### List of Suggested Reviewers or Reviewers Not To Include (optional)

**SUGGESTED REVIEWERS:**

Sylvia Anton, Angers cedex 01, France Silvia Arber, Basel, CH

**Abdel ElManira, Stockholm, SE Jan-Marino Ramirez, Seattle, USA Keith Sillar, St. Andrews, Sco Hans Straka, LMU, Munich**

**REVIEWERS NOT TO INCLUDE:**

**Not Listed**

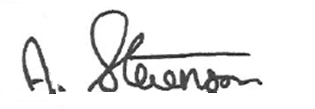


11 June 2019

Dear United States National Science Foundation

I am an authorized representative from the University of Lincoln (UK) and I confirm, on behalf of the University of Lincoln, that the research network between Professor Gregory Sutton (University of Lincoln, UK), Professor Roger Quinn (Case Western Reserve University, USA), Professor Ansgar Büschges (University of Cologne, German), Dr. Jan Ache (University of Würzburg, Germany), Professor Kei Ito (University of Cologne, Germany), Dr. Alexander Blanke (University of Cologne, Germany), Professor Hillel Chiel (Case Western Reserve University, USA), Professor Victoria Webster-Wood (Carnegie Mellon University, USA), Professor Cynthia Chestek (University of Michigan, USA), Professor Martin Fischer (Friedrich-Schiller-Universität, Germany), Professor Alexander Hunt (Portland State University, USA), Professor Marie-Claude Perreault (Emory University, USA), Professor Matthew Tresch (Northwestern University, USA), and Professor CJ Heckman (Northwestern University, USA) is endorsed and has been submitted by University of Lincoln Research Office.

Yours sincerely,



Andrew Stevenson

Director, Research and Enterprise University of Lincoln

Research & Enterprise

**University of Lincoln Brayford Pool Lincoln LN6 7TS United Kingdom**

[www.lincoln.ac.uk](http://www.lincoln.ac.uk/) T +44 (0)1522 837200 F +44 (0)1522 837201 [enterprise@lincoln.ac.uk](mailto:enterprise@lincoln.ac.uk)

|  |
| --- |
| [**The following information regarding collaborators and other affiliations (COA) must be separately provided for each**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)  [**individual identified as senior project personnel. The COA information must be provided through**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **use of this COA template.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane** [**Colla**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**borators and Other Affiliations single copy doc. Do not upload .pdf.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se note that some information requested in prior versions of the PAPPG is no longer requested. THIS IS PURPOSEFUL** [**AND**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **WE NO LONGER REQUIRE THIS INFORMATION TO BE REPORTED. Certain relationships will be reported in other sections** [**(i.e.,**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **the names of postdoctoral scholar sponsors should not be reported, however if the individual collaborated on research** [**with**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **their postdoctoral scholar sponsor, then they would be reported as a collaborator). The information in the tables is not** [**requ**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**ired to be sorted, alphabetically or otherwise.** |
| **There are five separate categories of information which correspond to the five tables in the COA template: COA template Table 1:**  **List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.** |
| **COA template Table 2:**  **List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.** |
| **COA template Table 3:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **The individual’s Ph.D. advisors; and** * **All of the individual’s Ph.D. thesis advisees.** |
| **COA template Table 4:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be**   **later); and**   * **Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.** |
| **COA template Table 5:**  **List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire**  **editorial board.**   * **Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and** * **Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.** |

The template has been developed to be fillable, however, the content and format requirements must not be altered by the user. This template must be saved in .xlsx or .xls format, and directly uploaded into FastLane as a Collaborators and Other Affiliations Single Copy Document. Using the .xlsx or .xls format will enable preservation of searchable text that otherwise would be lost. It is therefore imperative that this document be uploaded in .xlsx or .xls only. Uploading a document in any format other than .xlsx or .xls may delay the timely processing and review of the proposal.

**This information is used to manage reviewer selection. See Exhibit II-2 for additional information on potential reviewer**

**conflicts.**

1. **Note that graduate advisors are no longer required to be reported.**
2. **Editorial Board does not include Editorial Advisory Board, International Advisory Board, Scientific Editorial Board, or any other subcategory of Editorial Board. It is limited to those individuals who perform editing duties or manage the editing process (i.e., editor in chief).**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department (optional) Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and**

**To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. For "Last Active Date" and "Last Active" columns dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**“Last Active Date” and “Last Active” columns may be left blank for ongoing or current affiliations.**

**Table 1: List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

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| --- | --- | --- | --- |
| **1** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Quinn, Roger, D. | Case Western Reserve University |  |
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**Table 2: List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2** | **Name:** | **Type of Relationship** | **Optional (email, Department)** | **Last Active** |
| R: |  |  |  |  |
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Table 3: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following.

G: The individual’s Ph.D. advisors; and

**T: All of the individual’s Ph.D. thesis advisees.**

*to disambiguate common names*

|  |  |  |  |
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| **3** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |
| G: | Meirovitch, Leonard | Virginia Tech |  |

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| --- | --- | --- | --- |
| T: | Bachmann, Richard | CWRU |  |
| T: | Birch, Matthew | Remington |  |
| T: | Causey, Gregory | Consultant, Broofield, CO |  |
| T: | Chen, Chun-ta | Taiwan |  |
| T: | Chen, Jiunn |  |  |
| T: | Choi, Jongung |  |  |
| T: | Daltorio, Kathryn | CWRU |  |
| T: | Espenschied, Kenneth | Nordson |  |
| T: | Grodsinsky, Carlos | Zin Technologies |  |
| T: | Hunt, Alexander | Portland State |  |
| T: | Jeong, Chan-doo | Samsung |  |
| T: | Kaliyamoorthy, Sathya | Apple |  |
| T: | Kernbaum, Alexander | SRI |  |
| T: | Kernbaum, Nicole | Superflex Technologies |  |
| T: | Kingsley, Daniel | Exponent |  |
| T: | Kolacinski, Richard | Draper Labs |  |
| T: | Laksanacharoen, Sathaporn | Thailand |  |
| T: | Lee, Eunjeong |  |  |
| T: | Lewinger, William | University of Dundee |  |
| T: | Li, Wei | Private company in China |  |
| T: | Lin, Nan-jou | Taichung, Taiwan |  |
| T: | Mirletz, Brian | Catalia |  |
| T: | Nelson, Gabriel | Boston Dynamics |  |
| T: | Reinhardt, Andrew | Goodyear |  |
| T: | Rutkowski, Adam | Eglin Air Force Base |  |
| T: | Rutter, Brandon | Badgersett Farms |  |
| T: | Sari, Kemal |  |  |
| T: | Szczecinski, Nicholas | CWRU |  |
| T: | Taylor, Brian | University of North Carolina |  |
| T: | Vaidyanathan, Ravi | Imperial College |  |
| T: | Webster-Wood, Victoria | CMU |  |
| T: | Wei, Terence | Bridgestone |  |
| T: | Xie, Yang |  |  |
| T: | Yunis, Isam | NASA |  |
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Table 4: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:

A: Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may

**be later); and**

**C: Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

*to disambiguate common names*

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| --- | --- | --- | --- | --- |
| **4** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
| C: | Akkus, Ozan | CWRU |  |  |
| C: | Audu, Musa | CWRU |  |  |
| A: | Bracun, Drago | University of Ljubljana |  |  |
| A: | Bender, John | General UI Company |  |  |

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| --- | --- | --- | --- | --- |
| A: | Brown, Amy | Univ. of Illinois |  |  |
| A: | Büschges, Ansgar | Univ. of Cologne |  |  |
| A: | Chang, Sarah |  |  |  |
| C: | Chiel, Hillel | CWRU |  |  |
| A: | Diller, Eric | University of Toronto |  |  |
| A: | Endo, Yoichiro |  |  |  |
| C: | Fischer, Martin | University of Jena, Germany |  |  |
| A: | Gorb, Stanislav | Kiel University, Germany |  |  |
| A: | Guo, Peiyuan | Vanderbilt |  |  |
| A: | Harley, Cynthia | University of Minnesota |  |  |
| A: | Hart, Charles | CMU |  |  |
| C: | Huang, Helen | North Carolina State |  |  |
| A: | Hughes, Bradley | National Instruments |  |  |
| C: | Kobetic, Rudi | Cleveland Veterans Administration |  |  |
| A: | Kreinar, Edward J. | Setter Research |  |  |
| C: | Lee, Greg | CWRU |  |  |
| C: | Martin, Joshua | Colby College |  |  |
| C: | Merat, Frank | CWRU |  |  |
| A: | Michaels, Simone | Northrop Grummon Aerospace Systems |  |  |
| A: | Mu, Laiyong | U of Arizona |  |  |
| C: | Newman, Wyatt | CWRU |  |  |
| A: | Palmer, Luther | Wright State Unversity |  |  |
| A: | Prescott, Tony | Sheffield |  |  |
| C: | Ritzmann, Roy | CWRU |  |  |
| C: | Rybak, Ilya | Drexel |  |  |
| A: | Smith, Lauren | Northrop Grummon Aerospace Systems |  |  |
| A: | SunSpiral, Vytas | NASA Ames |  |  |
| C: | Svenson, Gavin | Cleveland Museum of Natural History |  |  |
| C: | Triolo, Ronald | CWRU |  |  |
| C: | Tyler, Dustin | CWRU |  |  |
| C: | Willis, Mark | CWRU |  |  |
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Table 5: List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief

**must list the entire editorial board.**

B: Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and

**E: Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

*to disambiguate common names*

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| --- | --- | --- | --- | --- |
| **5** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
| B: | Trimmer, Barry | Tufts University | Soft Robotics |  |
| E: |  |  |  |  |
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dŚĞ ĨŽůůŽǁŝŶŐ ŝŶĨŽƌŵĂƚŝŽŶ ƌĞŐĂƌĚŝŶŐ ĐŽůůĂďŽƌĂƚŽƌƐ ĂŶĚ ŽƚŚĞƌ ĂĨĨŝůŝĂƚŝŽŶƐ ;CKAͿ ŵƵƐƚ ďĞ ƐĞƉĂƌĂƚĞůǇ ƉƌŽǀŝĚĞĚ ĨŽƌ ĞĂĐŚ ŝŶĚŝǀŝĚƵĂů ŝĚĞŶƚŝĨŝĞĚ ĂƐ ƐĞŶŝŽƌ ƉƌŽũĞĐƚ ƉĞƌƐŽŶŶĞů͘ dŚĞ CKA ŝŶĨŽƌŵĂƚŝŽŶ ŵƵƐƚ ďĞ ƉƌŽǀŝĚĞĚ ƚŚƌŽƵŐŚ ƵƐĞ ŽĨ ƚŚŝƐ CKA ƚĞŵƉůĂƚĞ͘

**WůĞĂƐĞ ĐŽŵƉůĞƚĞ ƚŚŝƐ ƚĞŵƉůĂƚĞ ;Ğ͘Ő͕͘ EǆĐĞů͕ 'ŽŽŐůĞ ^ŚĞĞƚƐ͕ >ŝďƌĞKĨĨŝĐĞͿ͕ ƐĂǀĞ ĂƐ ͘ǆůƐǆ Žƌ ͘ǆůƐ͕ ĂŶĚ ƵƉůŽĂĚ ĚŝƌĞĐƚůǇ ĂƐ Ă &ĂƐƚůĂŶĞ CŽůůĂďŽƌĂƚŽƌƐ ĂŶĚ KƚŚĞƌ AĨĨŝůŝĂƚŝŽŶƐ ƐŝŶŐůĞ ĐŽƉǇ ĚŽĐ͘ DŽ ŶŽƚ ƵƉůŽĂĚ ͘ƉĚĨ͘**

**WůĞĂƐĞ ŶŽƚĞ ƚŚĂƚ ƐŽŵĞ ŝŶĨŽƌŵĂƚŝŽŶ ƌĞƋƵĞƐƚĞĚ ŝŶ ƉƌŝŽƌ ǀĞƌƐŝŽŶƐ ŽĨ ƚŚĞ WAWW' ŝƐ ŶŽ ůŽŶŐĞƌ ƌĞƋƵĞƐƚĞĚ͘ d,/^ /^ WhZWK^E&h> AED tE EK >KE'EZ ZEYh/ZE d,/^ /E&KZDAd/KE dK BE ZEWKZdED͘ CĞƌƚĂŝŶ ƌĞůĂƚŝŽŶƐŚŝƉƐ ǁŝůů ďĞ ƌĞƉŽƌƚĞĚ ŝŶ ŽƚŚĞƌ ƐĞĐƚŝŽŶƐ**

**;ŝ͘Ğ͕͘ ƚŚĞ ŶĂŵĞƐ ŽĨ ƉŽƐƚĚŽĐƚŽƌĂů ƐĐŚŽůĂƌ ƐƉŽŶƐŽƌƐ ƐŚŽƵůĚ ŶŽƚ ďĞ ƌĞƉŽƌƚĞĚ͕ ŚŽǁĞǀĞƌ ŝĨ ƚŚĞ ŝŶĚŝǀŝĚƵĂů ĐŽůůĂďŽƌĂƚĞĚ ŽŶ ƌĞƐĞĂƌĐŚ ǁŝƚŚ ƚŚĞŝƌ ƉŽƐƚĚŽĐƚŽƌĂů ƐĐŚŽůĂƌ ƐƉŽŶƐŽƌ͕ ƚŚĞŶ ƚŚĞǇ ǁŽƵůĚ ďĞ ƌĞƉŽƌƚĞĚ ĂƐ Ă ĐŽůůĂďŽƌĂƚŽƌͿ͘ dŚĞ ŝŶĨŽƌŵĂƚŝŽŶ ŝŶ ƚŚĞ ƚĂďůĞƐ ŝƐ ŶŽƚ ƌĞƋƵŝƌĞĚ ƚŽ ďĞ ƐŽƌƚĞĚ͕ ĂůƉŚĂďĞƚŝĐĂůůǇ Žƌ ŽƚŚĞƌǁŝƐĞ͘**

