



Data Formatting: Challenges and Potential Solutions

Central Nervous System Injury as a Use Case

Adam R. Ferguson, Ph.D.

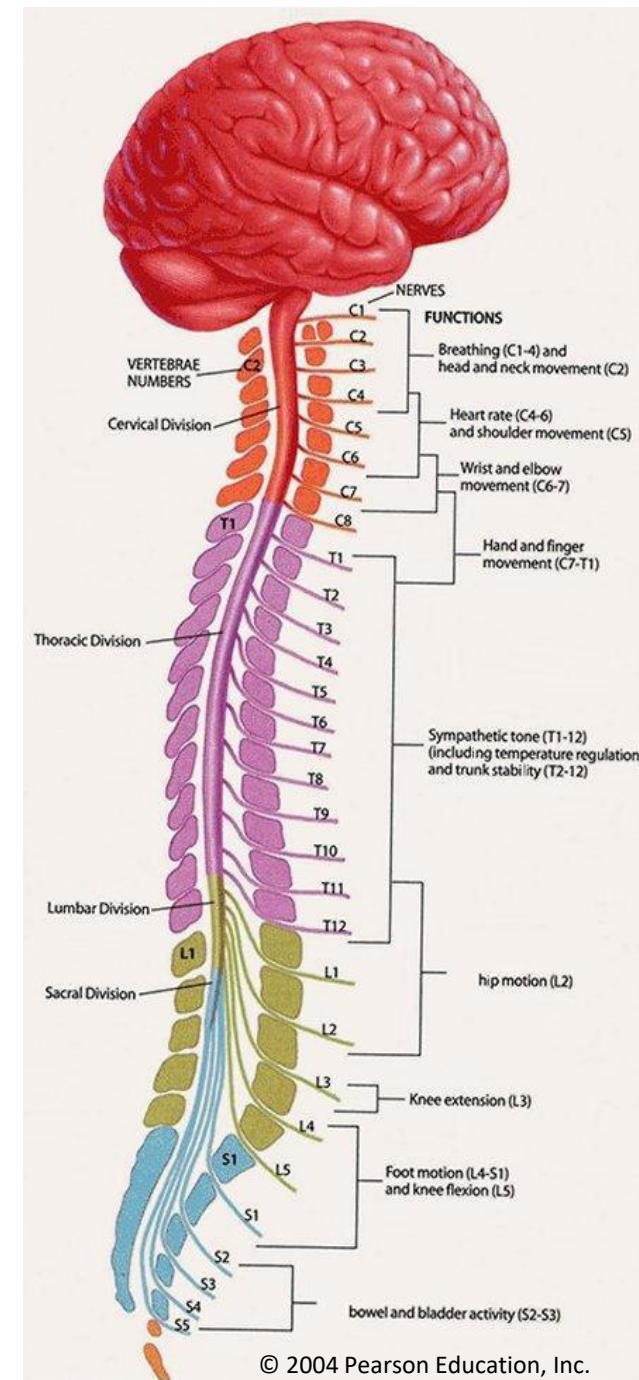
Director of Data Science Brain and Spinal Injury Center (BASIC)

Associate Professor, Department of Neurological Surgery

Weill Institute for Neurosciences, UCSF

Principal Investigator, SFVAHCS

Central Nervous System (CNS) Injury is Complex!



Gazillions of tiny measures of biofunction

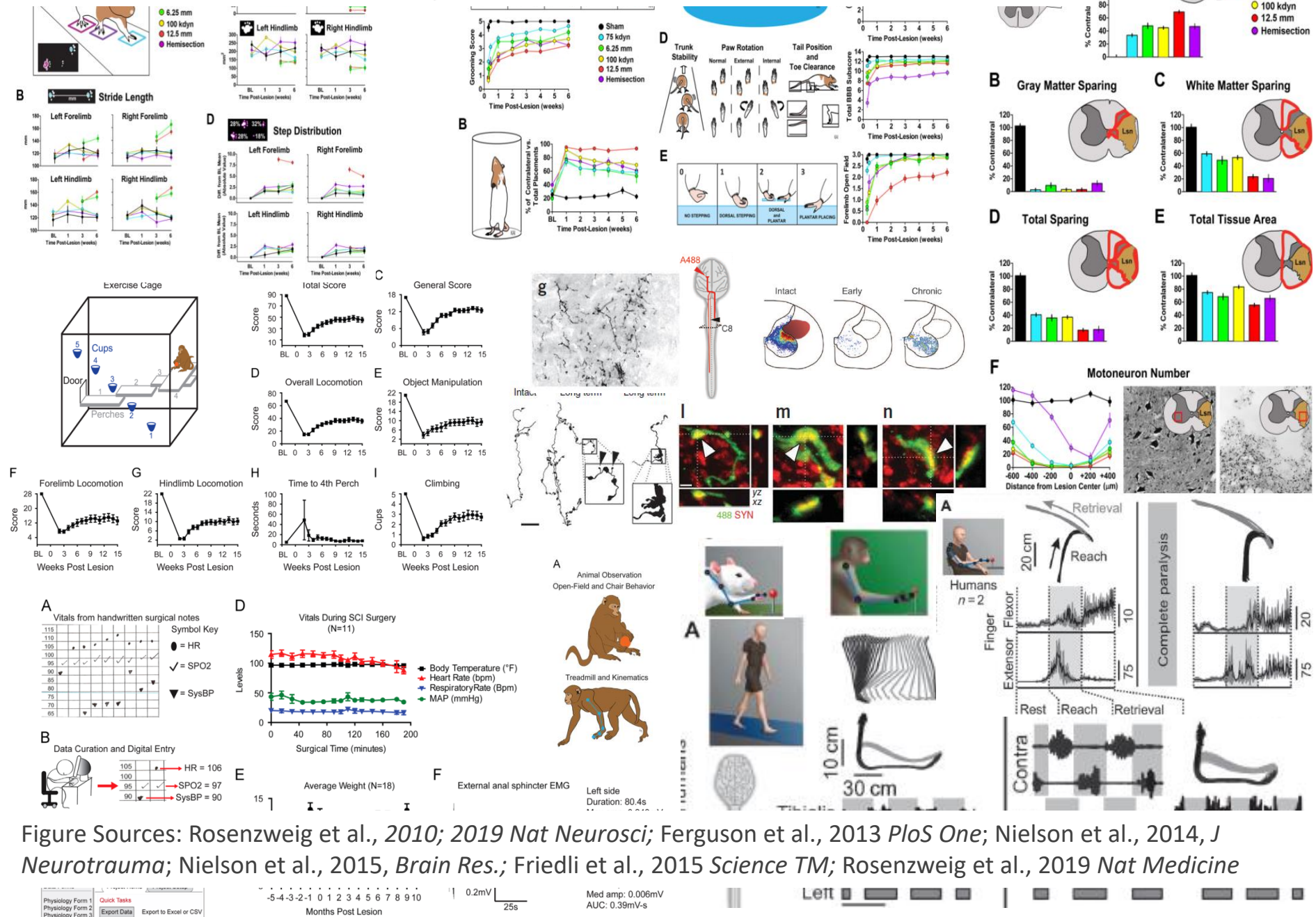


Figure Sources: Rosenzweig et al., 2010; 2019 *Nat Neurosci*; Ferguson et al., 2013 *PloS One*; Nielson et al., 2014, *J Neurotrauma*; Nielson et al., 2015, *Brain Res.*; Friedli et al., 2015 *Science TM*; Rosenzweig et al., 2019 *Nat Medicine*

