National Neuropsychology Network (NNN)

National Neuropsychology Network (NNN)

INS 2020
Toward Precision Neuropsychology

February 6, 2020

UCLA Semel Institute
Tennenbaum Center for the Biology of Creativity

UFHealth
UNIVERSITY OF FLORIDA HEALTH

MEDICAL COLLEGE OF WISCONSIN

EMORY UNIVERSITY

Journal of the International Neuropsychological Society (2011), **17**, 7–13.

doi:10.1017/S1355617710001396

SHORT REVIEW

Neuropsychology 3.0: Evidence-Based Science and Practice

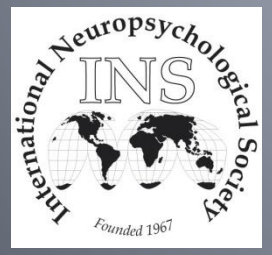
Robert M. Bilder[1,2,3]

[1]Jane and Terry Semel Institute for Neuroscience & Human Behavior at UCLA, Los Angeles, California
[2]Department of Psychiatry & Biobehavioral Sciences, David Geffen School of Medicine at UCLA, Los Angeles, California
[3]Department of Psychology, UCLA College of Letters & Science, Los Angeles, California

(Received August 13, 2010; Final Revision October 16, 2010; Accepted October 18, 2010)

Neuropsychology in the Era of Translational Neuroscience

Russell M. Bauer, Ph.D., ABPP
Departments of Clinical & Health Psychology and Neurology
McKnight Brain Institute
Clinical and Translational Science Institute
University of Florida, Gainesville, FL USA



INS 40th Meeting
Montreal, Quebec, CANADA
February 17, 2012

UF UNIVERSITY of FLORIDA
The Foundation for The Gator Nation

Neuropsychology THEN

- Clinical Neuropsychology
  - Standard administration of printed psychometric tests to individual patients
  - Test development/validation using classical test theory
  - Focus on diagnosis and prediction of treatment response
  - Data summarized in report then filed or buried in other ways
  - Local databanks useful, but inefficient and redundant
- Cognitive/Experimental Neuropsychology
  - Cognitive neuropsychological models of brain function; process-oriented decomposition through analysis of single cases
  - Small-N studies of group differences in neuropsychological ability; case-control studies; dissociation logic
  - Brain-behavior relations established by using neuroimaging and other biological correlates/markers as classifiers at the group level

Neuropsychology NOW

- Emerging translational opportunities to expand brain and behavior science
  - New multiplatform models of functional localization of cognition
  - Population-based studies
  - "Omics" revolution
  - Network neuroscience
  - Evidence-based practice
  - Electronic Medical Record (EMR)
- Increasing public awareness of neuropsychology
  - Public health education about risks/causes/consequences of brain injury
  - Brain health
  - Neurocognitive factors as risk for health behavior problems
- Developing novel delivery systems for NP assessments
  - Computerized neurocognitive assessment devices (computers, tablets)
  - Telehealth and web-based assessments and treatments
  - Internet of Things (IoT): wearables, GPS, etc.

