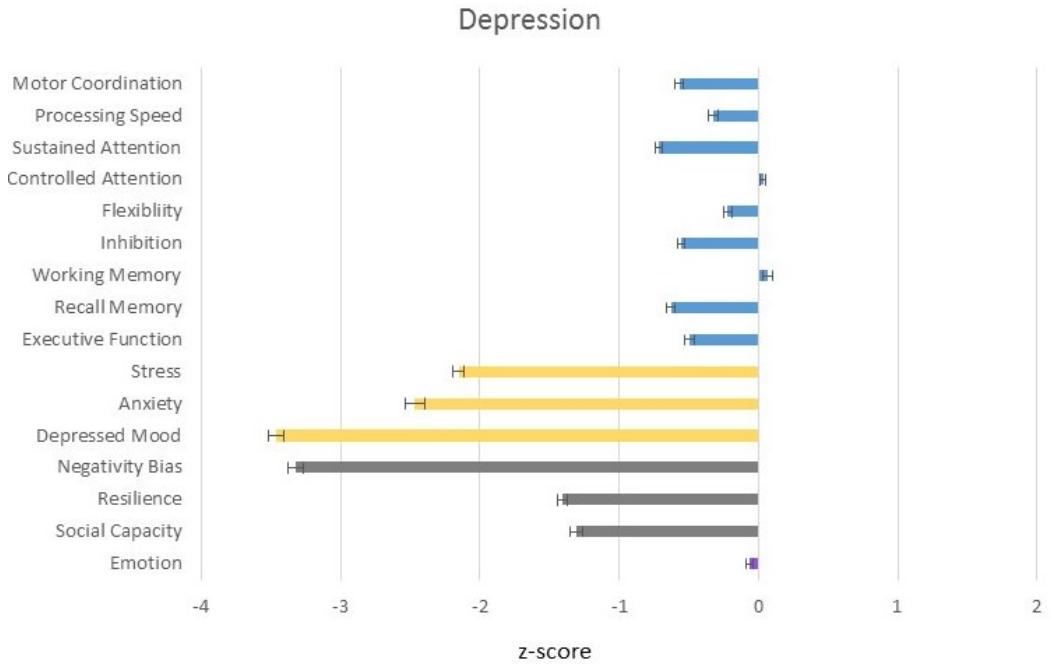
Some of the key findings in individual clinical disorders from the database to date are highlighted below.