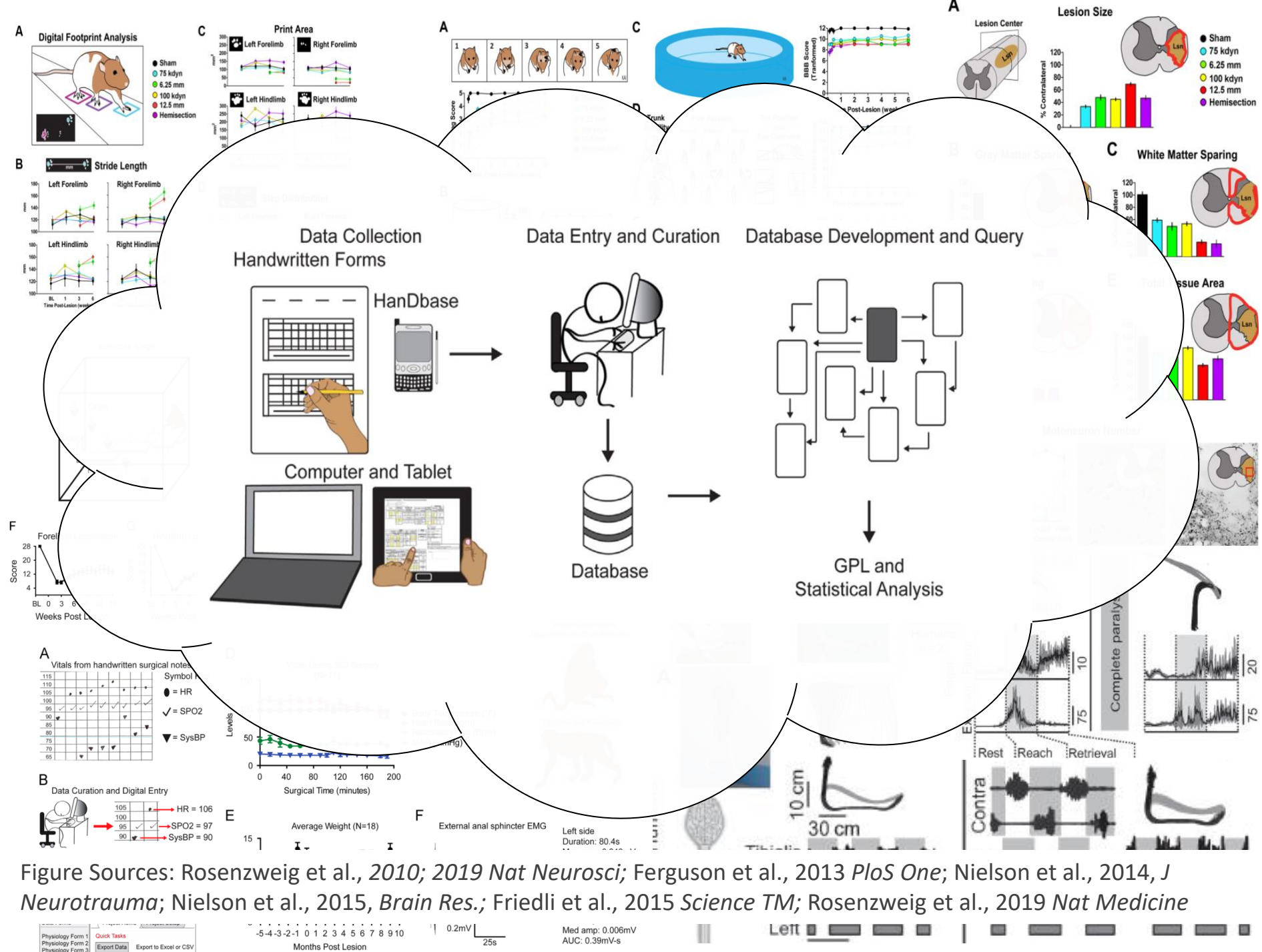


Figure Sources: Rosenzweig et al., 2010; 2019 *Nat Neurosci*; Ferguson et al., 2013 *PloS One*; Nielson et al., 2014, *J Neurotrauma*; Nielson et al., 2015, *Brain Res.*; Friedli et al., 2015 *Science TM*; Rosenzweig et al., 2019 *Nat Medicine*