**dŚĞƌĞ ĂƌĞ ĨŝǀĞ ƐĞƉĂƌĂƚĞ ĐĂƚĞŐŽƌŝĞƐ ŽĨ ŝŶĨŽƌŵĂƚŝŽŶ ǁŚŝĐŚ ĐŽƌƌĞƐƉŽŶĚ ƚŽ ƚŚĞ ĨŝǀĞ ƚĂďůĞƐ ŝŶ ƚŚĞ CKA ƚĞŵƉůĂƚĞ͗ CKA ƚĞŵƉůĂƚĞ dĂďůĞ ϭ͗**

**>ŝƐƚ ƚŚĞ ŝŶĚŝǀŝĚƵĂů͛Ɛ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĂŶĚ ŽƌŐĂŶŝǌĂƚŝŽŶĂů ĂĨĨŝůŝĂƚŝŽŶ ŝŶ ƚŚĞ ůĂƐƚ ϭϮ ŵŽŶƚŚƐ͘**

**CKA ƚĞŵƉůĂƚĞ dĂďůĞ Ϯ͗**

**>ŝƐƚ ŶĂŵĞƐ ĂƐ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĨŽƌ ǁŚŽŵ Ă ƉĞƌƐŽŶĂů͕ ĨĂŵŝůǇ͕ Žƌ ďƵƐŝŶĞƐƐ ƌĞůĂƚŝŽŶƐŚŝƉ ǁŽƵůĚ ŽƚŚĞƌǁŝƐĞ ƉƌĞĐůƵĚĞ ƚŚĞŝƌ ƐĞƌǀŝĐĞ ĂƐ Ă ƌĞǀŝĞǁĞƌ͘**

**CKA ƚĞŵƉůĂƚĞ dĂďůĞ ϯ͗**

**>ŝƐƚ ŶĂŵĞƐ ĂƐ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĂŶĚ ƉƌŽǀŝĚĞ ŽƌŐĂŶŝǌĂƚŝŽŶĂů ĂĨĨŝůŝĂƚŝŽŶƐ͕ ŝĨ ŬŶŽǁŶ͕ ĨŽƌ ƚŚĞ ĨŽůůŽǁŝŶŐ͗ ͻ dŚĞ ŝŶĚŝǀŝĚƵĂů͛Ɛ WŚ͘D͘ ĂĚǀŝƐŽƌƐ͖ ĂŶĚ**

* **Aůů ŽĨ ƚŚĞ ŝŶĚŝǀŝĚƵĂů͛Ɛ WŚ͘D͘ ƚŚĞƐŝƐ ĂĚǀŝƐĞĞƐ͘**

**CKA ƚĞŵƉůĂƚĞ dĂďůĞ ϰ͗**

**>ŝƐƚ ŶĂŵĞƐ ĂƐ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĂŶĚ ƉƌŽǀŝĚĞ ŽƌŐĂŶŝǌĂƚŝŽŶĂů ĂĨĨŝůŝĂƚŝŽŶƐ͕ ŝĨ ŬŶŽǁŶ͕ ĨŽƌ ƚŚĞ ĨŽůůŽǁŝŶŐ͗**

* **CŽͲĂƵƚŚŽƌƐ ŽŶ ĂŶǇ ďŽŽŬ͕ ĂƌƚŝĐůĞ͕ ƌĞƉŽƌƚ͕ ĂďƐƚƌĂĐƚ Žƌ ƉĂƉĞƌ ǁŝƚŚ ĐŽůůĂďŽƌĂƚŝŽŶ ŝŶ ƚŚĞ ůĂƐƚ ϰϴ ŵŽŶƚŚƐ ;ƉƵďůŝĐĂƚŝŽŶ ĚĂƚĞ ŵĂǇ ďĞ ůĂƚĞƌͿ͖ ĂŶĚ**
* **CŽůůĂďŽƌĂƚŽƌƐ ŽŶ ƉƌŽũĞĐƚƐ͕ ƐƵĐŚ ĂƐ ĨƵŶĚĞĚ ŐƌĂŶƚƐ͕ ŐƌĂĚƵĂƚĞ ƌĞƐĞĂƌĐŚ Žƌ ŽƚŚĞƌƐ ŝŶ ƚŚĞ ůĂƐƚ ϰϴ ŵŽŶƚŚƐ͘**

**CKA ƚĞŵƉůĂƚĞ dĂďůĞ ϱ͗**

**>ŝƐƚ ĞĚŝƚŽƌŝĂů ďŽĂƌĚ͕ ĞĚŝƚŽƌͲŝŶ ĐŚŝĞĨ ĂŶĚ ĐŽͲĞĚŝƚŽƌƐ ǁŝƚŚ ǁŚŽŵ ƚŚĞ ŝŶĚŝǀŝĚƵĂů ŝŶƚĞƌĂĐƚƐ͘ AŶ ĞĚŝƚŽƌͲŝŶͲĐŚŝĞĨ ŵƵƐƚ ůŝƐƚ ƚŚĞ ĞŶƚŝƌĞ ĞĚŝƚŽƌŝĂů ďŽĂƌĚ͘**

* **EĚŝƚŽƌŝĂů BŽĂƌĚ͗ >ŝƐƚ ŶĂŵĞ;ƐͿ ŽĨ ĞĚŝƚŽƌͲŝŶͲĐŚŝĞĨ ĂŶĚ ũŽƵƌŶĂů ŝŶ ƚŚĞ ƉĂƐƚ Ϯϰ ŵŽŶƚŚƐ͖ ĂŶĚ**
* **KƚŚĞƌ ĐŽͲEĚŝƚŽƌƐ ŽĨ ũŽƵƌŶĂů Žƌ ĐŽůůĞĐƚŝŽŶƐ ǁŝƚŚ ǁŚŽŵ ƚŚĞ ŝŶĚŝǀŝĚƵĂů ŚĂƐ ĚŝƌĞĐƚůǇ ŝŶƚĞƌĂĐƚĞĚ ŝŶ ƚŚĞ ůĂƐƚ Ϯϰ ŵŽŶƚŚƐ͘**

**dŚĞ ƚĞŵƉůĂƚĞ ŚĂƐ ďĞĞŶ ĚĞǀĞůŽƉĞĚ ƚŽ ďĞ ĨŝůůĂďůĞ͕ ŚŽǁĞǀĞƌ͕ ƚŚĞ ĐŽŶƚĞŶƚ ĂŶĚ ĨŽƌŵĂƚ ƌĞƋƵŝƌĞŵĞŶƚƐ ŵƵƐƚ ŶŽƚ ďĞ ĂůƚĞƌĞĚ ďǇ ƚŚĞ ƵƐĞƌ͘ dŚŝƐ ƚĞŵƉůĂƚĞ ŵƵƐƚ ďĞ ƐĂǀĞĚ ŝŶ ͘ǆůƐǆ Žƌ ͘ǆůƐ ĨŽƌŵĂƚ͕ ĂŶĚ ĚŝƌĞĐƚůǇ ƵƉůŽĂĚĞĚ ŝŶƚŽ &ĂƐƚ>ĂŶĞ ĂƐ Ă CŽůůĂďŽƌĂƚŽƌƐ ĂŶĚ KƚŚĞƌ AĨĨŝůŝĂƚŝŽŶƐ ^ŝŶŐůĞ CŽƉǇ DŽĐƵŵĞŶƚ͘ hƐŝŶŐ ƚŚĞ ͘ǆůƐǆ Žƌ ͘ǆůƐ ĨŽƌŵĂƚ ǁŝůů ĞŶĂďůĞ ƉƌĞƐĞƌǀĂƚŝŽŶ ŽĨ ƐĞĂƌĐŚĂďůĞ ƚĞǆƚ ƚŚĂƚ ŽƚŚĞƌǁŝƐĞ ǁŽƵůĚ ďĞ ůŽƐƚ͘ /ƚ ŝƐ ƚŚĞƌĞĨŽƌĞ ŝŵƉĞƌĂƚŝǀĞ ƚŚĂƚ ƚŚŝƐ ĚŽĐƵŵĞŶƚ ďĞ ƵƉůŽĂĚĞĚ ŝŶ ͘ǆůƐǆ Žƌ ͘ǆůƐ ŽŶůǇ͘ hƉůŽĂĚŝŶŐ Ă ĚŽĐƵŵĞŶƚ ŝŶ ĂŶǇ ĨŽƌŵĂƚ ŽƚŚĞƌ ƚŚĂŶ ͘ǆůƐǆ Žƌ ͘ǆůƐ ŵĂǇ ĚĞůĂǇ ƚŚĞ ƚŝŵĞůǇ ƉƌŽĐĞƐƐŝŶŐ ĂŶĚ ƌĞǀŝĞǁ ŽĨ ƚŚĞ ƉƌŽƉŽƐĂů͘**

**dŚŝƐ ŝŶĨŽƌŵĂƚŝŽŶ ŝƐ ƵƐĞĚ ƚŽ ŵĂŶĂŐĞ ƌĞǀŝĞǁĞƌ ƐĞůĞĐƚŝŽŶ͘ ^ĞĞ EǆŚŝďŝƚ //ͲϮ ĨŽƌ ĂĚĚŝƚŝŽŶĂů ŝŶĨŽƌŵĂƚŝŽŶ ŽŶ ƉŽƚĞŶƚŝĂů ƌĞǀŝĞǁĞƌ ĐŽŶĨůŝĐƚƐ͘**

**ϭ EŽƚĞ ƚŚĂƚ ŐƌĂĚƵĂƚĞ ĂĚǀŝƐŽƌƐ ĂƌĞ ŶŽ ůŽŶŐĞƌ ƌĞƋƵŝƌĞĚ ƚŽ ďĞ ƌĞƉŽƌƚĞĚ͘**

**Ϯ EĚŝƚŽƌŝĂů BŽĂƌĚ ĚŽĞƐ ŶŽƚ ŝŶĐůƵĚĞ EĚŝƚŽƌŝĂů AĚǀŝƐŽƌǇ BŽĂƌĚ͕ /ŶƚĞƌŶĂƚŝŽŶĂů AĚǀŝƐŽƌǇ BŽĂƌĚ͕ ^ĐŝĞŶƚŝĨŝĐ EĚŝƚŽƌŝĂů BŽĂƌĚ͕ Žƌ ĂŶǇ ŽƚŚĞƌ ƐƵďĐĂƚĞŐŽƌǇ ŽĨ EĚŝƚŽƌŝĂů BŽĂƌĚ͘ /ƚ ŝƐ ůŝŵŝƚĞĚ ƚŽ ƚŚŽƐĞ ŝŶĚŝǀŝĚƵĂůƐ ǁŚŽ ƉĞƌĨŽƌŵ ĞĚŝƚŝŶŐ ĚƵƚŝĞƐ Žƌ ŵĂŶĂŐĞ ƚŚĞ ĞĚŝƚŝŶŐ ƉƌŽĐĞƐƐ ;ŝ͘Ğ͕͘ ĞĚŝƚŽƌ ŝŶ ĐŚŝĞĨͿ͘**

**>ŝƐƚ ŶĂŵĞƐ ĂƐ >ĂƐƚ EĂŵĞ͕ &ŝƌƐƚ EĂŵĞ͕ DŝĚĚůĞ /ŶŝƚŝĂů͘ AĚĚŝƚŝŽŶĂůůǇ͕ ƉƌŽǀŝĚĞ ĞŵĂŝů͕ ŽƌŐĂŶŝǌĂƚŝŽŶ͕ ĂŶĚ ĚĞƉĂƌƚŵĞŶƚ ;ŽƉƚŝŽŶĂůͿ &ŝǆĞĚ ĐŽůƵŵŶ ǁŝĚƚŚƐ ŬĞĞƉ ƚŚŝƐ ƐŚĞĞƚ ŽŶĞ ƉĂŐĞ ǁŝĚĞ͖ ŝĨ ǇŽƵ ĐƵƚ ĂŶĚ ƉĂƐƚĞ ƚĞǆƚ͕ ƐĞƚ ĨŽŶƚ ƐŝǌĞ Ăƚ ϭϬƉƚ Žƌ ƐŵĂůůĞƌ͕ ĂŶĚ**

**dŽ ŝŶƐĞƌƚ *Ŷ* ďůĂŶŬ ƌŽǁƐ͕ ƐĞůĞĐƚ *Ŷ* ƌŽǁ ŶƵŵďĞƌƐ ƚŽ ŵŽǀĞ ĚŽǁŶ͕ ƌŝŐŚƚ ĐůŝĐŬ͕ ĂŶĚ ĐŚŽŽƐĞ /ŶƐĞƌƚ ĨƌŽŵ ƚŚĞ ŵĞŶƵ͘**

**zŽƵ ŵĂǇ ĨŝůůͲĚŽǁŶ ;ĐƌƚůͲDͿ ƚŽ ŵĂƌŬ Ă ƐĞƋƵĞŶĐĞ ŽĨ ĐŽůůĂďŽƌĂƚŽƌƐ͕ Žƌ ĐŽƉǇ ĂĨĨŝůŝĂƚŝŽŶƐ͘ EǆĐĞů ŚĂƐ ĂƌƌŽǁƐ ƚŚĂƚ ĞŶĂďůĞ ƐŽƌƚŝŶŐ͘ &Žƌ Η>ĂƐƚ AĐƚŝǀĞ DĂƚĞΗ ĂŶĚ Η>ĂƐƚ AĐƚŝǀĞΗ ĐŽůƵŵŶƐ ĚĂƚĞƐ ĂƌĞ ŽƉƚŝŽŶĂů͕ ďƵƚ ǁŝůů ŚĞůƉ E^& ƐƚĂĨĨ ĞĂƐŝůǇ ĚĞƚĞƌŵŝŶĞ ǁŚŝĐŚ ŝŶĨŽƌŵĂƚŝŽŶ ƌĞŵĂŝŶƐ ƌĞůĞǀĂŶƚ ĨŽƌ ƌĞǀŝĞǁĞƌ ƐĞůĞĐƚŝŽŶ͘**