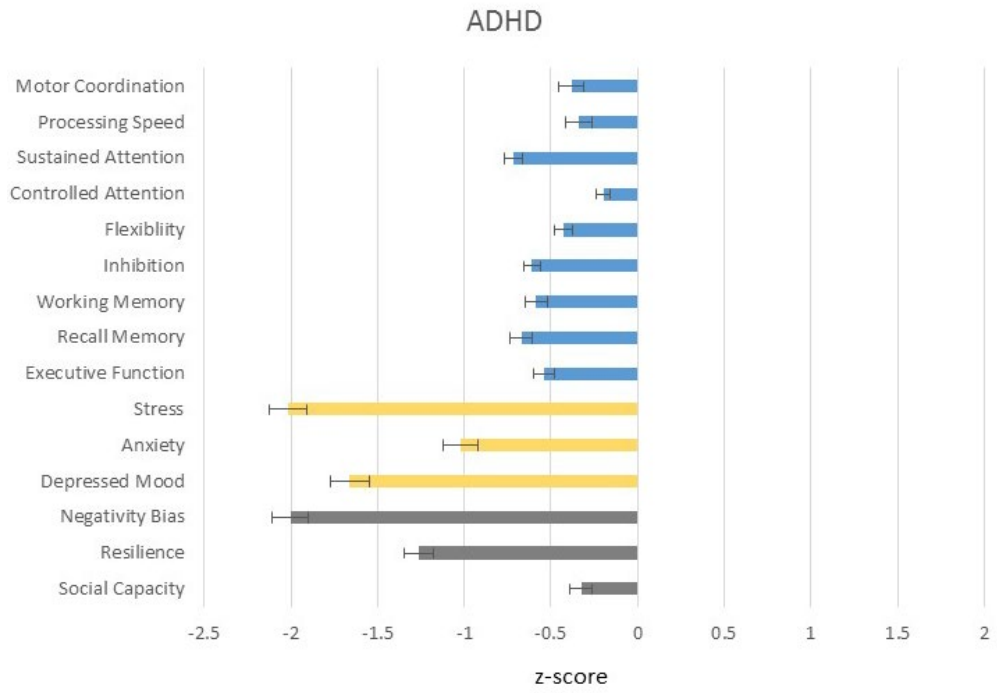
Cognitive profiles across disorders

Graphs below illustrate comparison of clinical groups versus database health controls (matched on gender, age, and years of education) on the key markers, Z scores are reports (Z scores have a normative average of 0, with a standard deviation of 1, and no upper of lower limit. Positive values reflect better than average performance, and negative values reflect poorer than average performance).

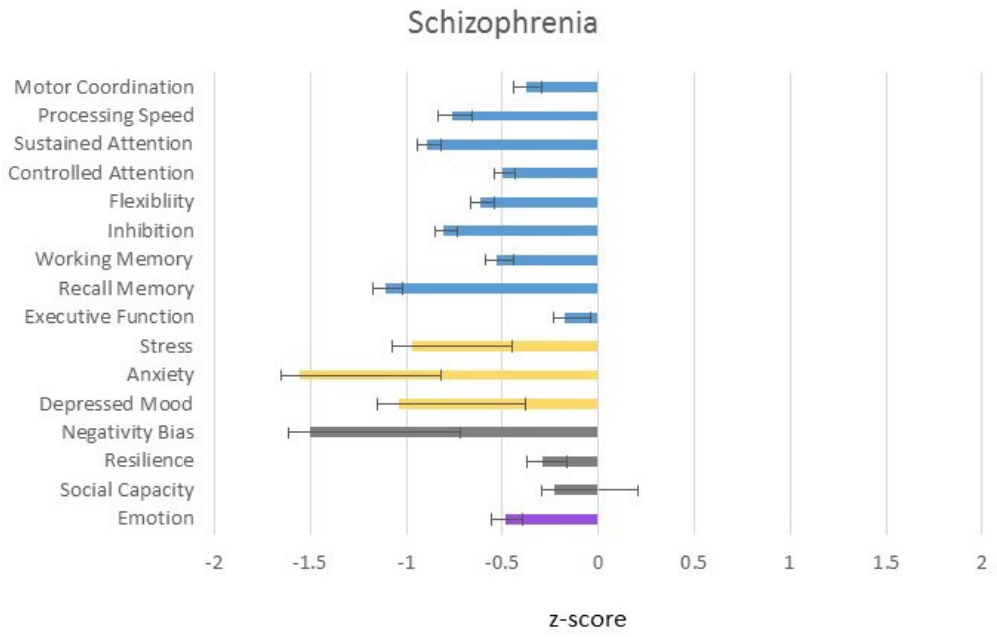
The Major Depressive Disorder (iSPOT-D n=1008) group is distinguished from the controls by Negativity Bias and Depressed Mood. This MDD group was also poorer than controls on Stress, Anxiety, Resilience, and Social Capacity.