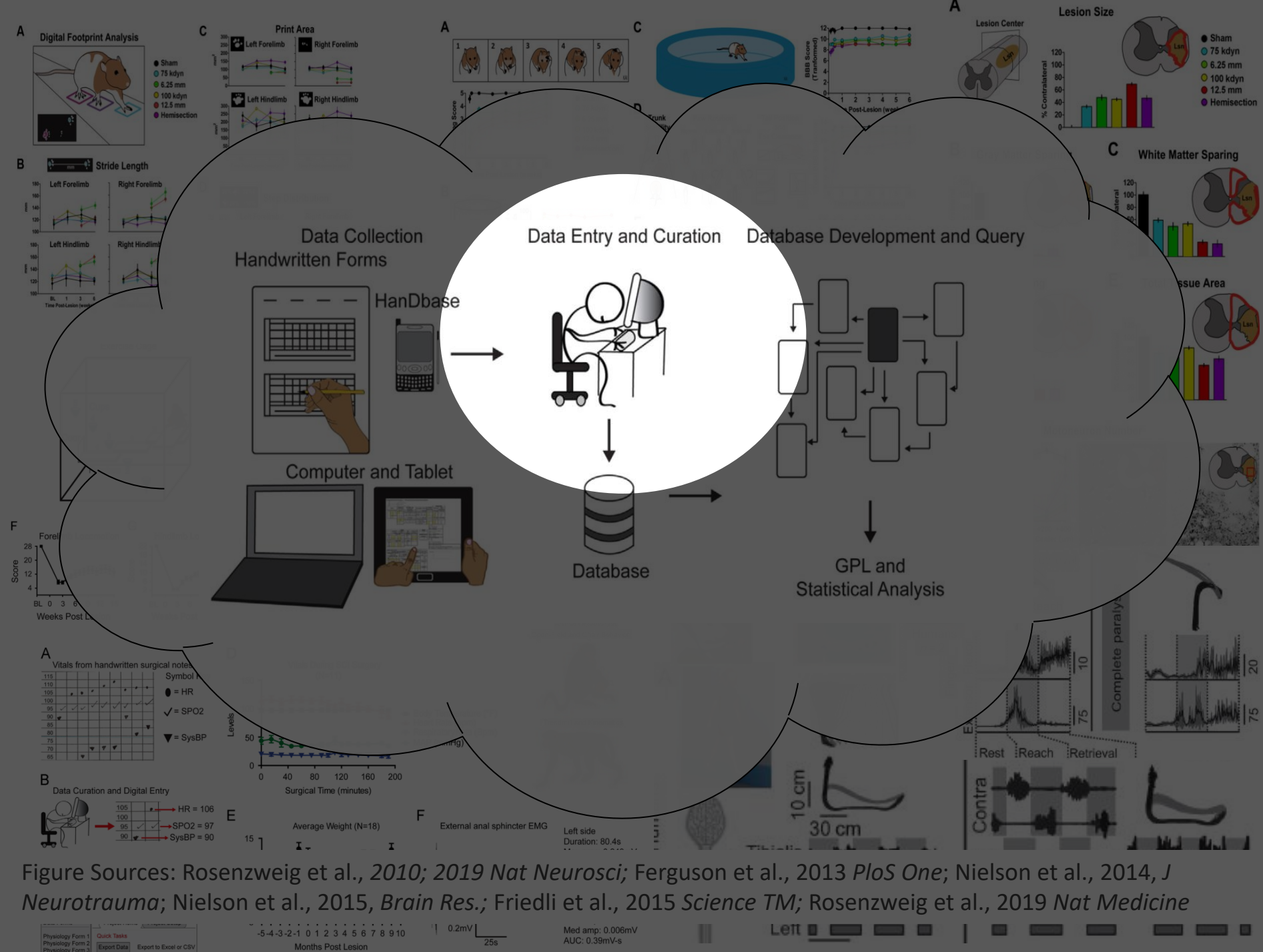


Figure Sources: Rosenzweig et al., 2010; 2019 *Nat Neurosci*; Ferguson et al., 2013 *PloS One*; Nielson et al., 2014, *J Neurotrauma*; Nielson et al., 2015, *Brain Res.*; Friedli et al., 2015 *Science TM*; Rosenzweig et al., 2019 *Nat Medicine*

CNS Injury as a 'big data' problem?



- volume
- velocity
- variety

Ferguson et al., Nat Neuro 2014;
Huie et al., 2019, *Curr Opin. Neurology*

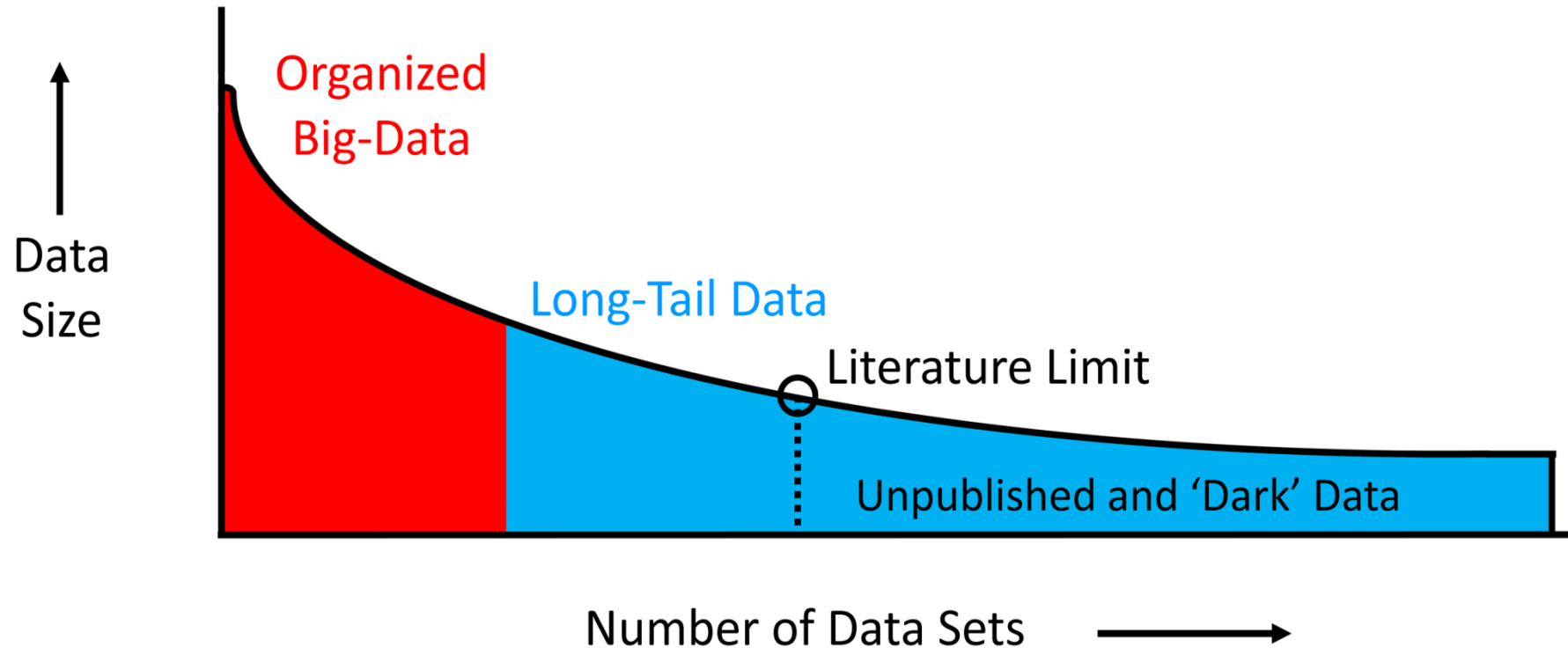
CNS Injury as a 'big data' problem?