**͞>ĂƐƚ AĐƚŝǀĞ DĂƚĞ͟ ĂŶĚ ͞>ĂƐƚ AĐƚŝǀĞ͟ ĐŽůƵŵŶƐ ŵĂǇ ďĞ ůĞĨƚ ďůĂŶŬ ĨŽƌ ŽŶŐŽŝŶŐ Žƌ ĐƵƌƌĞŶƚ ĂĨĨŝůŝĂƚŝŽŶƐ͘**

**dĂďůĞ ϭ͗ >ŝƐƚ ƚŚĞ ŝŶĚŝǀŝĚƵĂů͛Ɛ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĂŶĚ ŽƌŐĂŶŝǌĂƚŝŽŶĂů ĂĨĨŝůŝĂƚŝŽŶ ŝŶ ƚŚĞ ůĂƐƚ ϭϮ ŵŽŶƚŚƐ͘**

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| **ϭ** | **zŽƵƌ EĂŵĞ͗** | **zŽƵƌ KƌŐĂŶŝǌĂƚŝŽŶĂů AĨĨŝůŝĂƚŝŽŶ;ƐͿ͕ ůĂƐƚ ϭϮ** | **>ĂƐƚ AĐƚŝǀĞ DĂƚĞ** |
|  | CŚŝĞů͕ ,ŝůůĞů :͘ | CĂƐĞ tĞƐƚĞƌŶ ZĞƐĞƌǀĞ hŶŝǀĞƌƐŝƚǇ |  |
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**dĂďůĞ Ϯ͗ >ŝƐƚ ŶĂŵĞƐ ĂƐ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĨŽƌ ǁŚŽŵ Ă ƉĞƌƐŽŶĂů͕ ĨĂŵŝůǇ͕ Žƌ ďƵƐŝŶĞƐƐ ƌĞůĂƚŝŽŶƐŚŝƉ ǁŽƵůĚ ŽƚŚĞƌǁŝƐĞ ƉƌĞĐůƵĚĞ ƚŚĞŝƌ ƐĞƌǀŝĐĞ ĂƐ Ă ƌĞǀŝĞǁĞƌ͘**

**Z͗ AĚĚŝƚŝŽŶĂů ŶĂŵĞƐ ĨŽƌ ǁŚŽŵ ƐŽŵĞ ƌĞůĂƚŝŽŶƐŚŝƉ ǁŽƵůĚ ŽƚŚĞƌǁŝƐĞ ƉƌĞĐůƵĚĞ ƚŚĞŝƌ ƐĞƌǀŝĐĞ ĂƐ Ă ƌĞǀŝĞǁĞƌ͘**

*ƚŽ ĚŝƐĂŵďŝŐƵĂƚĞ ĐŽŵŵŽŶ ŶĂŵĞƐ*

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| **Ϯ** | **EĂŵĞ͗** | **dǇƉĞ ŽĨ ZĞůĂƚŝŽŶƐŚŝƉ** | **KƉƚŝŽŶĂů ;ĞŵĂŝů͕ DĞƉĂƌƚŵĞŶƚͿ** | **>ĂƐƚ AĐƚŝǀĞ** |
| Z͗ | Dreben, Elizabeth K. | ^ƉŽƵƐĞ |  |  |
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dĂďůĞ ϯ͗ >ŝƐƚ ŶĂŵĞƐ ĂƐ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĂŶĚ ƉƌŽǀŝĚĞ ŽƌŐĂŶŝǌĂƚŝŽŶĂů ĂĨĨŝůŝĂƚŝŽŶƐ͕ ŝĨ ŬŶŽǁŶ͕ ĨŽƌ ƚŚĞ ĨŽůůŽǁŝŶŐ͘

'͗ dŚĞ ŝŶĚŝǀŝĚƵĂů͛Ɛ WŚ͘D͘ ĂĚǀŝƐŽƌƐ͖ ĂŶĚ

**d͗ Aůů ŽĨ ƚŚĞ ŝŶĚŝǀŝĚƵĂů͛Ɛ WŚ͘D͘ ƚŚĞƐŝƐ ĂĚǀŝƐĞĞƐ͘**

*ƚŽ ĚŝƐĂŵďŝŐƵĂƚĞ ĐŽŵŵŽŶ ŶĂŵĞƐ*

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| **ϯ** | **AĚǀŝƐŽƌͬAĚǀŝƐĞĞ EĂŵĞ͗** | **KƌŐĂŶŝǌĂƚŝŽŶĂů AĨĨŝůŝĂƚŝŽŶ** | **KƉƚŝŽŶĂů ;ĞŵĂŝů͕ DĞƉĂƌƚŵĞŶƚͿ** |
| '͗ | tƵƌƚŵĂŶ͕ ZŝĐŚĂƌĚ :͘ | D͘/͘d͘ |  |

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| d͗ | DŽƵŐůĂƐ DŽƌƚŽŶ |  |  |
| d͗ | ^ƵŶŐͲEŝĞŶ zƵ |  |  |
| d͗ | ,Ƶŝ zĞ |  |  |
| d͗ | DĂǀŝĚ EĞƵƐƚĂĚƚĞƌ |  |  |
| d͗ | 'ƌĞŐ ^ƵƚƚŽŶ |  |  |
| d͗ | WŚĂƚƚĂŶĂƌĚ WŚĂƚƚĂŶĂƐƌŝ |  |  |
| d͗ | ,Ƶŝ >Ƶ |  |  |
| d͗ | DŝƌĂŶĚĂ CƵůůŝŶƐ |  |  |
| d͗ | :ĞĨĨ DĐDĂŶƵƐ |  |  |
| d͗ | <ĞŶĚƌŝĐŬ ^ŚĂǁ |  |  |
| d͗ | CĂƚŚĞƌŝŶĞ <ĞŚů |  |  |
| d͗ | :ĞĨĨ 'ŝůů |  |  |
| d͗ | DŝĐŚĂĞů BĞŶĚŝŶŐ |  |  |
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dĂďůĞ ϰ͗ >ŝƐƚ ŶĂŵĞƐ ĂƐ ůĂƐƚ ŶĂŵĞ͕ ĨŝƌƐƚ ŶĂŵĞ͕ ŵŝĚĚůĞ ŝŶŝƚŝĂů͕ ĂŶĚ ƉƌŽǀŝĚĞ ŽƌŐĂŶŝǌĂƚŝŽŶĂů ĂĨĨŝůŝĂƚŝŽŶƐ͕ ŝĨ ŬŶŽǁŶ͕ ĨŽƌ ƚŚĞ ĨŽůůŽǁŝŶŐ͗

A͗ CŽͲĂƵƚŚŽƌƐ ŽŶ ĂŶǇ ďŽŽŬ͕ ĂƌƚŝĐůĞ͕ ƌĞƉŽƌƚ͕ ĂďƐƚƌĂĐƚ Žƌ ƉĂƉĞƌ ǁŝƚŚ ĐŽůůĂďŽƌĂƚŝŽŶ ŝŶ ƚŚĞ ůĂƐƚ ϰϴ ŵŽŶƚŚƐ ;ƉƵďůŝĐĂƚŝŽŶ ĚĂƚĞ ŵĂǇ ďĞ ůĂƚĞƌͿ͖ ĂŶĚ

**C͗ CŽůůĂďŽƌĂƚŽƌƐ ŽŶ ƉƌŽũĞĐƚƐ͕ ƐƵĐŚ ĂƐ ĨƵŶĚĞĚ ŐƌĂŶƚƐ͕ ŐƌĂĚƵĂƚĞ ƌĞƐĞĂƌĐŚ Žƌ ŽƚŚĞƌƐ ŝŶ ƚŚĞ ůĂƐƚ ϰϴ ŵŽŶƚŚƐ͘**

*ƚŽ ĚŝƐĂŵďŝŐƵĂƚĞ ĐŽŵŵŽŶ ŶĂŵĞƐ*

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| **ϰ** | **EĂŵĞ͗** | **KƌŐĂŶŝǌĂƚŝŽŶĂů AĨĨŝůŝĂƚŝŽŶ** | **KƉƚŝŽŶĂů ;ĞŵĂŝů͕ DĞƉĂƌƚŵĞŶƚͿ** | **>ĂƐƚ AĐƚŝǀĞ** |
| A͗ | AůĞǆĂŶĚĞƌ :͘ ,ƵŶƚ | WŽƌƚůĂŶĚ ^ƚĂƚĞ hŶŝǀĞƌƐŝƚǇ |  |  |
| A͗ | ZŽŐĞƌ D͘ YƵŝŶŶ | CtZh |  |  |
| A͗ | <ĂƚŚƌǇŶ DĂůƚŽƌŝŽ | CtZh |  |  |
| A͗ | AůĞǆĂŶĚĞƌ >ŽŶƐďĞƌƌǇ | CtZh |  |  |

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| A͗ | sŝĐƚŽƌŝĂ tĞďƐƚĞƌͲtŽŽĚ | CDh |  |  |
| A͗ | WĞƚĞƌ dŚŽŵĂƐ | CtZh |  |  |
| A͗ | KǌĂŶ AŬŬƵƐ | CtZh |  |  |
| A͗ | hŵƵƚ 'ƵƌŬĂŶ | CtZh |  |  |
| C͗ | ^ƚĞǀĞŶ >ĞǁŝƐ | CtZh |  |  |
| A͗ | DŝĐŚĂĞů :ĞŶŬŝŶƐ | CtZh |  |  |
| C͗ | ZŽďĞƌƚŽ 'ĂůĂŶ | CtZh |  |  |
| C͗ | DĂƌĐ BƵĐŚŶĞƌ | CtZh |  |  |
| C͗ | /ůǇĂ ZǇďĂŬ | DƌĞǆĞů |  |  |
| C͗ | AďƌĂŚĂŵ :͘ ^ƵƐƐǁĞŝŶ | BĂƌ /ůĂŶ hŶŝǀĞƌƐŝƚǇ |  |  |
| C͗ | 'ƌĞŐŽƌǇ ^ƵƚƚŽŶ | BƌŝƐƚŽů hŶŝǀĞƌƐŝƚǇ |  |  |
| C͗ | CŚĂƌůĞƐ ,ŽƌŶ | WŝƚƚƐďƵƌŐŚ hŶŝǀĞƌƐŝƚǇ |  |  |
| C͗ | E͘ DƵĐŽ :ĂŶƐĞŶ | sĂŶĚĞƌďŝůƚ hŶŝǀĞƌƐŝƚǇ |  |  |
| C͗ | >ĞŶĂ dŝŶŐ | EŵŽƌǇ hŶŝǀĞƌƐŝƚǇ |  |  |
| A͗ | ^ǁĂƌƵƉ BŚƵŶŝĂ | CtZh |  |  |
| C͗ | :ĂŵĞƐ BƵƌŐĞƐƐ | CtZh |  |  |
| A͗ | KƌũĂŶ EŬĞďĞƌŐ | <d, CŽŵƉƵƚĞƌ ^ĐŝĞŶĐĞ ĂŶĚ CŽŵŵƵŶŝĐĂƚŝŽŶ | |  |
| A͗ | ^ƚĞǀĞŶ 'ĂƌǀĞƌŝĐŬ | CtZh |  |  |
| C͗ | DĂǀŝĚ >ǇƚƚĞ | CtZh |  |  |
| A͗ | ,ĞŝĚŝ DĂƌƚŝŶ | CtZh |  |  |
| A͗ | CĂƌůŽƐ DĂƐƚƌĂŶŐĞůŽ | hŶŝǀĞƌƐŝƚǇ ŽĨ hƚĂŚ |  |  |
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dĂďůĞ ϱ͗ >ŝƐƚ ĞĚŝƚŽƌŝĂů ďŽĂƌĚ͕ ĞĚŝƚŽƌͲŝŶ ĐŚŝĞĨ ĂŶĚ ĐŽͲĞĚŝƚŽƌƐ ǁŝƚŚ ǁŚŽŵ ƚŚĞ ŝŶĚŝǀŝĚƵĂů ŝŶƚĞƌĂĐƚƐ͘ AŶ ĞĚŝƚŽƌͲŝŶͲĐŚŝĞĨ ŵƵƐƚ ůŝƐƚ ƚŚĞ ĞŶƚŝƌĞ ĞĚŝƚŽƌŝĂů ďŽĂƌĚ͘

B͗ EĚŝƚŽƌŝĂů BŽĂƌĚ͗ >ŝƐƚ ŶĂŵĞ;ƐͿ ŽĨ ĞĚŝƚŽƌͲŝŶͲĐŚŝĞĨ ĂŶĚ ũŽƵƌŶĂů ŝŶ ƚŚĞ ƉĂƐƚ Ϯϰ ŵŽŶƚŚƐ͖ ĂŶĚ