NP Today and Tomorrow

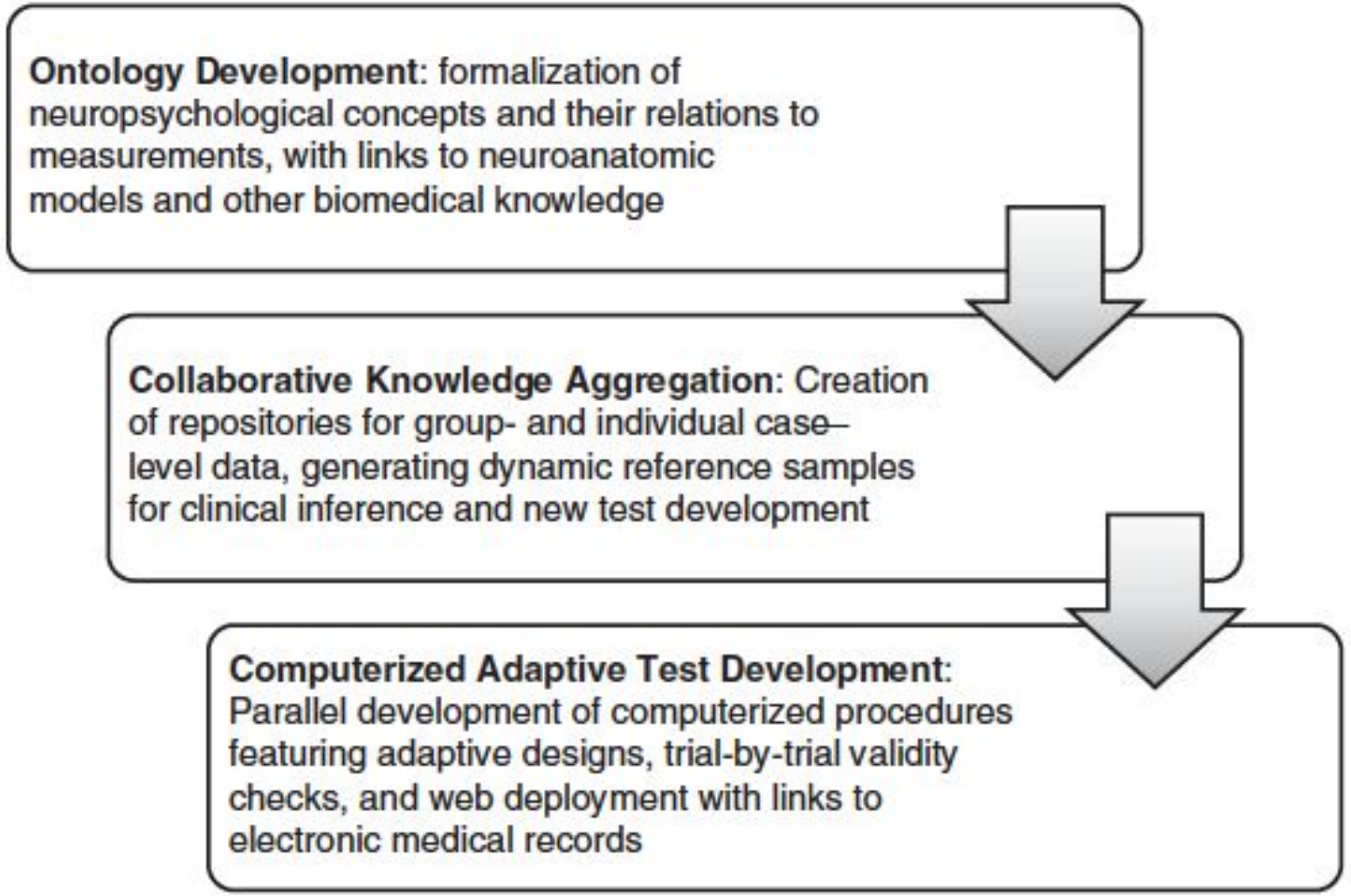
Today

- Big batteries with lots of redundant assessment
- Methods waste time: brilliant trainees marking papers, then entering scores into different programs, copying, pasting, reformatting…
- Data end up in file cabinets or text archives that are not ready for analysis

Tomorrow

- Efficient testing with flexible decisions about next-test and next-variable
- Efficient scoring: results available immediately after patient responds
- Data aggregation and analysis determine positive, negative predictive power for different tests with respect to different diagnostic or treatment decisions

Path to Development of Novel NP Paradigms



What entities exist?

Generate large data set; Big Data

NP redesign

Bilder, *Neuropsychology 3.0*

THE CLINICAL NEUROPSYCHOLOGIST
2019, VOL. 33, NO. 2, 220–245
https://doi.org/10.1080/13854046.2018.1521993

Routledge
Taylor & Francis Group

Neuropsychological tests of the future: How do we get there from here?

Robert M. Bilder[a,b] and Steven P. Reise[b]

[a]Departments of Psychiatry & Biobehavioral Science, Jane & Terry Semel Institute for Neuroscience and Human Behavior, University of California Los Angeles, Los Angeles, California, USA; [b]Department of Psychiatry & Biobehavioral Science, Los Angeles, California, USA

Method	Current	Future	Future Advantage
NP trait models	Unidimensional	Bifactor models, multidimensional IRT models (mIRT)	Each item can provide information about different traits; a single item or test can help specify both general factors and domain scores
Nominal response model	Different kinds of errors are treated identically	Each wrong response has a different meaning	Each item carries more information, enabling greater precision and/or assessing different constructs
Test linking	Total scores are compared in studies that use both tests	Item banks can be drawn from existing tests and new items, and all items calibrated together	Enables direct comparison of different tests and construction of new tests that are back-compatible with the originals
Computerized adaptive testing	Paper-pencil, fixed administration order, minimal branching	Information from each item response selection and speed used to select next most informative item	Efficiency gain of 50-95% in administration time or precision of measurement.
Differential item functioning (DIF)	Effects of group (diagnostic, age, sexual, racial, ethnic, cultural, etc.) determined by comparing total scores	DIF examines group effects for each item	Increased precision in specifying diagnostic and other group differences that may not be apparent in the scores of the whole test
Person fit statistics	Performance validity based on "cutoff" scores, mostly based on accuracy	Performance validity based on the fit of item response characteristics to the examinees overall estimated trait level	Performance validity can be examined within each test; every item response can be useful in detecting anomalies; increase sensitivity to intentional failure
Non-IRT Item-Level Strategies	Most emphasis on summary scores not trial-by-trial analysis	Focus on sequential dependence of responses and meaning of response sequences	Increased efficiency in identifying primary constructs; identification of qualitatively distinct response patterns