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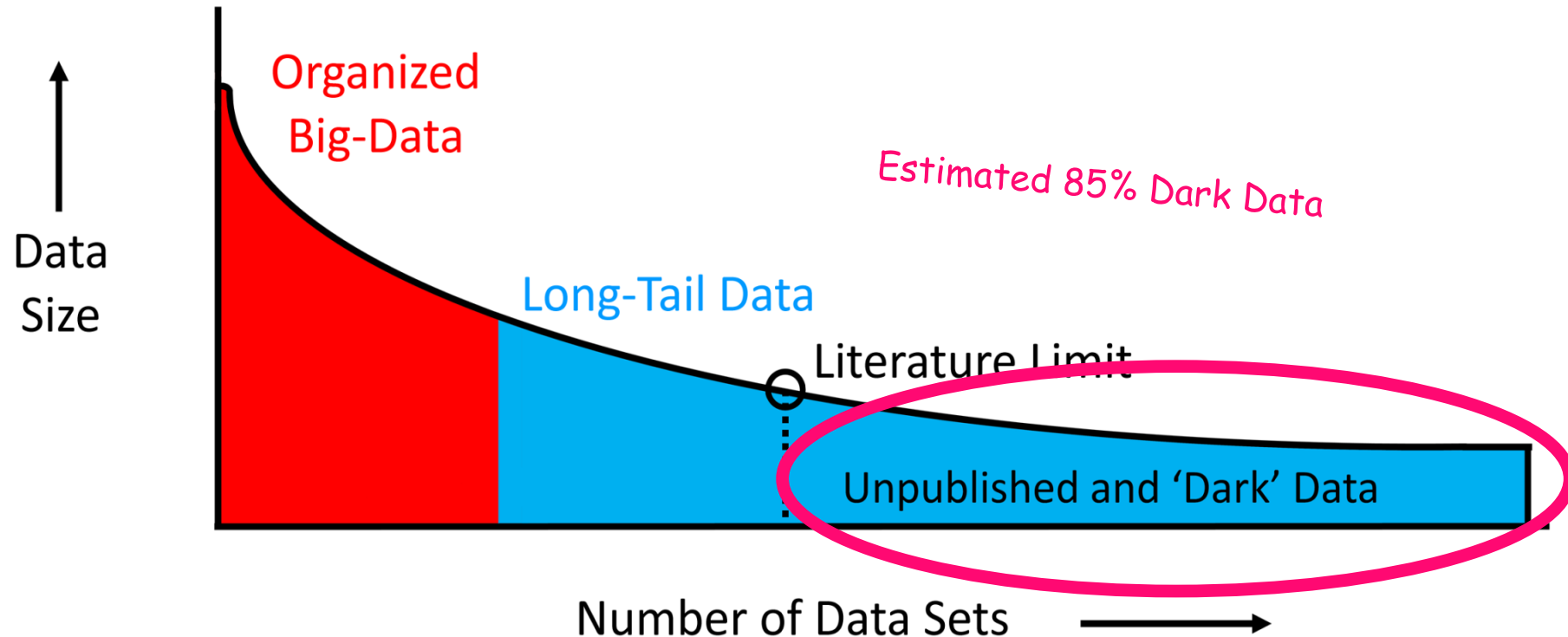
Ferguson et al., Nat Neuro 2014;
Huie et al., 2019, *Curr Opin. Neurology*

TOWARD 'DATAFICATION' OF BIOMEDICAL RESEARCH



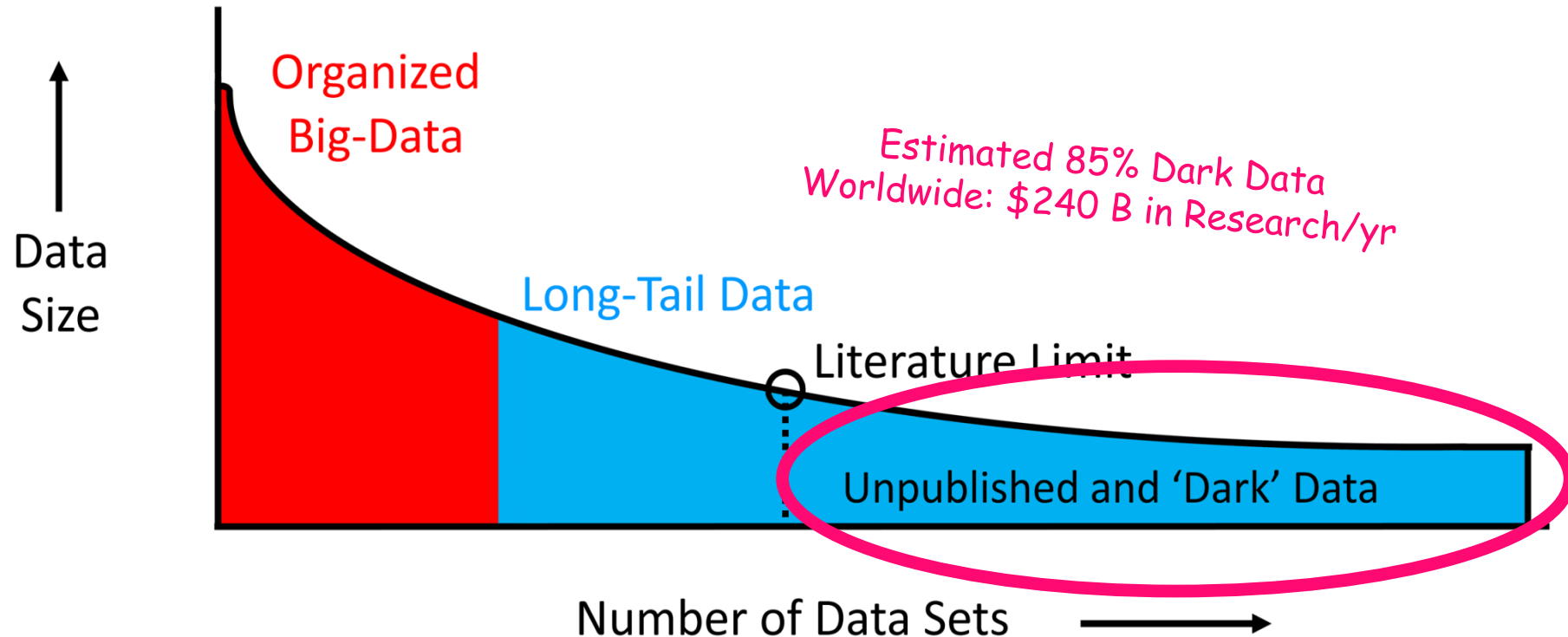
Ferguson et al., 2014, *Nature Neuroscience*
Huie et al., 2019, *Current Opinion in Neurology*
Hawkins et al., 2019, *Journal of Neurotrauma*