**E͗ KƚŚĞƌ ĐŽͲEĚŝƚŽƌƐ ŽĨ ũŽƵƌŶĂů Žƌ ĐŽůůĞĐƚŝŽŶƐ ǁŝƚŚ ǁŚŽŵ ƚŚĞ ŝŶĚŝǀŝĚƵĂů ŚĂƐ ĚŝƌĞĐƚůǇ ŝŶƚĞƌĂĐƚĞĚ ŝŶ ƚŚĞ ůĂƐƚ Ϯϰ ŵŽŶƚŚƐ͘**

*ƚŽ ĚŝƐĂŵďŝŐƵĂƚĞ ĐŽŵŵŽŶ ŶĂŵĞƐ*

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| **ϱ** | **EĂŵĞ͗** | **KƌŐĂŶŝǌĂƚŝŽŶĂů AĨĨŝůŝĂƚŝŽŶ** | **:ŽƵƌŶĂůͬCŽůůĞĐƚŝŽŶ** | **>ĂƐƚ AĐƚŝǀĞ** |
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| [**The following information regarding collaborators and other affiliations (COA) must be separately provided for each**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)  [**indi**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**v**[**idual identified as senior project personnel. The COA information must be provided through**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **use of this COA template.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane** [**Coll**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**aborators and Other Affiliations single copy doc. Do not upload .pdf.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se note that some information requested in prior versions of the PAPPG is no longer requested. THIS IS PURPOSEFUL** [**AND**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **WE NO LONGER REQUIRE THIS INFORMATION TO BE REPORTED. Certain relationships will be reported in other** [**secti**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**ons (i.e., the names of postdoctoral scholar sponsors should not be reported, however if the individual collaborated on** [**rese**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**arch with their postdoctoral scholar sponsor, then they would be reported as a collaborator). The information in the** [**tabl**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**es is not required to be sorted, alphabetically or otherwise.** |
| **There are five separate categories of information which correspond to the five tables in the COA template:**  **COA template Table 1:**  **List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.** |
| **COA template Table 2:**  **List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.** |
| **COA template Table 3:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **The individual’s Ph.D. advisors; and** * **All of the individual’s Ph.D. thesis advisees.** |
| **COA template Table 4:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may**   **be later); and**   * **Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.** |
| **COA template Table 5:**  **List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire editorial board.**   * **Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and** * **Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.** |

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**This information is used to manage reviewer selection. See Exhibit II-2 for additional information on potential reviewer conflicts.**

1. **Note that graduate advisors are no longer required to be reported.**
2. **Editorial Board does not include Editorial Advisory Board, International Advisory Board, Scientific Editorial Board, or any other subcategory of Editorial Board. It is limited to those individuals who perform editing duties or manage the editing process (i.e., editor in chief).**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. For "Last Active Date" and "Last Active" columns dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**“Last Active Date” and “Last Active” columns may be left blank for ongoing or current affiliations.**

**Table 1: List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Heckman, Charles J | Northwestern University |  |
|  |  |  |  |
|  |  |  |  |
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**Table 2: List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2** | **Name:** | **Type of Relationship** | **Optional (email, Department)** | **Last Active** |
| R: | none |  |  |  |
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Table 3: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for

**the following.**

G: The individual’s Ph.D. advisors; and

**T: All of the individual’s Ph.D. thesis advisees.**

*to disambiguate common names*

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| --- | --- | --- | --- |
| **3** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |

|  |  |  |  |
| --- | --- | --- | --- |
| G: | Binder, Marc D | Univerisity of Washington | Physiology and Biophysics |
| T: | Lee, Robert H | Georgia Tech | Biomedical Engineering |
| T: | Theiss, Renee D | Governers State University | Physical Therapy |
| T: | Kuo, Jason | Pharmaceutical Industry | Marketing |
| T: | Hyngstrom, Allison | Marquette University | Physical Therapy |
| T: | Kuo, Su-Wei | Duke University | Biomedical Engineering |
| T: | Schuster, Jenna | Hydrocephalis Foundation | Program Officer |
| T: | Theeradej Thaweerattanas | National Research Instiute of Thailand | Neuroscience |
| T: | Huh, Seoan | Abbot Labs | Research Manager, Drug Discovery |
| T: | Kim, Edward H | Northwestern University | Physiology |

Table 4: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:

A: Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be later); and

**C: Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

*to disambiguate common names*

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| --- | --- | --- | --- | --- |
| **4** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
| A: | Miller, Laura C. | Northwestern University |  | 4/10/2015 |
| A: | Kim, Hojeong | Daegu Gyeongbuk Institute of Science & Technology | | 6/18/2015 |
| A: | Sandercock, Thomas G. | Northwestern University |  | 6/18/2015 |
| A: | Collins,III, William F. | Stony Brook University |  | 7/22/2015 |
| A: | Elasiouny, Sherif M. | Wright State University |  | 7/22/2015 |
| A: | DiDonato, Christine J. | Northwestern University |  | 3/7/2016 |
| A: | thaweerattanasinp, Theer | Northwestern University |  | 7/16/2016 |
| A: | Corcos, Daniel M. | Northwestern University |  | 1/1/2017 |
| A: | deMello, Marco Tulio | University of São Paulo |  | 1/1/2017 |
| A: | Forjaz, Claudia | University of São Paulo |  | 1/1/2017 |
| A: | Kanegusuku, Helcio | University of São Paulo |  | 1/1/2017 |
| A: | Piemonte, Maria Elisa Pim | University of São Paulo |  | 1/1/2017 |
| A: | Roschel, Hamilton | University of São Paulo |  | 1/1/2017 |
| A: | Silva-Batista, Carla | University of São Paulo |  | 1/1/2017 |
| A: | Tavares Mattos, Eugenia C | University of São Paulo |  | 1/1/2017 |
| A: | Tricoli, Valmar | University of São Paulo |  | 1/1/2017 |
| A: | Ugrinowitsch, Carlos | University of São Paulo |  | 1/1/2017 |
| A: | Wilson, Jessica M. | Northwestern University |  | 1/1/2017 |
| A: | Che, Le | Jiangxi University of Science and Technology | | 3/10/2017 |
| A: | Kuo, Su-Wei | Northwestern University |  | 3/10/2017 |
| A: | Yimin, Mao | Northwestern University |  | 3/10/2017 |
| A: | Cain, Charlette | Northwestern University |  | 5/1/2017 |
| A: | Frigon, Alain | Université de Sherbrooke |  | 5/1/2017 |
| A: | Hurteau, Marie-France | Université de Sherbrooke |  | 5/1/2017 |
| A: | Hamm, Thomas M. | St. Joseph's Hospital & Medical Center |  | 7/1/2017 |
| A: | Lee, Robert H. | Georgia Institute of Technoloy |  | 7/1/2017 |
| A: | O'Neill, Derek | St. Joseph's Hospital & Medical Center |  | 7/1/2017 |
| A: | Siripuram, Ramamurthy | Georgia Institute of Technoloy |  | 7/1/2017 |
| A: | V.Turkin, Vladimir | St. Joseph's Hospital & Medical Center |  | 7/1/2017 |
| A: | Seoan, Huh | Northwestern University |  | 7/1/2017 |
| A: | Ciolino, Jody D. | Northwestern University |  | 7/5/2017 |
| A: | Tresch, Matthew C. | Northwestern University |  | 7/5/2017 |
| A: | Klein, D | Northwestern University |  | 9/6/2017 |
| A: | Manuel, Rebecca Imhoff- | Northwestern University |  | 9/6/2017 |

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| A: | Tresch, M. C. | Northwestern University |  | 9/6/2017 |
| A: | Tysseling, Vicki M. | Northwestern University |  | 9/6/2017 |
| A: | Chen, Albert | Northwestern University |  | 2/19/2018 |
| A: | Yao, Jun | Northwestern University |  | 2/19/2018 |
| A: | Manuel, Marin | Université Paris Descartes |  | 3/27/2018 |
| A: | Martinez-Silva, Maria De L | Université Paris Descartes |  | 3/27/2018 |
| A: | Roselli, Francesco | Ulm University |  | 3/27/2018 |
| A: | Sharma, Aarti | Columbia University |  | 3/27/2018 |
| A: | Shneider, Neil A | Columbia University |  | 3/27/2018 |
| A: | Zytnicki, Daniel | Université Paris Descartes |  | 3/27/2018 |
| A: | Galonska, Christina | Max Planck Institute for Molecular Genetics | | 4/5/2018 |
| A: | Gnirke, Andreas | MIT & Harvard |  | 4/5/2018 |
| A: | Gu, Hongcang | MIT & Harvard |  | 4/5/2018 |
| A: | Huang, Mei | Northwestern University |  | 4/5/2018 |
| A: | Kiskinis, Evangelos | Northwestern University |  | 4/5/2018 |
| A: | Maidl, Susanne | Max Planck Institute for Molecular Genetics, | | 4/5/2018 |
| A: | Martin, Eric J. | Northwestern University |  | 4/5/2018 |
| A: | Meissner, Alexander | MIT & Harvard |  | 4/5/2018 |
| A: | Meltzer, Herbert Y. | Northwestern University |  | 4/5/2018 |
| A: | Ortega, Juan A, | Northwestern University |  | 4/5/2018 |
| A: | Pardo, Alba Di | Northwestern University |  | 4/5/2018 |
| A: | Pop, Ramona | Harvard University |  | 4/5/2018 |
| A: | Quinlan, Katharina A. | University of Rhode Island |  | 4/5/2018 |
| A: | Santos, David P. | Northwestern University |  | 4/5/2018 |
| A: | Ziller, Michael J. | Max Planck Institute for Molecular Genetics, | | 4/5/2018 |
| A: | Dewald, Julius P. A. | Northwestern University |  | 6/21/2018 |
| A: | Ellis, Michael D. | northwestern University |  | 6/21/2018 |
| A: | Harden, R. Norman | Northwestern University |  | 6/21/2018 |
| A: | McPherson, Jacob G. | Florida International University |  | 6/21/2018 |
| A: | Chow, Jeffrey | Shirley Ryan Ability Lab |  | 7/25/2018 |
| A: | Franz, Colin K. | Northwestern University |  | 7/25/2018 |
| A: | Jordan, Lewis A. | Shirley Ryan Ability Lab |  | 7/25/2018 |
| A: | Ortega, J Alberto | Northwestern University |  | 7/25/2018 |
| A: | Done, Joseph | Northwestern University |  | 11/8/2018 |
| A: | Jiang, Mingchen C. | Northwestern University |  | 11/8/2018 |
| A: | Klumpp, David J. | Northwestern University |  | 11/8/2018 |
| A: | Rosen, John M. | Childrens Mercy |  | 11/8/2018 |
| A: | Rudick, Charles N. | Northwestern University |  | 11/8/2018 |
| A: | schaeffer, Anthony J. | Northwestern University |  | 11/8/2018 |
| A: | Yaggie, Ryan E. | Northwestern University |  | 11/8/2018 |
| A: | Yang, Wenbin | Northwestern University |  | 11/8/2018 |
| A: | Bennett, David J. | University of Alberta |  | 1/1/2019 |
| A: | Hari, Krishnapriya | University of Alberta |  | 1/1/2019 |
| A: | Lin, Shihao | University of Alberta |  | 1/1/2019 |
| A: | Singla, Rahul | Northwestern University |  | 1/1/2019 |
| A: | Stephens, Marilee J. | Northwestern University |  | 1/1/2019 |
| A: | Ying, Zhang | Dalhousie University |  | 1/1/2019 |
| A: | Black, Sophie | University of Alberta |  | 4/23/2019 |
| A: | Fenrich, Keith K. | University of Alberta |  | 4/23/2019 |
| A: | Fouad, Karim | University of Alberta |  | 4/23/2019 |
| A: | Lucas-Osma, Ana M. | University of Alberta |  | 4/23/2019 |
| A: | Murray, Katie | University of Alberta |  | 4/23/2019 |
| A: | Yaqing, Li | Northwestern University |  | 4/23/2019 |

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| A: | Farina, Dario | Imperial College London |  | 7/15/2019 |
| A: | Johnson, Michael D. | Northwestern University |  | 7/15/2019 |
| A: | McPherson, Laura M. | Florida International University |  | 7/15/2019 |
| A: | Negro, Francesco | Universita degli Studi Di Brescia |  | 7/15/2019 |
| A: | Powers, Randall K. | University of Washington |  | 7/15/2019 |
| A: | Thompson, Christopher K. | Temple University |  | 7/15/2019 |
| A: | Cox, Gregory A. | The Jackson Laboratory, |  | 3/7/216 |
| A: | Gautam, Mukesh | Northwestern University |  | 3/7/216 |
| A: | Genc, Baris | Northwestern University |  | 3/7/216 |
| A: | Heller, Daniel B | Northwestern University |  | 3/7/216 |
| A: | Jara, Javier H. | Northwestern University |  | 3/7/216 |
| A: | Klessner, Jodi L. | Northwestern University |  | 3/7/216 |
| A: | Ozdinler, P. Hande | Northwestern University |  | 3/7/216 |
| A: | Schultz, Megan C. | Northwestern University |  | 3/7/216 |
| A: | Sekerkova, Gabriella | Northwestern University |  | 3/7/216 |
| A: | Staford, Macdonell J. | Northwestern University |  | 3/7/216 |
| A: | Adimula, Adesoji | Northwestern University |  | 10/24/2017 |
| A: | Ahn, Andrew H. | Teva Pharmaceuticals |  | 4/23/2019 |
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Table 5: List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire editorial board.