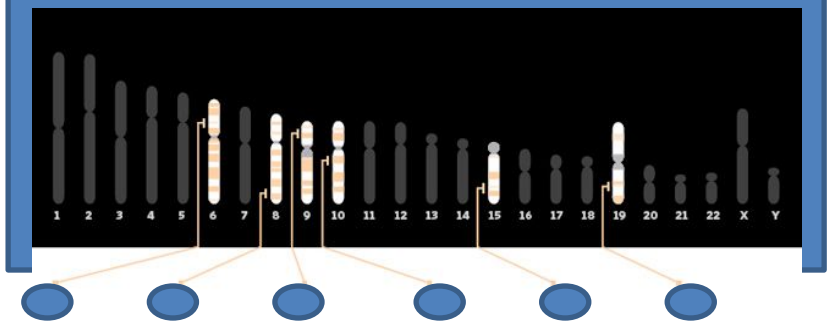
Method	Current	Future	Future Advantage
Evidence-based diagnostic batteries	Batteries with limited flexibility involve redundant testing	Test selection will proceed based on positive predictive power	Testing efficiently focuses time with respect to differential diagnostic questions or recommendations
Computerized testing	Print publishing model; paper-pencil data acquisition and scoring	Computerized tests for stimulus presentation and response acquisition	Precision in timing of stimulus presentation and response collection, automatic recording, scoring and database entry of responses, and automatic updating of software to new versions; acquisition of voice, video, motion.
Web-based testing	Testing done in clinic or lab	Testing done at home or wherever convenient for examinee	Scalable assessment at lower cost
Healthcare informatics and bioinformatics	Test results go to file cabinets, report text goes on medical record, usually unsearchable	Data elements will be part of medical record and integrated with analytics relating them to other health variables	NP data integrated into comprehensive model of patient; implications pushed to all care-team members and hypotheses fed back to NP clinicians for follow-up; "big data" analytics will find new patterns to inform future evidence-based practice
Mobile platforms	Not used; not trusted	Passive monitoring will dramatically increase data flow; experience sampling will augment self reports	Marked increase in longitudinal repeated measures for self-reports and tests; new variables extracted from passive monitoring
Wearables	Not used; not trusted	Passive monitoring of diverse physiological, activity, and experiential data	Data previously available only in cross-sectional lab studies (sleep, EEG, cardiovascular) will be widely available and assessed longitudinally)
Internet of Things (IOT)	Not used; not trusted	Passive monitoring of activities across multiple environments	Ecologically valid assessments will be done in real-world contexts; and environment can "respond" with appropriate cues and assistance

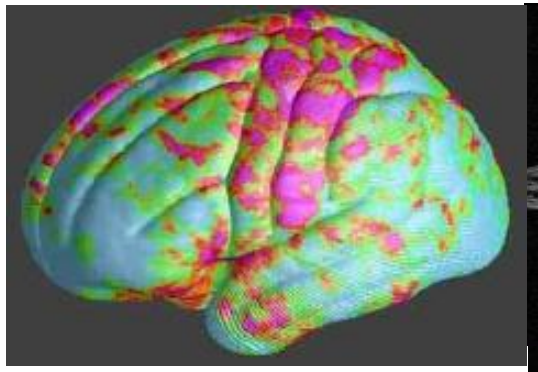
NP Dashboard of the Future?

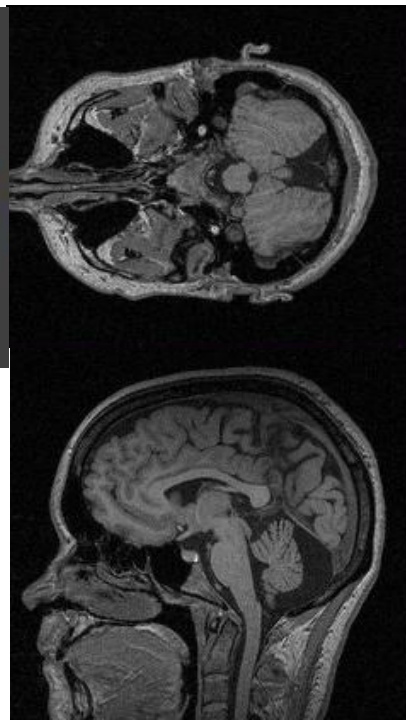
Demographic Profile	
Name	John H. Smth
DOB	xxxx.xx.xx
Academics	PreK, K, Elem, JHS, HS, Coll, Prison, Grad, PostGrad… {scores}
Occupation	Hist.occupation {current, prior, previous}
Sociologics	MarStat, Parent, Child, SES {social.network.stats}