TOWARD 'DATAFICATION' OF BIOMEDICAL RESEARCH



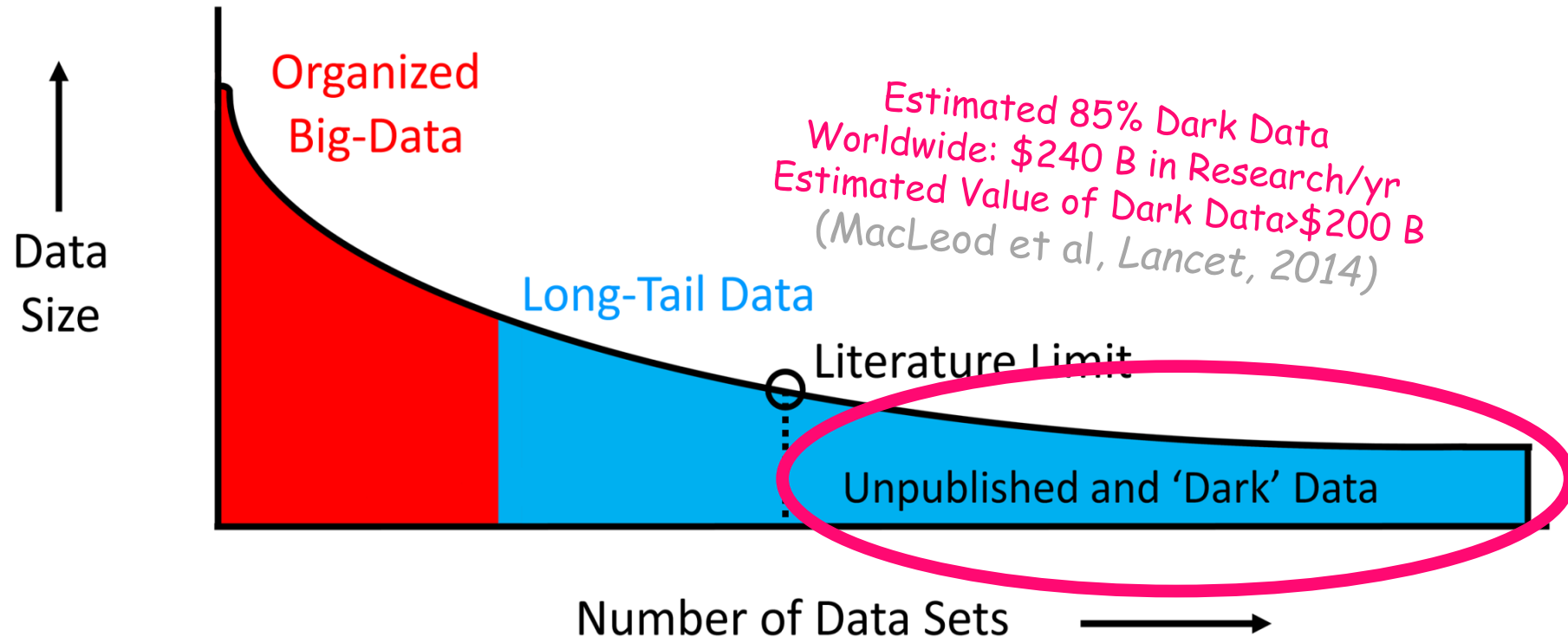
Ferguson et al., 2014, *Nature Neuroscience*
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Hawkins et al., 2019, *Journal of Neurotrauma*

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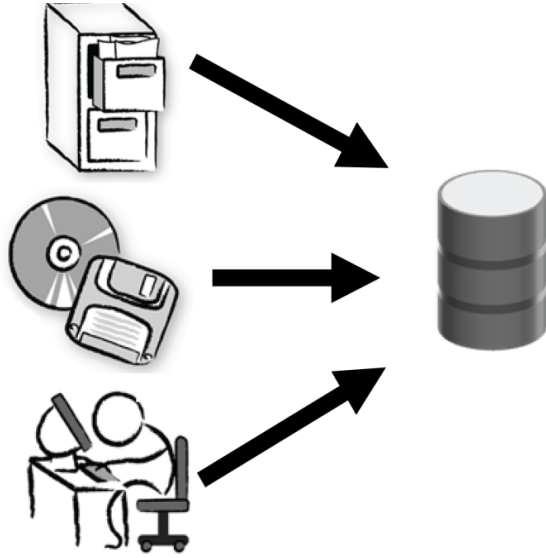
TOWARD 'DATAFICATION' OF BIOMEDICAL RESEARCH



Ferguson et al., 2014, *Nature Neuroscience*
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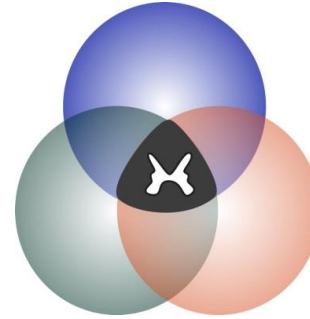
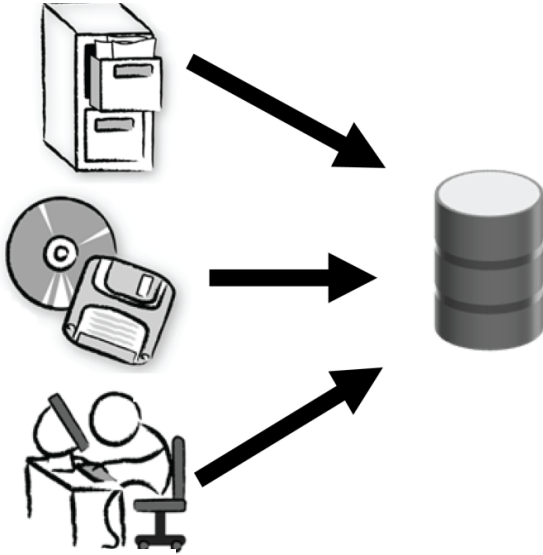
Raw Data
Sources

Multispecies
Data Repository



Raw Data
Sources

Multispecies
Data Repository



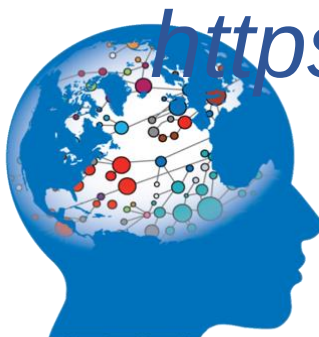
*Open Data
Commons for
SCI*
<https://odc-sci.org>