B: Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and

**E: Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **5** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
| B: | William Yates | University of Pittsburgh | Journal of Neurophysiology | 6/14/17 |
| E: | Monica Perez | Shirley Ryan AbilityLab | Journal of Neurophysiology | 6/14/17 |
|  |  |  |  |  |
|  |  |  |  |  |
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| --- |
| [**The following information regarding collaborators and other affiliations (COA) must be separately provided for each**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)  [**individual identified as senior project personnel. The COA information must be provided through**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **use of this COA template.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane** [**Colla**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**borators and Other Affiliations single copy doc. Do not upload .pdf.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se note that some information requested in prior versions of the PAPPG is no longer requested. THIS IS PURPOSEFUL** [**AND**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **WE NO LONGER REQUIRE THIS INFORMATION TO BE REPORTED. Certain relationships will be reported in other** [**secti**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**ons (i.e., the names of postdoctoral scholar sponsors should not be reported, however if the individual collaborated on** [**rese**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**arch with their postdoctoral scholar sponsor, then they would be reported as a collaborator). The information in the** [**tabl**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**es is not required to be sorted, alphabetically or otherwise.** |
| **There are five separate categories of information which correspond to the five tables in the COA template:**  **COA template Table 1:**  **List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.** |
| **COA template Table 2:**  **List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.** |
| **COA template Table 3:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **The individual’s Ph.D. advisors; and** * **All of the individual’s Ph.D. thesis advisees.** |
| **COA template Table 4:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may**   **be later); and**   * **Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.** |
| **COA template Table 5:**  **List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire editorial board.**   * **Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and** * **Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.** |

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**This information is used to manage reviewer selection. See Exhibit II-2 for additional information on potential reviewer conflicts.**

1. **Note that graduate advisors are no longer required to be reported.**
2. **Editorial Board does not include Editorial Advisory Board, International Advisory Board, Scientific Editorial Board, or any other subcategory of Editorial Board. It is limited to those individuals who perform editing duties or manage the editing process (i.e., editor in chief).**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department (optional) Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and**

**To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. For "Last Active Date" and "Last Active" columns dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**“Last Active Date” and “Last Active” columns may be left blank for ongoing or current affiliations.**

**Table 1: List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Chestek, Cynthia A. | University of Michigan | Current |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table 2: List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2** | **Name:** | **Type of Relationship** | **Optional (email, Department)** | **Last Active** |
| R: | (None) |  |  |  |
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|  |  |  |  |  |
|  |  |  |  |  |

Table 3: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for

**the following.**

G: The individual’s Ph.D. advisors; and

**T: All of the individual’s Ph.D. thesis advisees.**

*to disambiguate common names*

|  |  |  |  |
| --- | --- | --- | --- |
| **3** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |

|  |  |  |  |
| --- | --- | --- | --- |
| G: | Shenoy, Krishna | Stanford University | Electrical Engineering |
| G: | Henderson, Jaimie | Stanford University | Neurosurgery |
| T: | David Thompson (postdoc) | Kansas State University | Electrical Engineering |
| T: | Zachary Irwin | U Alabama Birmingham | Neurosurgery |
| T: | Karen Schroeder | Columbia U | Neuroscience |
| T: | Paras Patel | U Michigan | Biomedical Engineering |
|  |  |  |  |

Table 4: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:

A: Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be later); and

**C: Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **4** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
| A: | Krishna Shenoy | Stanford University |  |  |
| A: | Vikash Gilja | U California San Diego |  |  |
| A: | Paul Nuyujukian | Stanford University |  |  |
| A: | Euisik Yoon | U of Michigan |  |  |
| A: | Nicholas Kotov | U of Michigan |  |  |
| A: | Takashi Kozai | U of Pittsburgh |  |  |
| A: | Deanna Gates | U of Michigan |  |  |
| A: | Brian Kelly | U of Michigan |  |  |
| A: | Jaimie Henderson | Stanford University |  |  |
| A: | Kim Anderson | Case Western Reserve University |  |  |
| A: | William Stacey | U of Michigan |  |  |
| A: | Parag Patil | U of Michigan |  |  |
| A: | Paul Cederna | U of Michigan |  |  |
| A: | Adam Sachs | U of Ottawa |  |  |
| A: | George Mashour | U of Michigan |  |  |
| A: | Jessica Nicole Bentley | U of Alabama, Birmingham |  |  |
| A: | Michael Flynn | U of Michigan |  |  |
| C: | David Blaauw | U of Michigan |  |  |
| C: | Jamie Philips | U of Michigan |  |  |
| C: | James Weiland | U of Michigan |  |  |
| C: | Albert Shih | U of Michigan |  |  |
| C: | Hunseok Kim | U of Michigan |  |  |
| C: | Kevin Kilgore | Case Western Reserve University |  |  |
| C: | Bolu Ajiboye | Case Western Reserve University |  |  |
| C: | Hunter Peckham | Case Western Reserve University |  |  |
| C: | Hillel Chiel | Case Western Reserve University |  |  |
| C: | Roberto Galan | Case Western Reserve University |  |  |
| C: | Ellis Meng | U of Southern California |  |  |
| C: | X. Tracy Cui | U of Pittsburgh |  |  |
| C: | Victoria Wood | Carnegie Mellon University |  |  |
| C: | Roger Quinn | Case Western Reserve University |  |  |

must list the entire editorial board.

B: Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and

**E: Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

*to disambiguate common names*

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| --- | --- | --- | --- | --- |
| **5** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
| B: | (None) |  |  |  |

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| --- | --- | --- | --- | --- |
| E: |  |  |  |  |
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| --- |
| [**The following information regarding collaborators and other affiliations (COA) must be separately provided for each**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)  [**individual identified as senior project personnel. The COA information must be provided through**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **use of this COA template.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane** [**Colla**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**borators and Other Affiliations single copy doc. Do not upload .pdf.**  [**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se note that some information requested in prior versions of the PAPPG is no longer requested. THIS IS PURPOSEFUL** [**AND**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **WE NO LONGER REQUIRE THIS INFORMATION TO BE REPORTED. Certain relationships will be reported in other sections** [**(i.e.,**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **the names of postdoctoral scholar sponsors should not be reported, however if the individual collaborated on research** [**with**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **their postdoctoral scholar sponsor, then they would be reported as a collaborator). The information in the tables is not** [**requ**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**ired to be sorted, alphabetically or otherwise.** |
| **There are five separate categories of information which correspond to the five tables in the COA template:**  **COA template Table 1:**  **List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.** |
| **COA template Table 2:**  **List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.** |
| **COA template Table 3:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **The individual’s Ph.D. advisors; and** * **All of the individual’s Ph.D. thesis advisees.** |
| **COA template Table 4:**  **List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**   * **Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be**   **later); and**   * **Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.** |
| **COA template Table 5:**  **List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire editorial board.**   * **Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and** * **Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.** |

The template has been developed to be fillable, however, the content and format requirements must not be altered by the user. This template must be saved in .xlsx or .xls format, and directly uploaded into FastLane as a Collaborators and Other Affiliations Single Copy Document. Using the .xlsx or .xls format will enable preservation of searchable text that otherwise would be lost. It is therefore imperative that this document be uploaded in .xlsx or .xls only. Uploading a document in any format other than .xlsx or .xls may delay the timely processing and review of the proposal.

**This information is used to manage reviewer selection. See Exhibit II-2 for additional information on potential reviewer conflicts.**

1. **Note that graduate advisors are no longer required to be reported.**
2. **Editorial Board does not include Editorial Advisory Board, International Advisory Board, Scientific Editorial Board, or any other subcategory of Editorial Board. It is limited to those individuals who perform editing duties or manage the editing process (i.e., editor in chief).**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department (optional) Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and**

**To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. For "Last Active Date" and "Last Active" columns dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**“Last Active Date” and “Last Active” columns may be left blank for ongoing or current affiliations.**

**Table 1: List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Matthew C Tresch | Northwestern University | current |
|  | Matthew C Tresch | Shirley Ryan AbilityLab | current |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table 2: List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2** | **Name:** | **Type of Relationship** | **Optional (email, Department)** | **Last Active** |
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Table 3: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for

**the following.**

G: The individual’s Ph.D. advisors; and

**T: All of the individual’s Ph.D. thesis advisees.**

*to disambiguate common names*

|  |  |  |  |
| --- | --- | --- | --- |
| **3** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |
| G: | Emilio Bizzi | MIT |  |

|  |  |  |  |
| --- | --- | --- | --- |
| T: | Anthony Jarc | Intuitive Surgical |  |
| T: | Benjamin Rellinger | industry |  |
| T: | Laura Miller | Washington University |  |
| T: | Eric Shearer | Cleveland State University |  |
|  |  |  |  |
|  |  |  |  |

Table 4: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:

A: Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may

**be later); and**

**C: Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **4** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
| A: | Cristiano Alessandro | Northwestern University |  | current |
| A: | Filipe Barroso | Cajal Institure |  | current |
| A: | Benjamin Rellinger | Industry |  | 2018 |
| A: | Vicki Tysseling | Northwestern University |  | current |
| A: | Kathy Quinlan | University of Rhode Island |  | 2018 |
| A: | Bryan Yoder | Industry |  | 2018 |
| A: | David Tentler | Northwestern University |  | current |
| A: | Josephine Wallner | Northwestern University |  | current |
| A: | Amina Kinhabwala | California Institute of Technology |  | 2018 |
| A: | Maria Jantz | University of Pittsburgh |  | 2018 |
| A: | Robert Flint | Northwestern University |  | current |
| A: | Ambika Satish | Industry |  | 2018 |
| A: | Sarah Brodnick | University of Wisconsin-Madison |  | 2018 |
| A: | Aaron Suminski | University of Wisconsin-Madison |  | 2018 |
| A: | Justin Williams | University of Wisconsin-Madison |  | 2018 |
| A: | Thomas Sandercock | Northwestern University |  | current |
| A: | Yasin Dhaher | University of Texas-Southwestern |  | 2018 |
| A: | Philippe Saltiel | Universite de Montreal |  | 2018 |
| A: | Andrea d'Avella | University of Messina, Santa Lucia Foundation | | 2018 |
| A: | Kuno Wyler | Industry |  | 2018 |
| A: | David Klein | practicing physician |  | 2018 |
| A: | Rebecca Imhoff-Manuel | Universite de Paris Descartes |  | 2018 |
| A: | Marin Manuel | Universite de Paris Descartes |  | 2018 |
| A: | Elma Kajtaz | Georgia Institutue of Technology |  | 2018 |
| A: | Jody Ciolino | Northwestern University |  | 2018 |
| A: | Raeed Chowdury | University of Pittsburgh |  | 2018 |
| A: | Dinesh Pai | University of British Columbia |  | 2018 |
| A: | Qi Wei | George Mason University |  | current |
| A: | Lee E Miller | Northwestern University |  | current |
| C: | John Rogers | Northwestern University |  | current |
| C: | Philip Gutruf | University of Arizona |  | current |

Table 5: List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief

B: Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and

**E: Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **5** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
| B: | Bill Yates | University of Pittsburgh | Journal of Neurophysiology | current |
|  |  |  |  |  |

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**COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE  **NSF 19-563 06/14/19** | | | | | | | Special Exception to Deadline Date Policy | | | | | | | | | **FOR NSF USE ONLY** | |
| **NSF PROPOSAL NUMBER** | |
| FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)  **DBI - RESEARCH RESOURCES** | | | | | | | | | | | | | | | |
| DATE RECEIVED | NUMBER OF COPIES | | | | DIVISION ASSIGNED | | | | | FUND CODE | | DUNS# (Data Universal Numbering System) | | | | | FILE LOCATION |
|  |  | | | |  | | | | |  | | **077758407** | | | | |  |
| EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)  **341018992** | | | | SHOW PREVIOUS AWARD NO. IF THIS IS A RENEWAL  AN ACCOMPLISHMENT-BASED RENEWAL | | | | | | | | | IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES NO IF YES, LIST ACRONYM(S) | | | | |
| NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE | | | | | | | | ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE  **10900 Euclid Avenue**  **CLEVELAND, OH 441064901 US** | | | | | | | | | |
| **Case Western Reserve University** | | | | | | | |
| AWARDEE ORGANIZATION CODE (IF KNOWN) | | | | | | | |
| **0001024000** | | | | | | | |
| NAME OF PRIMARY PLACE OF PERF | | | | | | | | ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE | | | | | | | | | |
| **Case Western Reserve University** | | | | | | | | **Case Western Reserve University 10900 Euclid Avenue** | | | | | | | | | |
|  | | | | | | | | **Cleveland ,OH ,441064901 ,US.** | | | | | | | | | |
| IS AWARDEE ORGANIZATION (Check All That Apply) SMALL BUSINESS MINORITY BUSINESS  FOR-PROFIT ORGANIZATION WOMAN-OWNED BUSINESS | | | | | | | | | | | | | | | IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE | | |
| TITLE OF PROPOSED PROJECT **NeuroNex: Communication, Coordination, and Control in Neuromechanical Systems (C3NS)** | | | | | | | | | | | | | | | | | |
| REQUESTED AMOUNT  $ **2** | | PROPOSED DURATION (1-60 MONTHS)  **0** months | | | | | | | REQUESTED STARTING DATE | | | | | | SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE | | |
| THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW  BEGINNING INVESTIGATOR HUMAN SUBJECTS Human Subjects Assurance Number  DISCLOSURE OF LOBBYING ACTIVITIES Exemption Subsection or IRB App. Date  PROPRIETARY & PRIVILEGED INFORMATION FUNDING OF INT'L BRANCH CAMPUS OF U.S IHE FUNDING OF FOREIGN ORG  HISTORIC PLACES INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED VERTEBRATE ANIMALS IACUC App. Date  PHS Animal Welfare Assurance Number  TYPE OF PROPOSAL **Research** COLLABORATIVE STATUS  **A collaborative proposal from multiple organizations (PAPPG II.D.3.b)** | | | | | | | | | | | | | | | | | |
| PI/PD DEPARTMENT | | | | | | PI/PD POSTAL ADDRESS  **10900 Euclid Avenue**  **Cleveland,OH 44106 United States** | | | | | | | | | | | |
| **Mechanical & Aerospace Engineering** | | | | | |
| PI/PD FAX NUMBER | | | | | |
| **216-368-3007** | | | | | |
| NAMES (TYPED) | | | High Degree | | | | Yr of Degree | | | | Telephone Number | | | Email Address | | | |
| PI/PD NAME  **Roger D Quinn** | | | **PhD** | | | | **1985** | | | | **216-368-3222** | | | [**rdq@po.cwru.edu**](mailto:rdq@po.cwru.edu) | | | |
| CO-PI/PD  **Cynthia Chestek** | | | **PhD** | | | | **2010** | | | | **734-707-3356** | | | [**cchestek@umich.edu**](mailto:cchestek@umich.edu) | | | |
| CO-PI/PD  **Hillel J Chiel** | | | **PhD** | | | | **1980** | | | | **216-368-3846** | | | [**hjc@case.edu**](mailto:hjc@case.edu) | | | |
| CO-PI/PD  **Charles J Heckman** | | | **PhD** | | | | **1986** | | | | **312-503-2164** | | | [**c-heckman@nwu.edu**](mailto:c-heckman@nwu.edu) | | | |
| CO-PI/PD  **Matthew C Tresch** | | | **PhD** | | | | **1998** | | | | **312-503-1373** | | | [**m-tresch@northwestern.edu**](mailto:m-tresch@northwestern.edu) | | | |