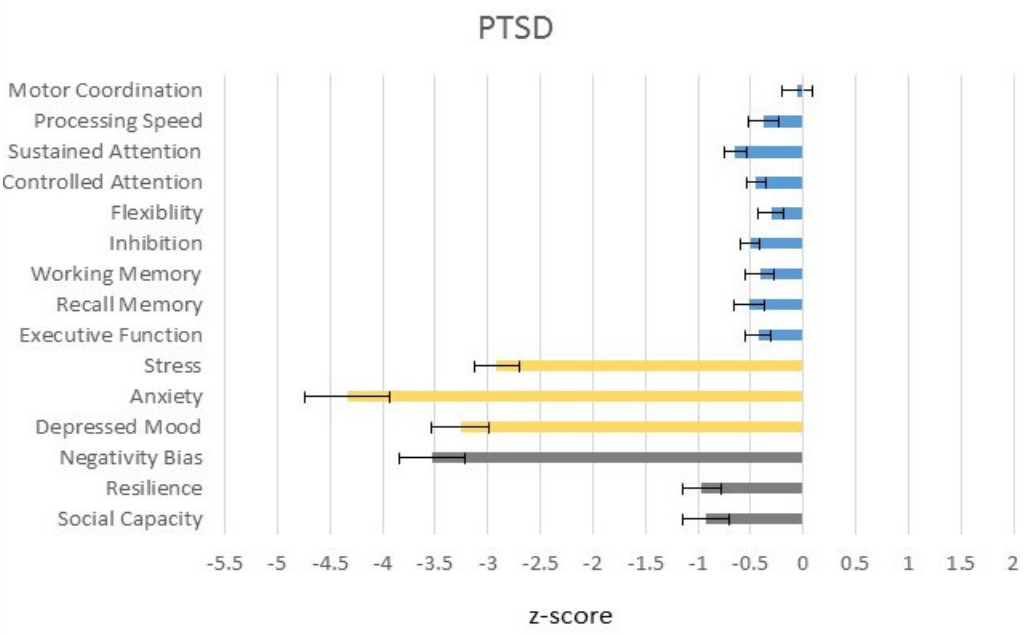
The ADHD (n=356) group are distinguished from controls by difficulties in Negativity Bias, Stress, Depressed Mood and Resilience.



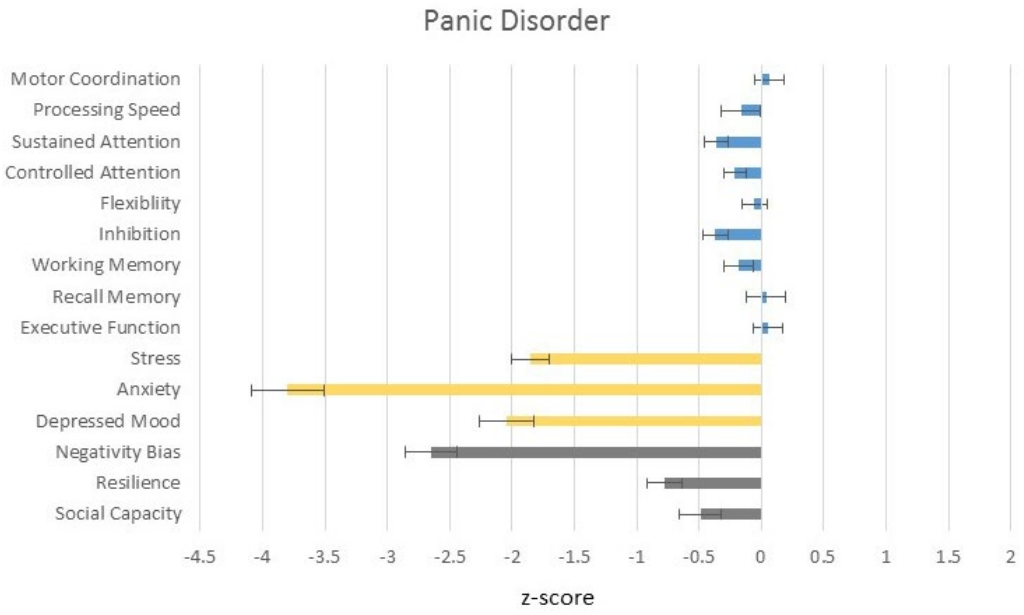
The First Onset Schizophrenia group (n=125) is distinguished from the controls across all domains, with particularly poor performance in Anxiety, Negativity Bias, Recall Memory, and Sustained Attention.