Medical History	
Name	John H. Smith
ID	xxxx.xx.xx
PriorVisitData	xxxx.xx.xx {indication}
MedicalRecords	UFLA (2008); UCLA-RRMC (2006); NSLIJ (2000); {earlier}
Current Dx	299.99; 143.75 {graphical view}

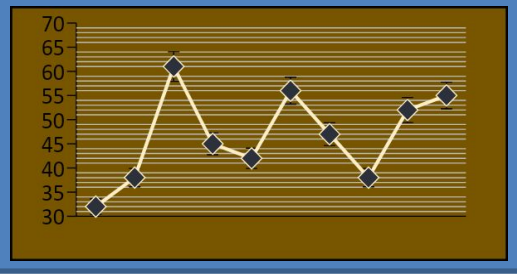
Genomic profile







Cognitive profile {xxxx.xx}



Primary Hypotheses: {dx1, dim1}
Rule-Outs: {dx1, dim1}
Investigations: {testa, testb, …}*[link.test]*
Possible rx: {rx1; tx1; lifestyletx2; …}

Bilder, 2010 AACN

How to launch the Neuropsychology Liberation Front?

- Collaborative data aggregation at the item level across clinics, nationwide
- Need to provide shared access to item-level data in a way that provides appropriate:
  - Privacy
  - Data security
  - Practicality for busy clinicians and staff
- Solutions:
  - Leverage current methods for data collection (e.g., Pearson Q-Interactive)
  - Develop novel software for point of testing data acquisition
  - Use existing privacy/security protocols developed by NIH for data archives (GUID)
- GOAL: simultaneously make life *easier* for clinicians AND share data to support assessments of the future.

National Neuropsychology Network

- National Data Archives (NDA) now aggregating item-level test data for NIH projects (Autism, RDoC, ADNI), n's increasing (RDoC=12k total), BUT…
  - Patient selection follows grant inclusion/exclusion criteria – how representative is this?
  - Test selection follows grant protocols, usually selected experimental measures, often not tests most widely used in practice
- Meanwhile: ~**500,000 *clinical NP exams are given each year***
- National Neuropsychology Network: clinical sites sharing item-level data with NDA for open analysis, generation of back-compatible, efficient assessments, and forward-looking introduction of novel items to expand banks for existing and novel construct measurement

Which tests to include?

- How to accommodate the broad range of tests used?
- Surprise: despite flexible approaches to NP there is considerable homogeneity of actual tests used
- Rabin et al (2016) survey – 80% of exams covered by:
  - WAIS-IV, WMS-IV, CVLT-2, D-KEFS (Trails, Fluency, CWIT)
  - OTHERS: RAVLT, HVLT, ROCFT, WRAML-2, BVMT-R, WCST, BNT, MMSE, MoCA

R01MH118514 – (3/4/19 to 1/31/24): National Neuropsychology Network

- Sites/PIs
  - UCLA: Robert Bilder, Ph.D., ABPP-CN (Dear Leader of NNN)
  - University of Florida: Russell Bauer, Ph.D., ABPP-CN
  - Medical College of Wisconsin: Laura Umfleet, Psy.D., ABPP-CN
  - Emory University: David Loring, Ph.D., ABPP-CN, and Daniel Drane, Ph.D., ABPP-CN
- UCLA – coordinating, statistical expertise including:
  - Steve Reise, Ph.D.: head of quantitative area, UCLA Psychology; Catherine Sugar, Ph.D., Director, Semel Institute Biostatistics Core; Fiona Whelan, M.S.; Stone Shih, B.A.
- Pearson – collaborative deposit of Q-interactive results into NIMH Data Archive for shared use by NP community
  - Dustin Wahlstrom, Ph.D. (Director of Portfolio Management and Delivery - Therapeutics) Kristen Getz, M.A. (Research Director, Digital Products/Platforms, Clinical Assessment)