Page 1 of 3

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**CERTIFICATION PAGE**

**Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant**

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide (PAPPG). Willful provision of false information in

this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

**Certification Regarding Conflict of Interest**

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of PAPPG Chapter IX.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were,

or prior to the organization’s expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization’s conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists,

must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

**Drug Free Work Place Certification**

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Proposal & Award Policies & Procedures Guide.

**Debarment and Suspension Certification** (If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded

from covered transactions by any Federal department or agency? Yes No

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Proposal & Award Policies & Procedures Guide.

**Certification Regarding Lobbying**

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

**Certification for Contracts, Grants, Loans and Cooperative Agreements**

The undersigned certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ‘‘Disclosure of Lobbying Activities,’’ in accordance with its instructions.
3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

**Certification Regarding Nondiscrimination**

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Proposal & Award Policies & Procedures Guide.

**Certification Regarding Flood Hazard Insurance**

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

1. community in which that area is located participates in the national flood insurance program; and
2. building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

1. for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
2. for other NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

**Certification Regarding Responsible Conduct of Research (RCR)**

**(This certification is not applicable to proposals for conferences, symposia, and workshops.)**

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Chapter IX.B. , the institution has a plan in place to provide appropriate training and oversight in the

responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research. The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

Page 2 of 3

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Certification Regarding Organizational Support**  By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.  **Certification Regarding Federal Tax Obligations**  When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:   1. has filed all Federal tax returns required during the three years preceding this certification; 2. has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and 3. has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the   subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.  **Certification Regarding Unpaid Federal Tax Liability**  When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:  By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.  **Certification Regarding Criminal Convictions**  When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:  By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.  **Certification Dual Use Research of Concern**  By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern. | | | | |
| AUTHORIZED ORGANIZATIONAL REPRESENTATIVE | | SIGNATURE | | DATE |
| NAME | |  | |  |
| TELEPHONE NUMBER | EMAIL ADDRESS | | FAX NUMBER | |
|  | | | | |

**CERTIFICATION PAGE - CONTINUED**

fm1207rrs-07

Page 3 of 3

*Foundational question under investigation, rationale for the Network, and anticipated synergies:*

Animals move to seek food, mates, and shelter. In the phyla Arthropoda, Mollusca, and Chordata, the nervous system cephalized into a higher-level brain and lower-level sensorimotor network to control behavior. The brain would not exist without a body, and yet surprisingly little is understood about how the nervous system controls and coordinates distributed body parts. Many fundamental questions remain unanswered: How is information encoded and communicated between the more cephalized levels and those dedicated to coordinating multiple body segments? How does the system correct for perturbations from the environment? How does the body’s passive biomechanics affect the neuronal response to motion? In sum: **How do biological nervous systems control and execute interactions with the environment?** We propose an international Network of interdisciplinary research groups (IRGs) consisting of modelers, engineers, and experimentalists to explore the *Communication, Coordination, and Control in Neuromechanical Systems* (**C3NS**). C3NS will investigate the foundational question in model genera from three different phyla: adult *Drosophila* from Arthropoda, adult *Aplysia* from Mollusca, and small mammals from Chordata. Each IRG will study the control of a behavior in which the body interacts with the environment, for example, grasping, feeding, and walking. Investigators will explore how higher-level command centers (HLCCs) formulate descending commands to lower-level motor centers (LLMCs), how systems of subnetworks accomplish the desired behavior in coordination with the animal’s biomechanics, and then how they report their status back to HLCCs. Examining this question across different organisms while using the same modeling framework will give rise to a bottom-up theory for how the nervous system

controls movement, particularly when interacting with the environment.

*Brief description of proposed interdisciplinary research groups (IRGs), including their intellectual merit:*

C3NS will contain four IRGs: modelers and experimentalists studying adult *Drosophila* (IRG1), adult *Aplysia* (IRG2), and small mammals (IRG3); and modelers and engineers generalizing the knowledge gained by the other three IRGs (IRG4). All of these model organisms interact strongly with solid media in their environments, as they walk on the ground or grasp and eat food. In addition, each has technical advantages, and current knowledge and models provide foundation for connecting the work. Many genetic tools for network recording and manipulation in behaving animals are available in *Drosophila*, enabling IRG1 to explore individual pathways between the HLCC and LLMC. By applying the MINT NeuroNex Network’s carbon fiber electrode (CFE) array, IRG2 will record from many neurons at once as *Aplysia* behaves freely, uncovering the communication protocol between the HLCC and LLMC. Calcium imaging and optogenetic tools will be applied to *Mus* by IRG3 to understand the networks that underlie adaptive behavior in vertebrates. IRG3 will also combine 3D X-ray videography, force plates, and electromyography in *Rattus* to explore the control of perturbed walking. *Felis* offers an even larger nervous system, enabling effective recording from CFE arrays.

Studying animals across three phyla will enable the extraction of general principles of motor control. IRG4 will consolidate the results from IRGs 1-3 to produce an abstracted neuromechanical model that explains the collected data and serves as an embodied theory of motor control. This model will explain how local sensory feedback and biomechanics may simplify the communication needed between the HLCC and LLMC and yet ensure that the body can stably interact with its environment. This neuromechanical model will be implemented both in software and in robots, as a thorough test of its predictions.

*Broader impacts such as research, education/outreach, shared facilities and resources, and collaborations:* C3NS will have far reaching broader impacts in biology, health, and robotics. Post-docs and students will be exchanged between laboratories, providing them opportunities to work with different model organisms, leading to better generalization of neuroscience principles, and broadening the trainees’ education. Our Network seeks to flip the typical workflow of neuroscience by leveraging our strengths in modeling to build concrete, hypothetical synthetic neural networks to guide experimental research. We will also improve the state of the art in robot control by applying the generalized principles uncovered by this

research to develop a method for designing and tuning neural robot controllers.

C3NS will enrich our many existing outreach programs by the presence of international, interdisciplinary collaborators and allow for new, larger initiatives that will reach thousands of people each year. Public demonstrations, day camps and internships will expose K-12 students, primarily from underserved communities, to interdisciplinary research and international collaborators’ ideas and culture. We also propose to construct exhibits at natural science museums in our Network’s major cities (co-PI Fischer is also a museum director) and an interactive website both describing how very different animals solve similar problems in similar ways with emphasis on how animals control their bodies. Finally, C3NS will present modules at the Interdisciplinary College in Guenne/Moehnesee, Germany.

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* 1. Participating Investigators

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Hillel J. Chiel, Professor, Departments of Biology, Neuroscience, and Biomedical Engineering, Case Western Reserve University, Cleveland, USA. *Aplysia* neurobiology and neuromechanical modeling, IRG2.

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* 1. Introduction and Strategic Plan

*Rationale, Significance, and Vision of the Network; Need for Synergistic, Interdisciplinary Investigators:*

We propose an international Network of interdisciplinary research groups (IRGs) consisting of modelers, engineers, and experimentalists to address the foundational question: **How do biological nervous systems control and execute interactions with the environment?** Animals must solve this problem, whether during walking, grasping, feeding, or other behaviors. Our NeuroNex Network will focus on the *Communication, Coordination, and Control in Neuromechanical Systems* (**C3NS**) to develop a comprehensive model of sensorimotor control and its relationship to the environment, both within individual species, and across the phyla Arthropoda, Mollusca, and Chordata. This comparative analysis of a diversity of organisms is necessary to uncover underlying general principles of sensorimotor control [1]–[3]. The inclusion of modelers and engineers to guide the research of experimentalists will provide a bottom-up, scale-based theory for efficient communication between higher and lower levels of the nervous system. Such a theory will lead to transformative knowledge about how movement is controlled and modulated across the animal kingdom.

The control of behavior is only partially understood for two reasons: the dynamics of downstream networks, and the dynamics of the environment are both extremely complex. First, **the downstream networks that implement motor control are highly dynamic**, containing multiple levels of sensory feedback loops [4], [5], pattern generating networks [3], context-dependent neuromodulation [2], and inter- appendage communication [6]. Such components create a complex context in which the potential simplicity of the descending signals is difficult to understand. For example, when the mollusk *Aplysia californica* feeds, the neuronal networks that control its feeding apparatus naturally generate rhythms to grasp and ingest food in its environment. However, the cerebral ganglion can use ascending sensory information to determine that hard-to-ingest food should be rejected, and this is accomplished by descending commands that alter the phasing of the feeding program. Thus, descending commands may simply modify the phasing of an already-existing program in a dedicated neuronal network, which is economical both in terms of the number of neurons required and the amount of information communicated from the cerebral ganglion to the dedicated neuronal network (buccal ganglion). What is the encoding protocol of these descending commands? What are their exact targets? How does the dynamical nature of these networks affect these commands? We hypothesize that answering these questions will enable us to understand general principles for motor control networks.

Second, **the environment itself is highly dynamic**. For example, as an animal walks through its environment, it must cope with small obstacles, uneven terrain, and other challenges on an instant-to- instant basis. These challenges are solved on multiple levels: passive biomechanics [7]–[9], low-level reflexes, interleg connections [6], and higher-latency ascending pathways to the brain [10], which then forms new descending commands [11]. The higher level command centers make predictions based on past experience, which are updated by ascending information from motor ganglia [12]. What is the protocol used to communicate to the brain the state of the environment as it affects the periphery, and how might reflexes and mechanics simplify these protocols? This is critical to understanding how the brain controls behavior.

**Computer and robotic models direct research** in three phylum-specific IRGs within our Network, C3NS. Modelers and engineers will generate models whose unknown aspects serve as testable hypotheses related to the foundational question. Experimentalists will evaluate these hypotheses about how each organism executes behaviors within its environment, leading to the refinement of the models. Through IRG4, in which all modelers will participate, common principles and platforms will be developed that will accelerate the work in IRGs 1-3. By understanding sensorimotor integration across three phyla, IRG4 will uncover **general principles** of neuronal communication and coordination.

*High-Level Research:*

**IRG1 will focus on adult *Drosophila melanogaster*** (arthropod). To investigate how different neuromeres within the ventral nerve cord (VNC) communicate with one another and higher-level command centers (HLCCs), IRG1 will expand multi-level neuromechanical models of walking, focusing on how ascending and descending signals may modulate the speed and direction of locomotion. The model’s hypotheses will be tested by optogenetic techniques that modulate ascending and descending neurons, and by optical and electrophysiological recordings from brain and VNC networks in behaving animals.

**IRG2 will focus on adult sea slugs *Aplysia californica*** (mollusk). To investigate how biomechanics and sensory feedback simplify communication between HLCCs and lower-level motor centers (LLMCs), IRG2 will develop multi-level neuromechanical models to study behavioral changes implemented by ascending and descending signals. IRG2 will leverage technology developed under MINT, a **previous**

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**NeuroNex program,** to record from many neurons in sea slug ganglia and monitor descending/ascending activity between HLCCs and LLMCs during behavioral changes. Measuring activity from as large a fraction of the nervous system simultaneously is much harder to achieve in insects or mammals. These data will test hypotheses predicted by computer and robotic models, which will serve to refine them.

**IRG3 will focus on small mammals** (chordates). To investigate how the nervous system coordinates muscle recruitment for different tasks, rejects perturbations while walking, and communicates local and global limb state variables, IRG3 will expand multi-level neuromechanical models of mammalian locomotion. IRG3 will simultaneously record 3D kinematics, 3D dynamics, and electromyography of rats via stereo, high-speed, X-ray camera systems, recording over a dozen muscles’ activity during locomotion. Recordings from large populations of neurons in the spinal cord and brainstem during perturbations will elucidate how subsystems throughout the nervous system coordinate to maintain stability. Calcium imaging of neuronal populations in the neonatal mouse will help to elucidate the neuronal networks in the spinal cord and brainstem responsible for such adaptive behavior.