*Open Data
Commons for
TBI*



VA Gordon
Mansfield SCI
Consortium



<https://odc-tbi.org>

TRACK-TBI

Transforming Research and Clinical Knowledge
in Traumatic Brain Injury

International Traumatic Brain Injury Research Initiative



TRACK-SCI
TRANSFORMING RESEARCH AND CLINICAL
KNOWLEDGE IN SPINAL CORD INJURY

Developing a FAIR Share Community

Sharing Data that is

Findable

Accessible

Interoperable

Reusable

October 4-5, 2016
6001 Executive Blvd.
North Bethesda, MD

FAIR-SCI Ahead

SCI Preclinical Community
Readiness and Next Steps

Washington DC,
November 10, 2017

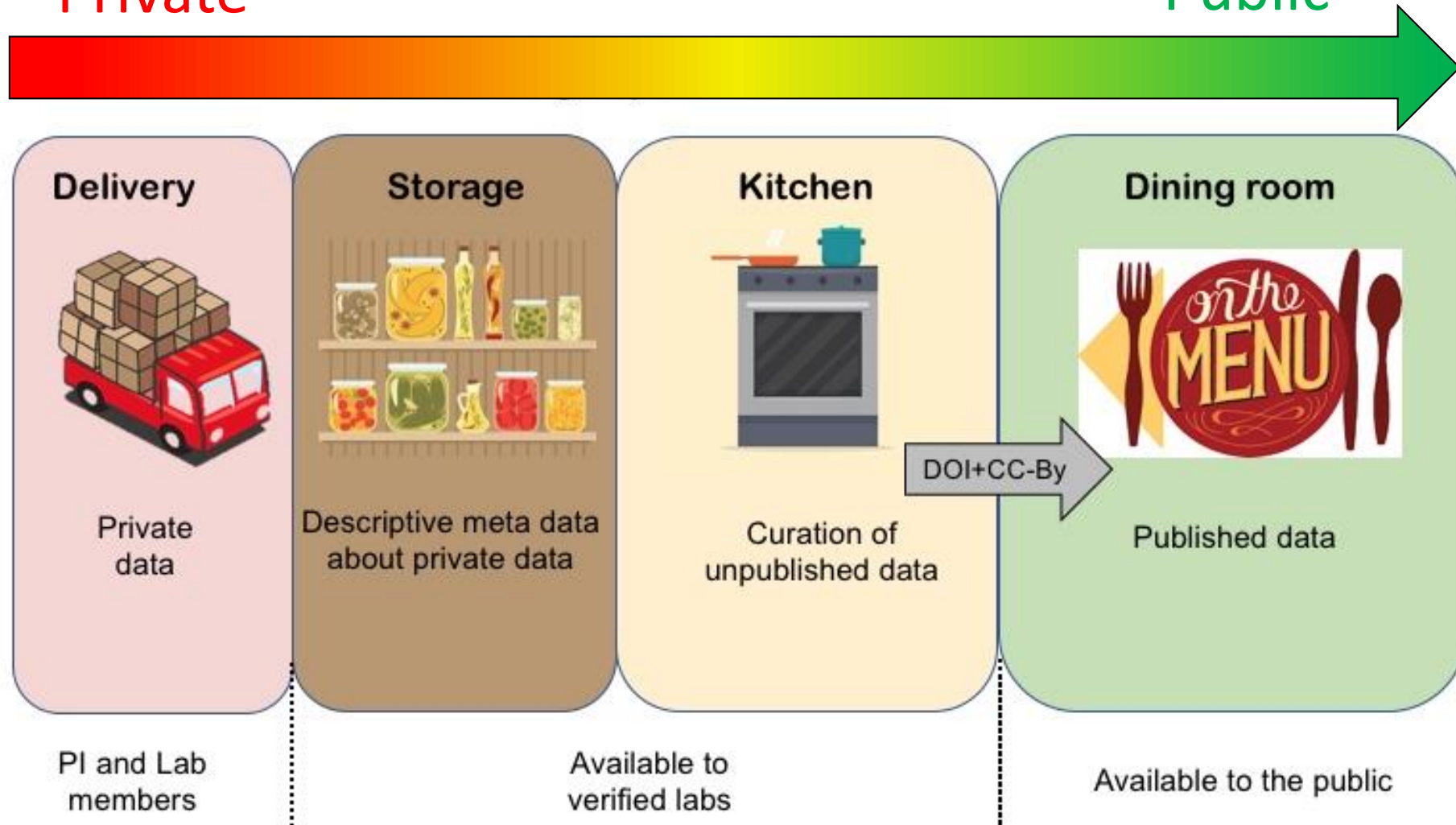
STREET-FAIR

SCI Team Research, Enabling Expansion
and Translation of FAIR data sharing

November 4, 2018
San Diego, CA

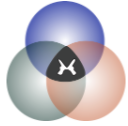
Private

Public



HTTP://ODC-SCI.ORG

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So you now have big data...
THEN WHAT??



? ? ?
? ? ?



Abel Torres-Espín, PhD
Now: Assistant Prof. UCSF



TOOLS AND RESOURCES



Reproducible analysis of disease space via principal components using the novel R package syndRomics

**Abel Torres-Espín^{1,2,3}, Austin Chou^{1,2,3}, J Russell Huie^{1,2,3}, Nikos Kyritsis^{1,2,3},
Pavan S Upadhyayula⁴, Adam R Ferguson^{1,2,3,5*}**

Torres-Espín et al. eLife 2021;10:e61812. DOI: <https://doi.org/10.7554/eLife.61812>



Jessica Nielson, PhD
Now: Assistant Professor University of Minnesota
Dept. Psychiatry and Institute of Health Informatics (IHI)



ARTICLE

Received 1 Jun 2015 | Accepted 6 Sep 2015 | Published 14 Oct 2015

DOI: 10.1038/ncomms9581

OPEN

Topological data analysis for discovery in preclinical spinal cord injury and traumatic brain injury

Jessica L. Nielson¹, Jesse Paquette², Aiwen W. Liu¹, Cristian F. Guandique¹, C. Amy Tovar³, Tomoo Inoue⁴, Karen-Amanda Irvine⁵, John C. Gensel⁶, Jennifer Klope⁷, Tanya C. Petrossian⁸, Pek Y. Lum⁹, Gunnar E. Carlsson^{7,10}, Geoffrey T. Manley¹, Wise Young¹¹, Michael S. Beattie¹, Jacqueline C. Bresnahan¹ & Adam R. Ferguson^{1,12}

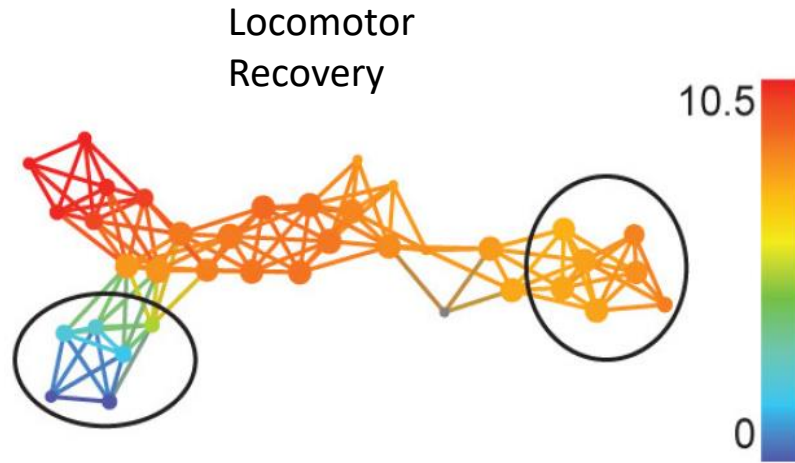
Long-tail data archive: Multicenter animal spinal cord injury study (MASCIS) 1994-1996