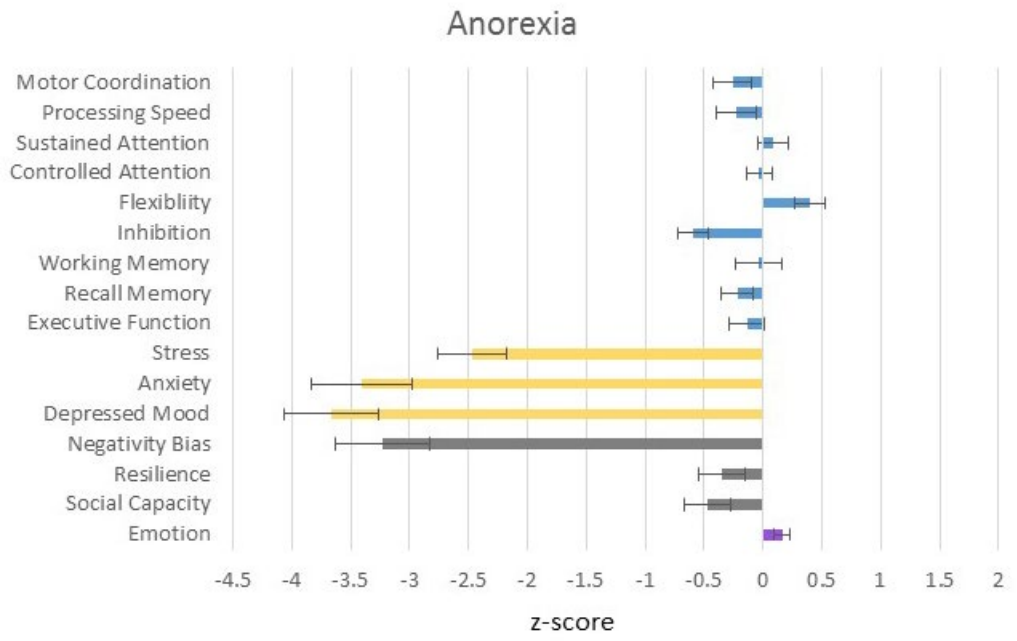
The PTSD group (n=69) is distinguished from controls by particularly marked difficulties in Anxiety, Negativity Bias, Depressed Mood, and Stress.



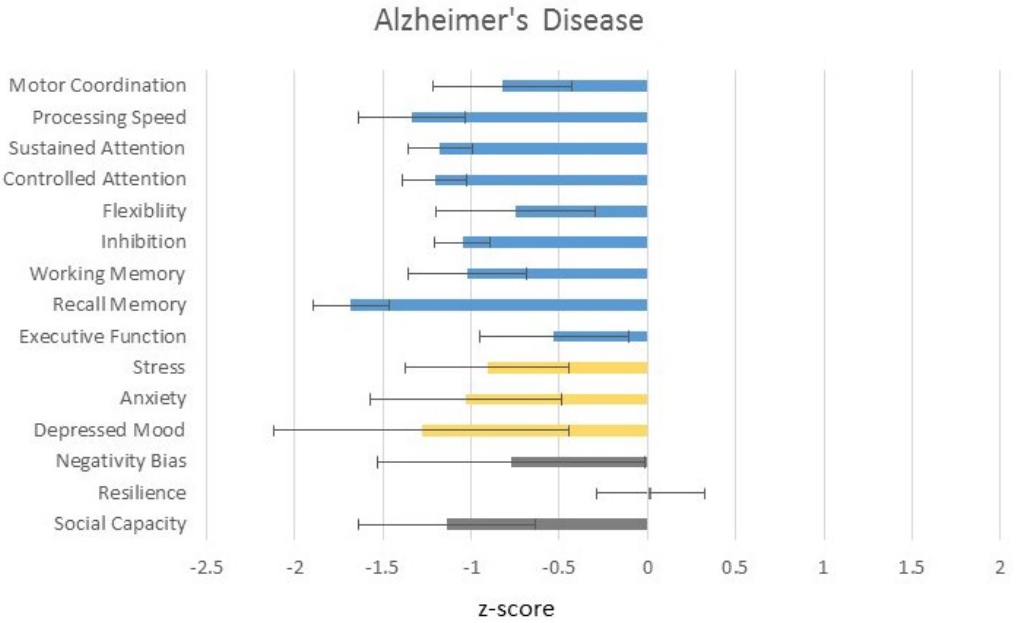
The Panic Disorder group (n=53) show particularly poor performance on Anxiety, Negativity Bias, Depressed Mood, and Stress.