**IRG4 will generalize learned principles across phyla.** To investigate how body size affects neuronal reactions to perturbations, how feedback loops at different levels of the nervous system minimize perturbations, and how these principles can be exploited to simplify communication between neuronal centers, IRG4 will compare and contrast results and models across IRGs 1-3, and determine common feedback pathways and mechanical forces that transform neuronal activity into controlled behavior. With this knowledge, IRG4 will build a **general model** of multi-level behavioral control. This general model will be validated in both computational and robotic models.

*Synergistic Partnerships with Existing Neurotechnology Developments:*

C3NS combines several key neurotechnology and modeling advances from other research fields. IRG1 exploits fly-specific technologies such as optogenetic manipulation and calcium imaging of select neurons in combination with multibody dynamics and finite element analysis based on high-throughput nano-CT scanning, enabling analysis of *Drosophila* neuronal networks, joints, muscles, tissues, and the associated kinematics and kinetics in unprecedented detail on a population wide scale.

IRG2 will track neuronal activity propagation throughout the cerebral and buccal ganglia, and correlate descending and ascending activity, by using the flexible carbon fiber electrode (CFE) array developed by MINT, a previous NeuroNex Network. Recordings of this scale are not practical in other model organisms. IRG3 will measure many parameters of nominal and perturbed locomotion using stereo, high-speed,

X-ray videography coupled to a force plate substrate that enables freely walking rats to have 3D kinematics, 3D dynamics, and electromyography synchronously recorded. IRG3 will also use multi-neuron calcium imaging and CFE array recordings to assess functional connections and recruitment of identified spinal neurons by various descending inputs and to monitor spinal neurons during fictive locomotion, elucidating the networks that underlie intact behavior.

IRG4 will build generalized models of neural control by applying our functional subnetwork approach, which has been shown to readily incorporate neurobiological data into neural models and facilitate their expansion without loss of previous functionality [13], [14]. Some of C3NS’s neurobiologists have found these network models to be sufficiently detailed to compare behavior on a neuron-to-neuron basis [13], [15]. Thus, **this approach is very valuable for framing theories by modeling hypothetical circuits.**

*Education:*

C3NS will provide unique opportunities for interdisciplinary education for graduate students and post- docs. The diversity of experimental techniques and organisms is an educational strength of C3NS as scientists will extend their conceptual horizon in different groups within their IRG, and the Network as a whole. Many of our team members have already established mechanisms for exchanging students. This will be greatly expanded as discussed in Section 4e along with exciting new plans for museum exhibits, an interactive website and other outreach efforts made possible by this Network.

*Potential Societal Impacts:*

C3NS’s research will have broad impacts in biology, health, and robotics. Exploring the convergent mechanisms of motor control across phyla will lead to a better understanding of the diversity of life on Earth, and may suggest general organizing principles for the nervous system. Understanding the communication protocols between different levels of the nervous system will aid in the investigation of motor disorders that disrupt locomotion and balance, such as Parkinson’s, and assist in the development of neurally-controlled prostheses that can effectively process human neural inputs to more naturally and effectively grasp objects or walk smoothly. Control principles may then be applied to robotics, in order to produce machines that more effectively interact with their environment while walking or grasping objects, for example.

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* 1. Interdisciplinary Research Group Descriptions

*IRG1 – Studying the sensorimotor transformation between the brain and ventral nerve cord (VNC) in walking, adult Drosophila*

To study the origins of adaptive, robust walking in naturalistic environments, IRG1 will study how the adult fruit fly *Drosophila* communicates sensory and motor information between its brain (cerebral and gnathal ganglia) and ventral nerve cord (VNC, thoracic ganglia). The neuronal control of insect locomotion is known to be distributed [3]; the fact that insects are able to walk in the absence of descending connections from brain ganglia underlines this modularity [16]. However, the brain clearly plays an important role in producing adaptive locomotion by processing sensory and ascending information to modulate downstream low level reflexes, modulating inter-ganglion pathways, and initiating, stopping, and modifying locomotion [17]. But many questions remain: What are the types of information shared between the brain and VNC by descending and ascending neurons? What are their neuronal downstream targets? What do these pathways encode? IRG1 will use its neuromechanical modeling method [18], its neurorobot Drosophibot [19], advanced genetic tools, and the experience of the team to experimentally explore these questions synergistically with models and experiments.

This IRG will use computational neuromechanical models of *Drosophila* and the neurorobot, Drosophibot [19], in two roles: Generating hypotheses to test experimentally, and collecting results from multiple levels of the nervous system. First, the neuromechanical model and Drosophibot’s neural controller will be expanded based on the IRG’s hypotheses, and used as a theoretical framework to guide experimental research. These models will provide targeted hypotheses of what types of neurons and networks may be present in the nervous system, how their activity controls behavior, and how they may be modulated by one another. Second, Drosophibot will provide a substrate for integration across multiple levels of the nervous system, specifically, between the brain and the VNC. As more is learned about a particular part of the network, that part of the model will be validated and updated. As research continues, this model will lead to a more complete, bottom-up theory to explain the descending and ascending control of insect legged locomotion.

*Hypothesis 1:* Sensory information from the chordotonal organs (CO), campaniform sensilla (CS), hairs (external sensilla, ES), and other sensory organs in the legs is transformed and transmitted in a simple code that is robust to changes in sensor number and placement. The VNC uses this code to share information between neuromeres, and the VNC abstracts this information to communicate with the brain (rather than sending detailed sensory signals).

*Hypothesis 2*: Descending information from the brain to the VNC regulates walking probability, speed, and direction “indirectly” by acting on pattern generating networks and sensory feedback gains. Similarly, ascending information from the VNC to the brain reports the legs’ state via an abstracted code.

*Research goals and intellectual focus:*

*Goal 1:* Investigate how neuromeres in the VNC communicate sensory information to one another.

*Goal 2:* Investigate the types of ascending information sent from the VNC to the brain, how the VNC processes and abstracts this information, and the targets of these pathways.

*Goal 3:* Investigate the types of descending information sent from the cerebral and gnathal ganglia to the VNC, what networks they target in the VNC, and their context-dependent modulation.

*Relationship to the overall Network goals:*

*Relationship 1:* IRG1 will provide data about inter-segmental connections in the VNC and possible communication protocols to IRGs 2 and 3. Such data may suggest communication schemes in their model organisms. Such cross-phylum comparison is necessary to find general principles.

*Relationship 2*: Results from IRG1 will contribute knowledge about communication protocols between neuromeres to IRG4, in which modelers and engineers will distill general principles regarding ascending/descending control of behavior and use them to build a species-agnostic robotic model of motor control. IRG4 will compare these results to those collected by IRGs 2 and 3.

*Planned research activities:*

*Goal 1:* To construct a neuromechanical model to generate concrete hypotheses about control, Quinn and Szczecinski will apply the functional subnetwork approach, which is detailed in IRG4 [18]. Quinn and Szczecinski will expand their previous computational and robotic neuromechanical models of insects, including Drosophibot, to study rhythm generation and motor control in the VNC [20], sensory integration between different segments of the VNC [14], and descending control of motor networks from the brain to the VNC [21], [22]. One strength of this approach is that spiking and nonspiking neurons and synapses can

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be interfaced and combined, both of which are known to be critical to control motor networks in the VNC [23]. These neural control models will generate concrete models to support Goals 1-3 above.

To understand the communication protocols used within the VNC, Büschges will study sensory encoding schemes, and determine what information is shared between VNC neuromeres to coordinate the legs’ timing during walking. Do the neuromeres share raw sensory data, processed sensory data, or abstract leg states with the other legs? Sensory pathways will be monitored via calcium imaging to search for possible sensory encoding schemes, and optogenetically inhibited, to observe the effects of sensory deficits on walking. Transgenic driver lines that label interganglionic connections will be identified. Quinn and Szczecinski will incorporate these findings into their model, and explore how they might simplify the communication between legs. This will extend Büschges’ prior work studying insect walking [3], [24], [25], especially interleg coordination of *Drosophila* [26]–[28]. These results will shed light on a more general communication scheme between ganglia, including from the VNC to the brain, intertwining with Goal 2.

The mechanical form of the legs of *Drosophila*, including which degrees of freedom and sensors are present, will be necessary information to understand sensory coding. Blanke, an expert in evolutionary biomechanics [29]–[33], will perform high throughput nano-CT scans of the legs of *Drosophila* from several genetic strains, providing the team with detailed information regarding the placement, number, and orientation of sensors embedded in the exoskeleton (i.e. campaniform sensilla and hairs), as well as the placement and orientation of the degrees of freedom in the leg. This data will enable Büschges to investigate the neuronal basis for robust sensory coding, and will enable Quinn and Szczecinski to construct more detailed anatomical biomechanical models of *Drosophila*.

*Goal 2:* Transgenic driver lines that target local sensory networks and ascending pathways reveal that sensory information is first transduced and processed in the VNC and sent to the brain via ascending pathways. Ito will leverage his expertise to investigate how the animal is able to monitor its posture, locomotion, and external environment via such pathways. Ito unraveled the first map of ascending pathways in insect nervous systems from the sensory organs in the body to the brain [34], and he will expand this work to find exactly which modalities terminate in the brain, where they terminate [35], how they may be combined or abstracted by the VNC before or while being transmitted, and the latency of such pathways. In addition, Ito will image the activity of these pathways as the animal performs behaviors, such as walking straight, walking along a curve, and starting and stopping walking. These pathways can then be optogenetically activated or suppressed to examine their effect on behavior, specifically, on the fly’s ability to overcome perturbations while walking. This work will address Goal 2, but will also contribute to Goal 3.

*Goal 3:* To understand how sensory cues are encoded in the insect brain and distilled to generate task-dependent descending motor commands, Ache will investigate how descending pathways are affected by behavioral state changes to enable adaptive, context-dependent action selection [36]. Instead of mediating higher-level decision-making processes, Ache will focus on long-distance motor responses to directly connect sensors on the head to motor networks of the VNC, thus enabling rapid behavioral responses [37], [38]. Unravelling the underlying mechanisms will be critical for understanding how locomotor patterns are controlled by sensory signals from the brain. In this project, Ache will combine *in- vivo* electrophysiology and calcium imaging in behaving *Drosophila* to answer three questions: How do descending neurons integrate multimodal sensory and internal state information to enable adaptive locomotion? Is the descending control of locomotion better described by the activity of a few command-like neurons, or by a distributed population code? How is ascending feedback from VNC networks integrated with descending signals to enable adaptive locomotion? These questions are primarily related to Goal 3 above, but will additionally integrate aspects of Goals 1 and 2 to facilitate synergies between the other groups within this IRG.

*Achieving interactive, interdisciplinary team-science:*

Modelers and experimentalists will work together. This will involve exchanging postdocs and graduate students between labs. For example, Szczecinski will travel to Büschges’ and other labs to learn more about experimental techniques, and work side-by-side with staff to develop biologically plausible neural models of their results. In addition, experimental labs will send students to modelers’ and engineers’ labs, as already happened between Büschges’ and Quinn’s lab, where experimentalists can learn more about robots and modeling, as well as share detailed information about anatomy with the engineers. We have found that such interdisciplinary exchange enriches both groups, with the experimentalists helping the modelers refine theories and models, and with the modelers generating new, testable hypotheses for experiments [28], [39].

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*IRG2 – Modeling and measuring signaling between "higher order" and "lower order" ganglia controlling choice and adaptive changes during feeding in the marine mollusk Aplysia californica*

The ability to respond rapidly to changing environmental conditions and different mechanical loads is crucial for a variety of behaviors, such as locomotion and grasping. To generalize the understanding of these problems, IRG2 will focus on a flexible form of grasping, feeding behavior in the marine mollusk *Aplysia californica*. IRG2 will determine how interactions between the encephalized cerebral ganglion and the ganglia dedicated to the control of the feeding apparatus (the buccal ganglia) give rise to the ability to adjust, on an instant-to-instant basis, the behavioral choices and forces generated as *Aplysia* consume natural, complex food. In isolation, the buccal ganglia can generate feeding motor programs, but they are primarily egestive patterns; only when connected to the cerebral ganglion can the animal generate flexible ingestive feeding motor patterns [40]. Thus, the "higher level" control due to interneurons within the cerebral ganglion must interact with the "lower level" control in the buccal ganglion to coordinate complex feeding sequences. A great advantage of the *Aplysia* system is that the neurons can be identified reliably across animals, and the large somata are electrically compact, making it possible to regulate all the outputs of the neuron by controlling their activity at the soma. A novel technology developed by MINT, a previous NeuroNex program, carbon fiber electrode (CFE) arrays, makes it possible to selectively control individual neurons while recording from large numbers of neurons. The electrodes are 8 microns in diameter and thus can be inserted through the sheath surrounding the neurons, and record juxta-cellular voltages from individual neurons. The Chiel group has also demonstrated that they can be used to excite or inhibit individual neurons in the ganglion.