Data integration
team

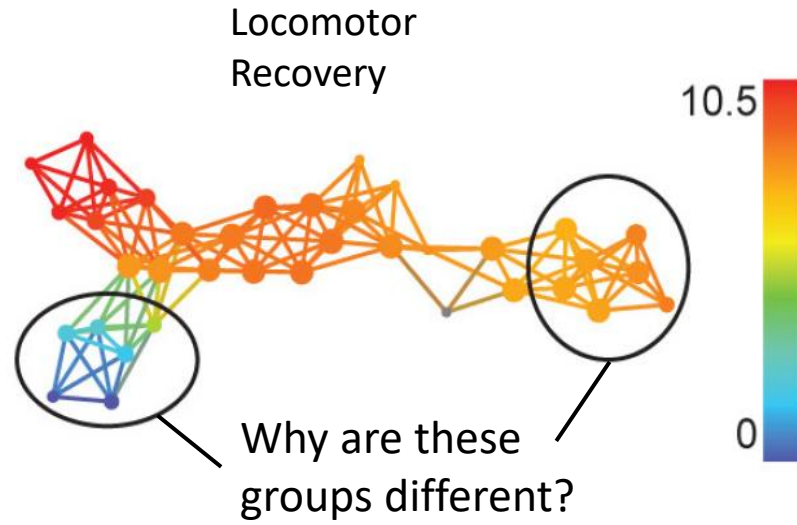


Multicenter Animal SCI Study (MASCIS 1994-96)



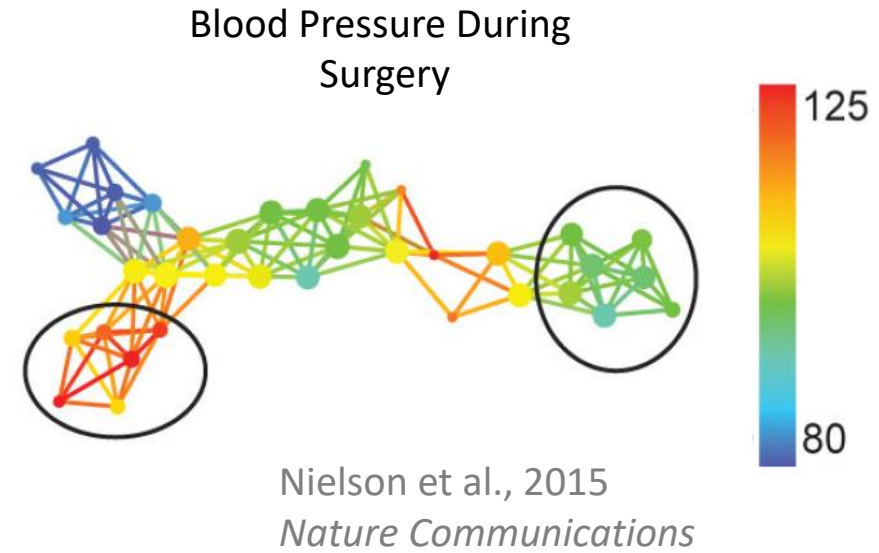
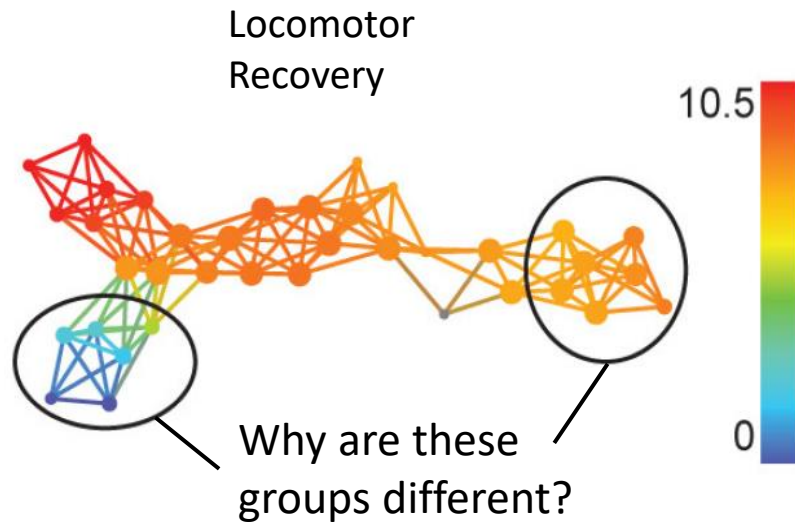
Nielson et al., 2015
Nature Communications

Multicenter Animal SCI Study (MASCIS 1994-96)



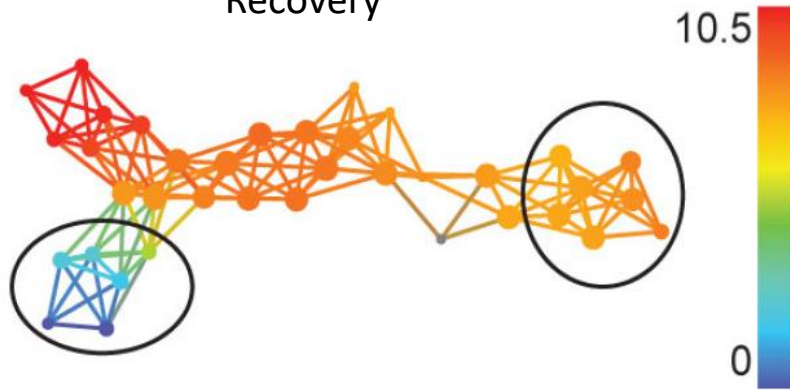
Nielson et al., 2015
Nature Communications

Multicenter Animal SCI Study (MASCIS 1994-96)

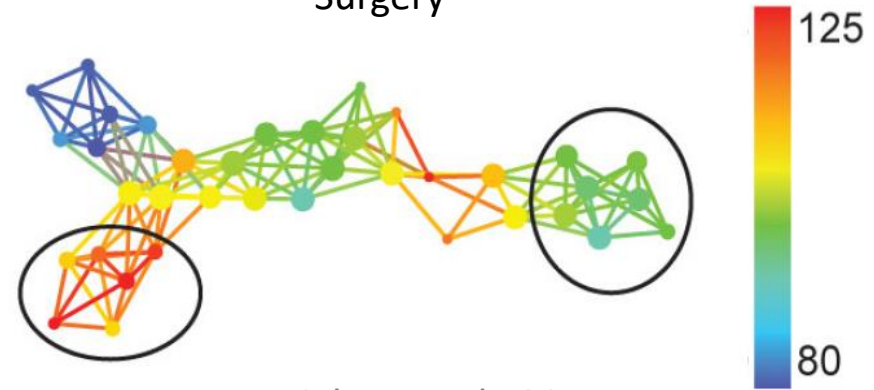


Multicenter Animal SCI Study (MASCIS 1994-96)