EMORY UNIVERSITY

MEDICAL COLLEGE OF WISCONSIN

UFHealth UNIVERSITY OF FLORIDA HEALTH

UCLA Semel Institute
Tennenbaum Center for the Biology of Creativity

Table 2. Tests Most Frequently Administered by NNN Sites

Battery or Domain	Test	Total x 4 years	QI		Battery or Domain	Test	Total x 4 years	QI
WAIS-IV	Digit Span	14900	*		General	MOCA	4000	
WAIS-IV	Coding	11140	*		Symptom	Beck Depression Inventory	3700	
WMS-IV	Logical Memory	10300	*		WMS-IV	Verbal Paired Associates	3620	*
WAIS-IV	Block Design	10200	*		Memory	Hopkins Verbal Learning Test	3520	
Language	Boston Naming Test	10200			WAIS-IV	Letter-Number Sequencing	3420	*
WMS-IV	Visual Reproduction	10020	*		Memory	Brief Vis Memory Test-Revised	2920	
Executive	Wisconsin Card Sorting Test	9320			Visuospatial	Facial Recognition Test	2600	
WAIS-IV	Symbol Search	8140	*		General	Mini-Mental State Exam	2000	
WAIS-IV	Similarities	8100	*		Language	WMS-III Mental Control	2000	
WAIS-IV	Matrix Reasoning	7940	*		Language	Test of Memory Malingering	1916	
WAIS-IV	Information	7620	*		Memory	Rey Auditory Verbal Learning Test	1900	
Memory	Rey Complex Figure Test	6420			PVT	Green's Word Memory Test	1640	
D-KEFS	Verbal Fluency Test	6220	*		D-KEFS	Design Fluency Test	1600	*
WAIS-IV	Arithmetic	6140	*		Exec	EXIT25	1600	
WAIS-IV	Vocabulary	6060	*		Symptom	Beck Anxiety Inventory	1500	
D-KEFS	Color-Word Interference Test	5720	*		WAIS-IV	Picture Completion	1440	*
Motor	Grooved Pegboard Test	5500			PVT	Medical Symptom Validity Test	1400	
D-KEFS	Trail Making Test	5420	*		Executive	Symbol Digit Modalities Test	1320	
General	ACS-Test of Premorbid Function	4820	*		WMS-IV	Design Memory	1180	*
Memory	California Verbal Learning Test	4820	*		Achievement	Woodcock Johnson-subtests	1060	
WAIS-IV	Visual Puzzles	4720	*		General	NIH Toolbox	1000	
Motor	Finger Tapping Test	4500			Language	Emory Semantic Fluency Paradigm	800	
Visuospatial	Judgment of LIne Orientation	4120			Language	Columbia Auditory Naming Test	800	
					General	RBANS	800	

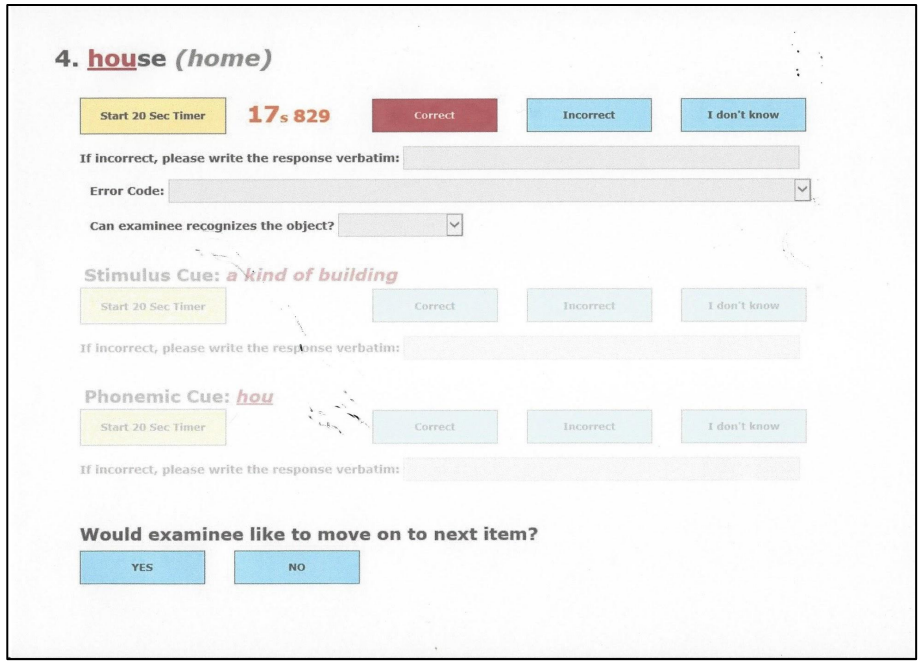
Note. QI: * test administered on Q-interactive platform. The rest will be administered via a new, tablet-based/web-based point-of-testing data acquisition program.