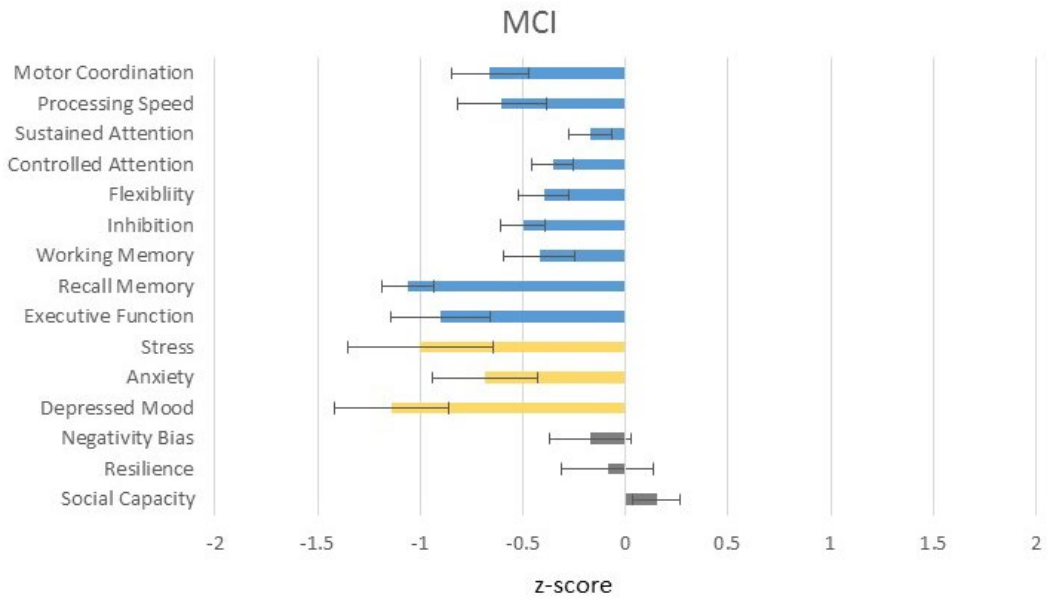
The Anorexia Nervosa group (n=41) is distinguished from the controls by difficulties in Stress, Anxiety, Depressed Mood, Negativity Bias, and Inhibition.



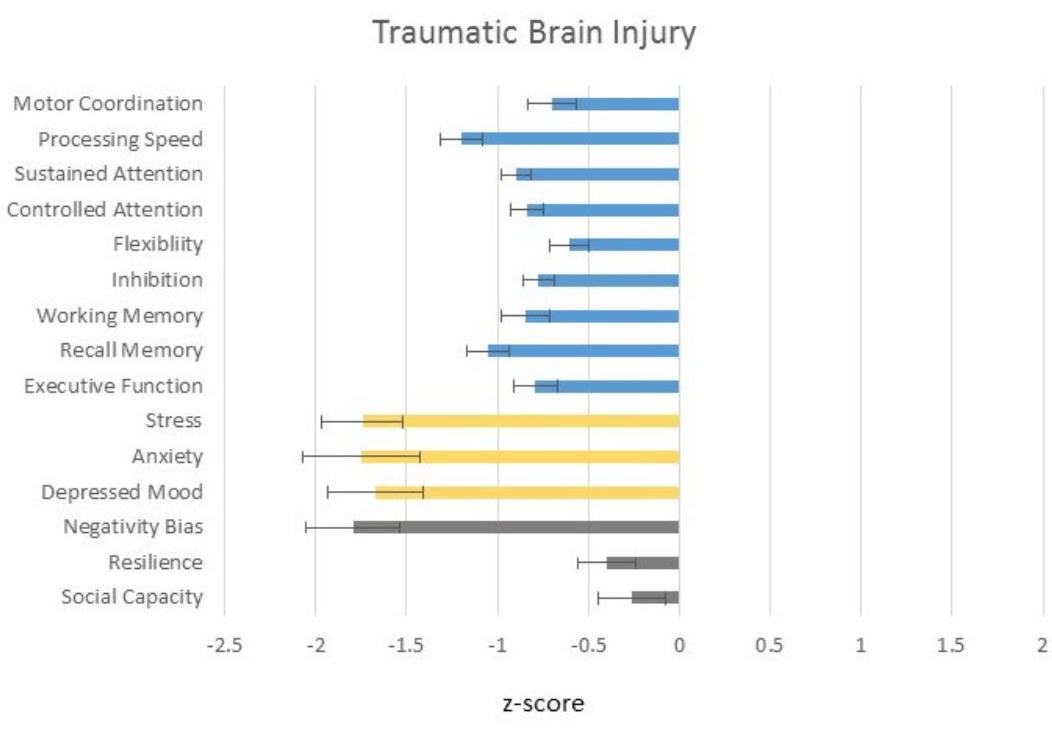
The Alzheimer's group (n=25) showed poor performance across all domains, with particularly pronounced difficulties in Recall Memory, Processing Speed, Attention, and Depressed Mood.