Locomotor
Recovery



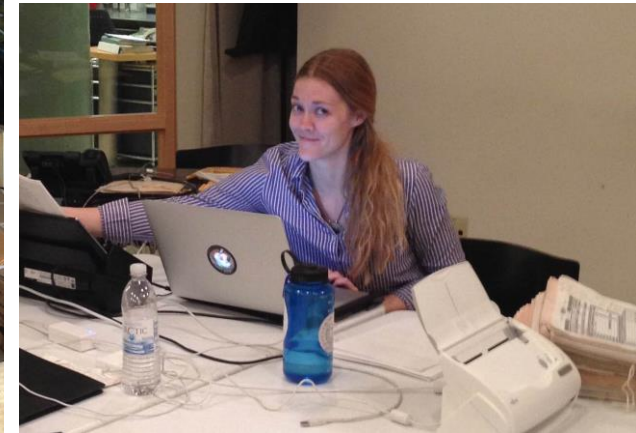
Blood Pressure During
Surgery

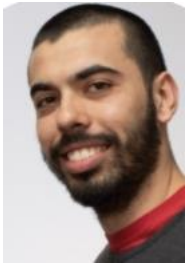


Nielson et al., 2015
Nature Communications



Jessica Nielson, PhD





Carlos Almeida, MS
Current PhD Student, University of Louisville

Neuroinformatics

<https://doi.org/10.1007/s12021-021-09512-z>

ORIGINAL ARTICLE

Excavating FAIR Data: the Case of the Multicenter Animal Spinal Cord Injury Study (MASCIS), Blood Pressure, and Neuro-Recovery

Carlos A. Almeida¹ • Abel Torres-Espin¹ • J. Russell Huie¹ • Dongming Sun² • Linda J. Noble-Haeusslein^{3,4} • Wise Young² • Michael S. Beattie¹ • Jacqueline C. Bresnahan¹ • Jessica L. Nielson^{5,6} • Adam R. Ferguson^{1,7} 

Accepted: 11 January 2021

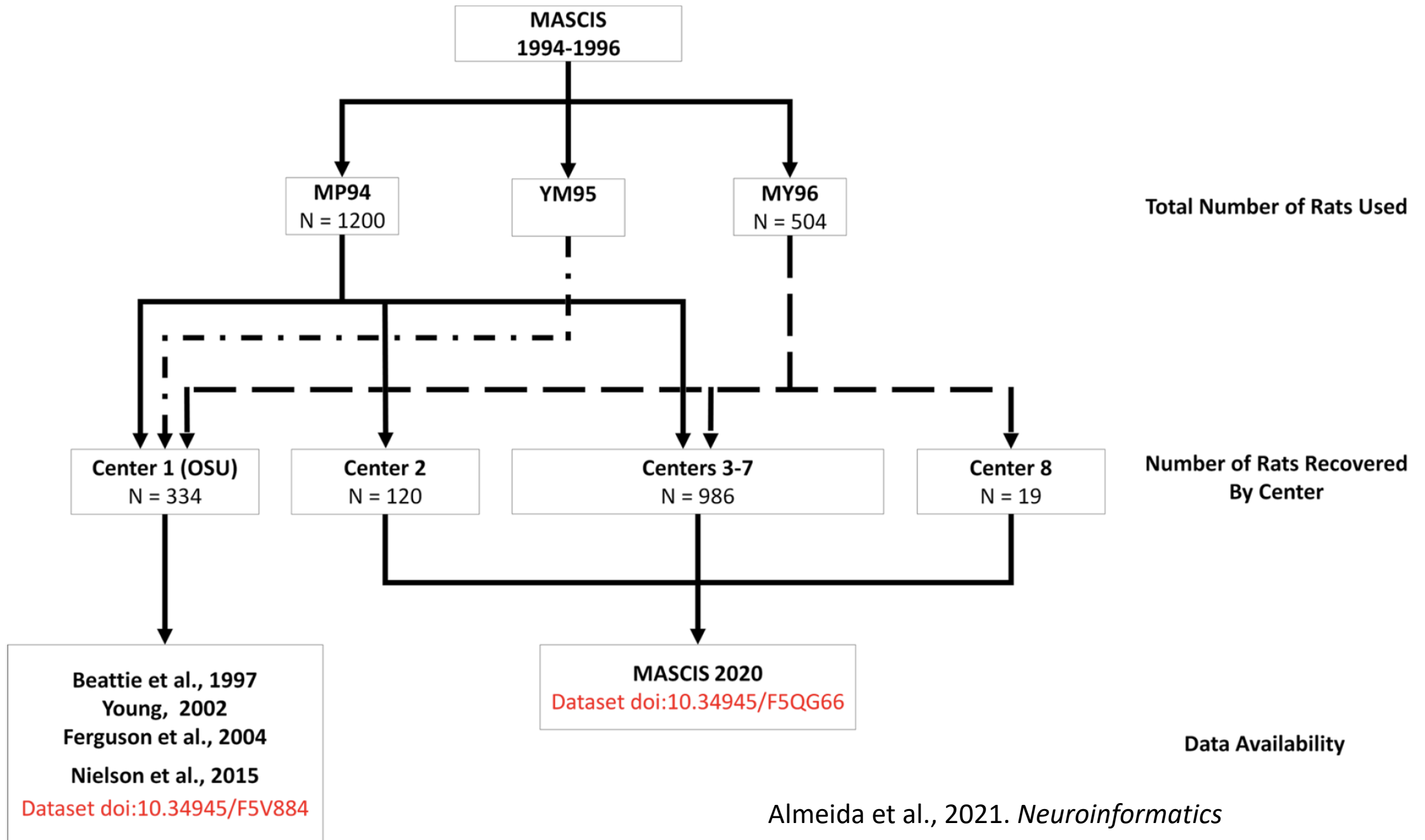
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Individual Rats

Variables

Unique Subject Identifier	Sex	Birth_Date	Perfusion_Date	InjuryCondition	Baseline_Weight	LesionSurgery_Date	Pento_Initial_Route	Pento_Initial_Time	Pento_Initial_dose	Pento_Initial_vol
Center 2, Rat 078										
Center 2, Rat 079										
Center 2, Rat 080										
Center 3, Rat 007										
Center 4, Rat 049										
Center 4, Rat 051										
Center 4, Rat 055										
Center 4, Rat 056										
Center 5, Rat 009										
Center 5, Rat 010										
Center 5, Rat 014										

 Data Recovered  Data Missing



Takeaway Messages:

1) *Long-tail* and *Dark data* comprise majority of biomedical research data.

2) User-facing (community) repositories provide a way to make these data FAIR, open and reusable by both human and machine intelligence tools.

TECHNOLOGY FEATURE

Dark data see the light

Ellen P. Neff

LabAnimal

46 Volume 47, No. 2 | FEBRUARY 2018

NEWS FEATURE

Predictable response:

Finding optimal drugs and doses using artificial intelligence

By Shraddha Chakradhar

NATURE MEDICINE VOLUME 23 | NUMBER 11 | NOVEMBER 2017

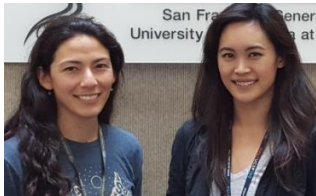
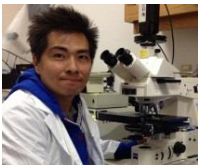
UCSF Weill Institute for
Neurosciences

Brain and Spinal
Injury Center



ZUCKERBERG
SAN FRANCISCO GENERAL
Hospital and Trauma Center





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Questions?