Table 3. Estimated Clinic Flow for Major Diagnostic Groups

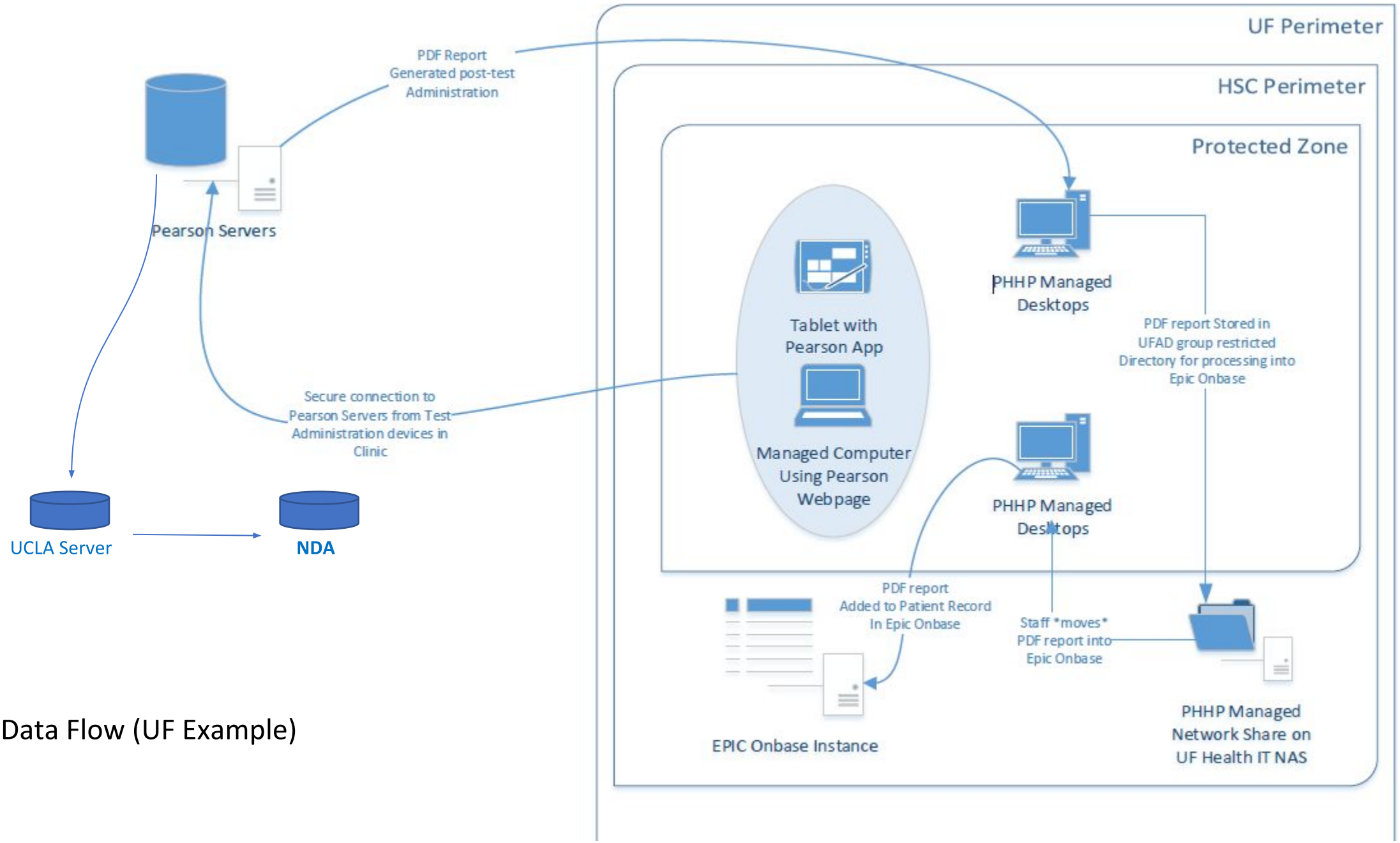
Condition/Diagnostic Group	Emory	MCW	UCLA	UF	Total Per Year	Total x 4 years
Dementia, MCI, Memory Loss	250	400	280	200	1,130	4,520
Epilepsy	175	75	120	50	420	1,680
Transplant Service, Brief Inpatient Evals	5	10	50	100	165	660
Movement Disorders, Surgical, DBS	150	20	50	200	420	1,680
ADHD/Learning Disability	0	150	50	75	275	1,100
Traumatic Brain Injury	20	750	50	100	920	3,680
Neoplasm, Stroke	50	150	50	50	300	1,200
Primary Psychiatric	55	0	50	25	130	520
TOTAL	**705**	**1,555**	**700**	**800**	**3,860**	**15,040**

Tablet (iPad)-Based Assessment

Pearson Q-interactive



NNN Point-of-Testing System for Other Tests (BNT example here)



Data Flow (UF Example)