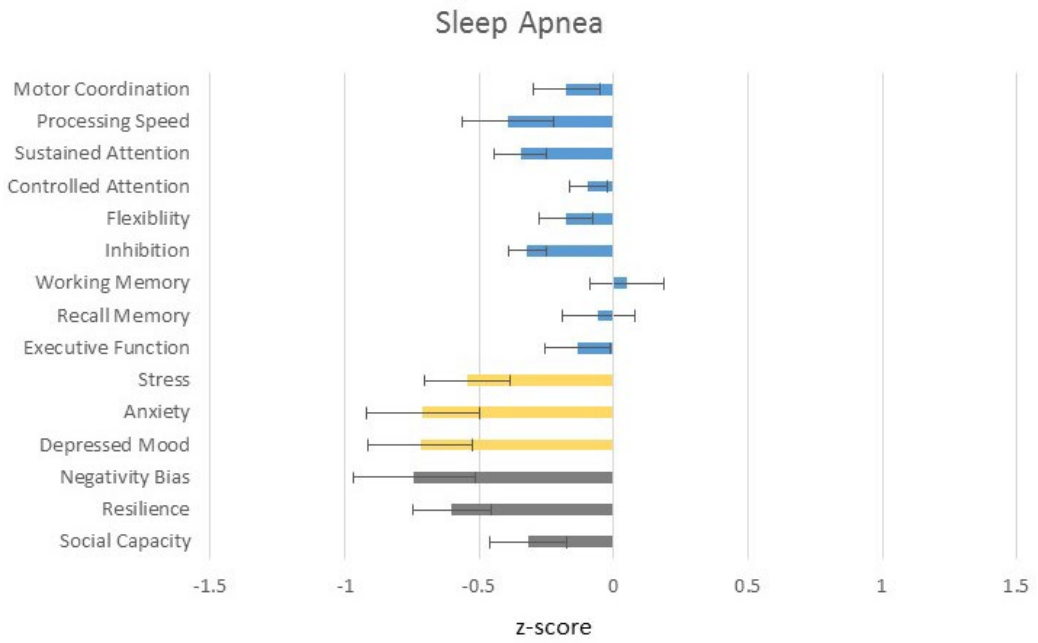
The Mild Cognitive Impairment group (n=43) is distinguished from controls by poor Recall Memory, Executive Function, Stress, and Depressed Mood.



The Traumatic Brain Injury group (n=85) is distinguished from controls by difficulties across all domains, particularly with managing stress and anxiety, and Processing Speed and Recall Memory.



The Sleep Apnea group (n=61) is distinguished from controls particularly on Feeling (Stress, Anxiety, Depression), and Self-regulation (Negativity Bias, Resilience).