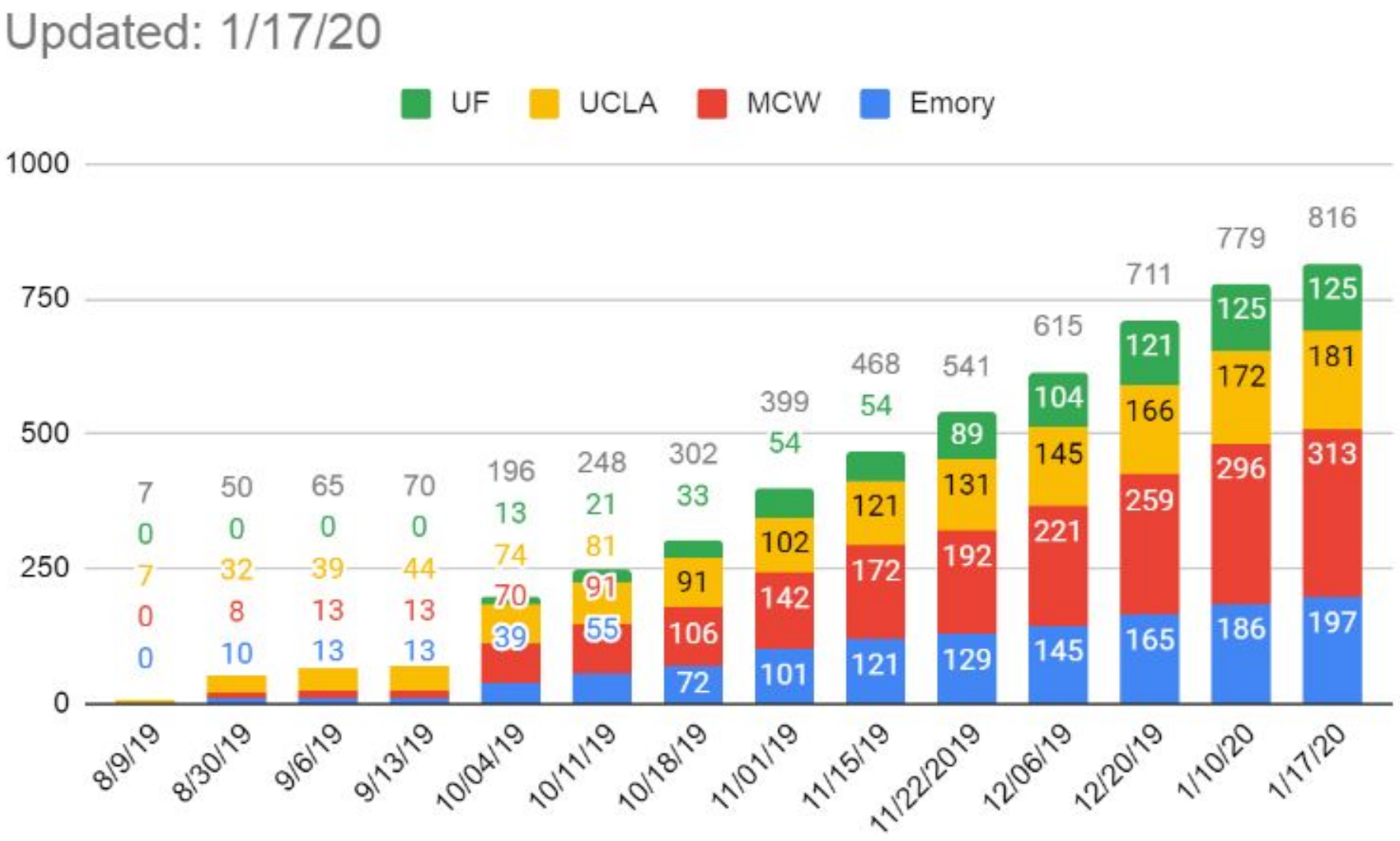
Structured Clinical Protocol/ Common Data Elements – Lucia Cavanagh

- Clinical measures will include structured demographic, diagnostic, and dimensional ratings of key symptoms using instruments proposed as common data elements by the NIMH Research Panel (Barch et al., 2016):
  - Structured History Protocol for Neuropsychology (SHiP-NP)
  - Patient Reported Outcome Measures (Self-Reports)
    - DSM-5 Self-Rated Level 1 Cross-Cutting Symptoms Measure - Adult
    - Patient Reported Outcomes Measurement Information System (PROMIS) Adult Depression Computerized Adaptive Test (CAT)
    - PROMIS Adult Anxiety CAT
    - World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0)
  - DSM-5 Clinician-Rated Dimensions of Psychosis Symptom Severity
  - NINDS CDEs, Neuro-QOL, NIDA Substance Abuse HER Data Elements, NIH Toolbox

Deliverables: Data

- Collect data on 10,000 cases over 4 years and deposit all item-level data in NDA (enrollment targets are 325 cases per site/year, yielding ~1300 cases/year for the network, or ~5200 cases over the 4-year period of data collection).
- Inclusion/Exclusion criteria:
  - Broad: representative of clinical NP services nationally
  - dementia and degenerative conditions, epilepsies (including psychogenic non-epileptic seizures [PNES]), movement disorders, and other complex neuropsychiatric disorders
  - In all these syndromes, depression, anxiety, or psychotic symptoms are either directly part of the differential diagnosis (e.g., “dementia vs depression”) or the psychiatric symptoms may be critical moderators of cognitive impairment