GROWTH AND FUTURE EXPANSION

GROWTH AND FUTURE EXPANSION

The Brain Resource International Database continues to expand at an increasing rate, with over 30,000 assessments currently being completed very month (as of March 2017).

This is likely to escalate exponentially in 2018 as the current large clients (including Boeing; Kaiser; AARP) increase adoption and the mobile version goes live this month, and TOTAL BRAIN – THE UPDATED VERSION OF MY BRAIN SOLUTIONS HAS BEEN LAUNCHED AND IS ACHIEVING RAPID ADOPTION.

The crucial power of standardization and integration

Is that if a new user only uses 1 element of the methodology -

We can add value to what it Means by looking into the underlying **interconnections** to that element (such as Cognition).

This is an unprecedented standardized and integrative database and potential for predictive analytics in brain-body-behavior optimal outcomes.

KEY PUBLICATIONS FROM DATABASE

10 SELECTED KEY PUBLICATIONS FROM THE DATABASE

Cognitive improvements following brain training:

Gordon, E., Palmer, D.M., Liu, H., Rekshan, W. (2013). Online cognitive brain training associated with measurable improvements in cognition and emotional wellbeing. Technology and Innovation, 15(1), 53-62.

Pathways to depression and anxiety: Gene-Environment interactions

Gatt, J. M., Nemeroff, C. B., Dobson-Stone, C., Paul, R. H., Bryant, R. A., Schofield, P. R., et al. (2009). Interactions between BDNF Val66Met polymorphism and early life stress predict brain and arousal pathways to syndromal depression and anxiety. Molecular Psychiatry, 14(7), 681-695.

Cognitive changes across the lifespan:

Clark, C.R., Paul, R.H., Williams, L.M., Arns, M., Fallahpour, K., Handmer, C., & Gordon, E. (2006). Standardized assessment of cognitive functioning during development and aging using an automated touchscreen battery. Archives of Clinical Neuropsychology, 21: 449-467.

Neural underpinnings of cognition:

Rowe, D.L, Cooper, N.J., Liddell, B.J., Clark, C.R., Gordon, E., & Williams, L.M. (2007). Brain structure and function correlates of general and social cognition. Journal of Integrative Neuroscience, 6: 35-74.

Maintenance of positivity and resilience with aging:

Williams, L.M., Brown, K.J., Palmer, D., Liddell, B.J., Kemp, A.H., Olivieri, G., Perduto, A., & Gordon, E. (2006). The Journal of Neuroscience, 26: 6422-30.

Negativity Bias and Resilience: A marker for poor functioning

Williams, L.M., Cooper, N.J., Wisniewski, S.R., Gatt, J.M., Koslow, S.H., Kulkarni, J., Gordon, E. & Rush, A.J. (2012). Sensitivity, specificity, and predictive power of the “Brief Risk-resilience Index for SCreening", a brief pan-diagnostic web screen for emotional health. Brain and Behavior, 2: 576-89.

Neural underpinnings of Negativity Bias:

Gordon, E., Barnett, K.J., Cooper, N.J., Tran, N., & Williams, L.M. (2008). An “integrative neuroscience” platform: Application to profiles of negativity and positivity bias. Journal of Integrative Neuroscience, 7: 345-66.

Predictive cognition biomarkers from the iSPOT-Depression study:

Gordon E, Rush AJ, Palmer DM, Braund TA, Rekshan W (2015). Toward and online cognitive and emotional battery to predict treatment remission in depression. Neuropsychiatric Disease and Treatment, 11: 517-531.

Overview of all predictive biomarkers from the iSPOT-Depression study:

Palmer, DM (2015). Biomarkers for Antidepressant Selection: iSPOT-D Study. Current Behavioral Neuroscience Reports, 2: 137-145.

Predictive cognition biomarkers from the iSPOT-ADHD study:

Elliott GR, Blasey C, Rekshan W, Rush AJ, Palmer DM, Clarke S, Kohn M, Kaplan C, Gordon E. (2014). Cognitive testing to identify children with ADHD who do and do not respond to methylphenidate.Journal of Attention Disorders [E-pub].