NNN Enrollment

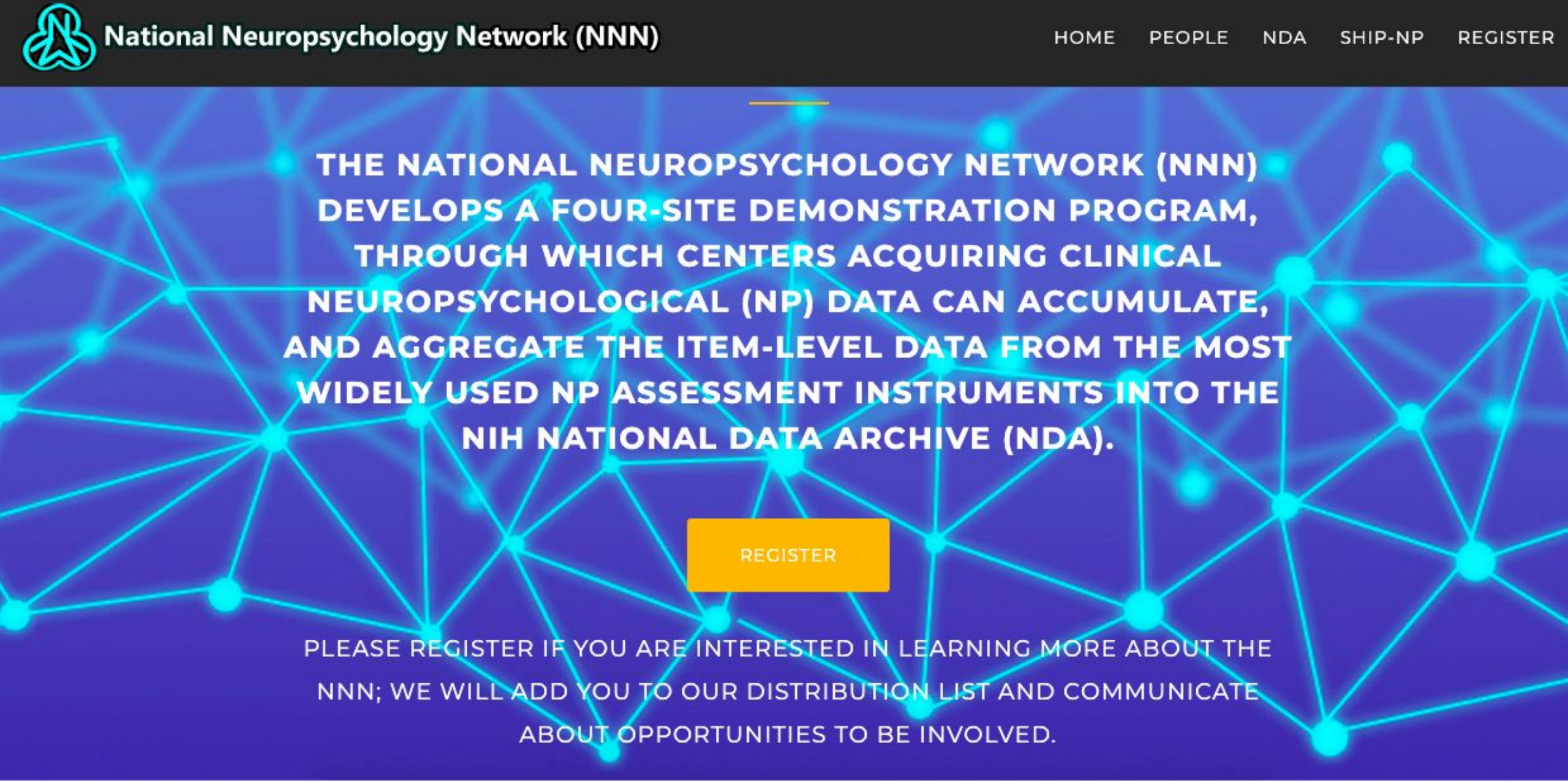


Deliverables: Results

- Evidence-based battery selection – this includes adaptive test selection within batteries of tests, to determine which test in the battery provides the highest predictive power for selected differential diagnostic applications, given prior test results
- Computerized adaptive tests – including adaptive item selection within tests, given prior item results, to provide measurement of specific traits with prescribed levels of precision
- Fixed short-forms of tests that increase efficiency of testing even when adaptive testing is not practical
- Analyses will examine test operating characteristics, sensitivity, specificity, positive and negative predictive power of both original and new measures to aid in differential diagnosis of neurocognitive disorders and major psychiatric syndromes
- Establish a testbed for evidence, enabling future measures to be examined directly for equivalence or superiority

Next steps -- on to the Future

- Expand data elements/tests to include both English & Spanish, over time add other languages
- National NP Network in the USA could serve as model for international development
- Modern psychometric specs critical for alignment with test characteristics in other languages and cultures
  - For this – various methods to identify invariance including DIF, “harmonization” and “phenotype alignment” may help
- Ideal – a global bank of methods to be shared freely, used to expand access to high quality NP services and reduce health disparities, and increase knowledge about human health and disease in the broadest sense



https://www.sistat.ucla.edu/NNNWeb/index.html