A neuromechanical model will integrate and direct the efforts of IRG2. Members of the group will develop a neural model of *Aplysia’s* feeding circuitry using the functional subnetwork method (see IRG4) based upon available knowledge about *Aplysia’s* nervous system and current understanding of the biomechanics of feeding. To directly connect neuronal activity to behavior and to test the neural model, IRG2 will develop two biomechanical models: a computational model and a novel soft robotic grasper. A computational model can explore a wide range of inputs and parameter values whereas an actual grasper incorporates the physics of the world, providing direct evidence for the effectiveness of the control signals. Previously, investigators in IRG2 developed a grasper based on *Aplysia’s* feeding apparatus [41], but it was not fully soft, and it did not completely capture the animal’s biomechanics, so this part of the project will also create a novel approach to soft robotic control. The software and robotics models will be controlled by the neural model; predictions of the model will direct animal experiments that will test our hypotheses. *Aplysia* is the one animal in C3NS that will allow us to subsequently control the robot *directly* using neural signals from *Aplysia*. This is valuable because it will provide a direct comparison of animal behavior with the efficacy of the model neural controller.

IRG2 will test two central hypotheses:

*Hypothesis 1*: Peripheral biomechanics both simplify and constrain the neuronal signals used to choose qualitatively different behaviors, and to modify behavior on an instant-to-instant basis in response to changing environmental conditions.

*Hypothesis 2*: Behavioral switching or modifications in response to external stimuli are due to a mix of sensory feedback and "higher level" commands.

*Research goals and intellectual focus:*

*Goal 1*: Develop neuromechanical models (computational and robotic) of the *Aplysia* feeding system and deduce the key control commands and sensory feedback needed to generate the different biomechanical outputs.

*Goal 2*: Experimentally test the predictions of the models for both the "lower level" and "higher level" control and communication between the levels for adaptive feeding behavior by measuring and manipulating neurons during behavior, and use the results to refine the neural and biomechanical models.

*Goal 3:* Compare *in vivo* "higher order" commands with those predicted from the neuromechanical models and from a predictive engineering approach.

*Relationship to the overall Network goals:*

*Relationship 1*: Sutton, a member of both IRG2 and IRG4, will provide theory and modeling expertise for slow and fast behaviors dominated by either inertial, viscous or elastic forces.

*Relationship 2*: Chestek will provide support for signal analysis of higher order neuronal commands for control using predictive machine learning approaches in IRG1 and IRG2.

*Relationship 3*: Quinn will be a member of all IRGs and will guide the neural modeling effort in the

Network using his group’s functional subnetwork approach.

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*Planned research activities:*

*Goal 1*: A model of the neuronal circuits controlling the feeding system will be built using the functional subnetwork approach. The model will be developed by Quinn, Sutton, and Chiel, based on available data about both the neural control and the biomechanics. The model will be used to control the biomechanical models and be refined based upon our experimental results throughout the project. Sutton has created an initial biomechanical model of the feeding apparatus of *Aplysia* that takes firing frequencies as inputs, and predicts forces and movements that can be compared to those of intact animals [42]. Using this model, Sutton will explore ranges of inputs that generate different feeding responses (biting, swallowing or rejection), and predict the variations in the inputs from the motor neurons that can generate each of these behaviors, and how the inputs should vary as the mechanical load increases. His results will be used to refine the neural model. Webster-Wood, who has extensive expertise in developing soft and biohybrid robots, will build on the state-of-the-art in pneumatic actuation [43], [44] and flexible electronics [45] to print novel fiber-reinforced, biomimetic actuators and build a soft robotic grasper based on *Aplysia* feeding apparatus anatomy. She will also explore the inputs that generate biting, swallowing and rejection movements. The neural model will be used to control the robot, and experiments will be conducted to evaluate both models in comparison to the animal’s behavior.

*Goal 2*: Control predictions generated by the computational and hardware neuromechanical models will be tested by Chiel using a preparation that includes the feeding apparatus, the “lower level” buccal ganglion and “upper level” cerebral ganglion [46], recording activity in individual neurons (including sensory neurons) using carbon fiber electrode (CFE) arrays created by the MINT Neuronex Network. These arrays will also be used to manipulate individual neurons (exciting or inhibiting them), and thus the “higher order” commands from the cerebral ganglion and sensory inputs during behavior can be measured, compared to the predictions from the models in Goal 1, and manipulated to test their actual effect on control. Results from this goal directly test Hypothesis 2.

*Goal 3*: Modern engineering predictive techniques can be used to transform higher order neuronal signals (measured from motor cortex in primates) into control signals for motor control, but often have shortcomings due to the complexity of the primate nervous system. While investigators use a variety of advanced machine learning techniques, essentially all of them maintain a simple linear regression between motor cortex firing rate and endpoint position/velocity, and augment this model with better parameter training [47] or better regularization [48]. How do these techniques compare to the “higher order” signals predicted from the neuromechanical models (Goal 1) or those actually measured in the animal (Goal 2)? Chestek, who is currently using these techniques in studies of finger control in primates, will compare predictive engineering techniques to empirical “ground truth” data in an actual animal to directly test Hypothesis 1, and develop more sophisticated ways of mapping between “higher order” signals and “lower order” signals.

*Achieving interactive, interdisciplinary team science:*

Twice monthly meetings of all members of IRG2 via Skype will ensure tight integration of theory, modeling and experimental work. Preliminary neuromechanical models (Goal 1) will direct early experimentation by Chiel (Goal 2), which will then refine the models created by Sutton, Quinn, and Webster- Wood in Goal 1, and provide initial inputs to the predictive engineering models generated by Chestek in Goal 3. This will be an iterative process. As data are obtained in Goal 2 and compared to predictions from Goal 1, the models in Goal 1 will be modified to improve their predictive power, which will in turn direct experiments in Goal 2. If neural models that are well-integrated with biomechanics lead to much better control than those generated using advanced machine learning techniques (Goal 3), Chestek will begin to create novel machine learning approaches that integrate biomechanics. Chestek and Webster-Wood will also work together to create a wireless interface [49] that will allow signals from *Aplysia* ganglia to perform *direct, closed loop control* of the novel robotic soft grasper in parallel with direct control of the feeding apparatus to compare the effects of control signals on the mechanical model with the animal’s actual behavior. Results will be used to refine the neural and biomechanical models.

Graduate students and postdoctoral fellows will be shared across the different members of IRG2, and regular visits of students to different research groups will be scheduled, so that students will spend time in the different labs of members of IRG2.

Because members of IRG2 will also participate in IRGs 1, 3 and 4, all four IRGs will regularly coordinate their efforts. IRG4 will help to integrate all the different groups by abstracting from the details of each of the models and control architectures used in the three other IRGs to integrate and create general neural control principles.

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*IRG3 – Studying sensorimotor transformations between spinal and brainstem systems in the mammalian nervous system*

IRG3 will study how the state of the body and locomotor commands are encoded and communicated between neuronal systems in the spinal cord and brainstem in mammals. Classic work in cats has established the organization of canonical mammalian spinal circuits, such as the Ia reciprocal inhibitory system Renshaw cells, Ib, and group II neurons [50]. Parallel work has focused on elaborating the organization of pattern generating networks in the spinal cord responsible for locomotion in rodents [51]. Much less is known about the nature of descending systems in the brainstem and how they interact with spinal circuits [52], [53]. More fundamentally, the functional role of these networks remains unclear. How do they interact with one another and with the intelligent mechanics of the musculoskeletal system to enable effective motor control? What sensorimotor control principles do they instantiate? The experiments and analysis of IRG3 will examine these issues, using a combination of behavioral, neurophysiological, and computational experiments and exploiting the range of expertise in our research team. C3NS will enhance this investigation, with the experiments of IRG3 being strengthened by parallel and complementary experiments in IRGs 1 and 2.

This IRG will use computational neuromechanical models of quadrupedal mammals and the neurorobot Muscle Mutt [54] to play two central roles in this investigation: generating hypotheses and consolidating findings. First, the neural models will be used as a theoretical framework to guide our experimental approach. Hypotheses on the role of spinal circuits will be generated in the model and then evaluated in behavioral and neurophysiological experiments. Second, these models will be used to integrate information obtained from experiments and generate new hypotheses. This iterative loop between theory and experimentation is central to our approach. IRG3 has the following hypotheses:

*Hypothesis 1:* The spinal cord and brainstem exploit peripheral mechanics to implement a series of hierarchical control strategies that enable the efficient production of effective behavior.

*Hypothesis 2:* Descending systems in the brainstem exploit the simplification of control produced by spinal circuits such that descending signal commands relate to higher-level behavioral goals.

*Research goals and intellectual focus:*

*Goal 1:* To evaluate how mammalian sensorimotor systems maintain robust performance in the face of perturbations due to a continuously changing body and environment.

*Goal 2:* To evaluate how neurons in the spinal cord and brainstem encode the state of the body in response to changes in the environment.

*Goal 3:* To evaluate how information about limb state is communicated from the spinal cord to brainstem neurons and how activity in brainstem neurons alters behaviors produced by the spinal cord.

*Relationship to the overall Network goals:*

*Relationship 1:* IRG3 will share its results about sensory encoding with IRGs 1 and 2, to suggest possible shared encoding schemes. Such cross-phylum comparison is necessary to discover general principles.

*Relationship 2:* IRG3 will provide information about the neuronal response to mechanical perturbations to IRG4. Such information will be critical for understanding how nervous systems engage with their environment, including how a robot may walk through or grasp items in its environment.

*Planned research activities:*

*Goal 1:* To evaluate how the mammalian nervous system maintains robust locomotion in the face of perturbations, Quinn and Hunt have created neuromechanical computational models and robots to investigate sensorimotor control networks producing locomotion [55]–[57]. These models will be integrated with behavioral experiments by Fischer to characterize the control principles implemented by spinal and brainstem systems. Fischer and Andrada have expertise in comparative biomechanics [58]–[61] and have established techniques to measure synchronously detailed kinematics with biplanar high speed fluoroscopy along with EMGs and force plate recordings during locomotion in small mammals [62], [63]. They have also established sophisticated techniques for dynamically perturbing limbs during locomotion. They will extend these experiments using methods developed in the Tresch lab to record EMG activity chronically in large numbers of muscles across the body.

To evaluate the control strategies implemented by spinal and brainstem systems, Fischer and Andrada will work together with Quinn and Hunt to perform a series of perturbation experiments. They will use both transient perturbations (e.g. torque pulses to limbs, ground displacement) and persistent perturbations (e.g. adding a mass to the torso, changing the incline, or paralyzing a muscle) to evaluate the hypothesis that spinal and brainstem systems regulate higher-level aspects of behavior (e.g. center of mass trajectory, or

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leg stiffness) while allowing lower-level aspects of movement to vary (e.g. individual joint angles or muscle activation). By examining the latencies of reflexes, they will gain insight into whether responses reflect the actions of spinal or descending circuits. They will use the computational model to design additional perturbations to validate or challenge model assumptions and to test potential theories of control principles implemented by spinal and brainstem circuits. These experiments will also provide critical information to interpret and guide the neurophysiological experiments in Goal 2.

*Goal 2:* To determine how spinal and brainstem systems encode the state of the limb during transient and persistent perturbations, Heckman will leverage his extensive expertise in the neurophysiological characterization of sensorimotor systems in the spinal cord [64]–[68]. His lab has recently developed techniques for recording simultaneously from large numbers of motoneurons, sensory afferents, and spinal interneurons in response to different perturbations in the cat. He will record from spinal interneurons and brainstem neurons in experiments with the same perturbations used in the experiments of Goal 1. These experiments will identify how local spinal circuits encode information of limb state and communicate this information to the brainstem. Importantly, he will examine this encoding in a functional context, evaluating how neuronal activity in spinal and brainstem systems is related to the control strategies observed in the experiments of Goal 1. These activity patterns will be integrated with the neuromechanical models developed by Hunt and Quinn, evaluating whether they confirm the predictions of the model or suggest refinements.

To improve the possibilities for data collection in spinal systems, Heckman will also work with Tresch to develop similar techniques for recording activity in rats, exploiting the carbon fiber electrode (CFE) arrays developed by the MINT NeuroNex Network. Tresch has expertise in investigating how animals regulate muscle control under perturbations and characterizing spinal neuronal function [69]–[72]. The improved properties of the carbon fiber electrodes will enable these experiments in rats, despite the animal’s smaller size. They will compare the activity in spinal and brainstem networks between rats and cats to evaluate whether neuronal circuits are organized differentially across mammals. These experiments in rats will also provide more direct integration with the experiments of Goal 1. Heckman and Tresch will also evaluate the exciting possibility that the properties of these electrodes will permit spinal neuronal recordings in behaving animals. A lack of spinal neuronal activity data in intact animals is a fundamental gap in the understanding of the neural control of movement. Although these would be challenging experiments, they have the potential to transform the field’s understanding of motor control.

*Goal 3:* To evaluate how spinal and brainstem systems communicate with one another to produce adaptations of locomotion, Perreault will leverage her extensive expertise examining the function of spinal and brainstem systems in the production and modulation of locomotion [53], [73]–[76]. She will perform experiments to stimulate and inactivate brainstem systems descending to the spinal cord and evaluate their effects on ongoing locomotion. Exploiting the advantages of the *in vitro* mouse spinal cord, Perreault will image activity in functionally distinct populations of identified motoneurons during the production of locomotion. Using electrical stimulation, selective lesions, and optogenetic manipulations, she will investigate how commands from descending brainstem systems alter the timing and amplitude of locomotor outputs. These experiments will also record the activity of spinal interneurons during locomotion and characterize how they are modulated by descending activity. Perreault will also work with Tresch and Heckman to perform complementary experiments *in vivo*, stimulating brainstem sites or descending tracts and evaluating their effect on locomotion and on spinal interneuronal activity. In particular, they will evaluate how descending systems alter activation of motor neurons across the body to modulate key aspects of ongoing movements (e.g. center of mass trajectory, speed or direction of locomotion).

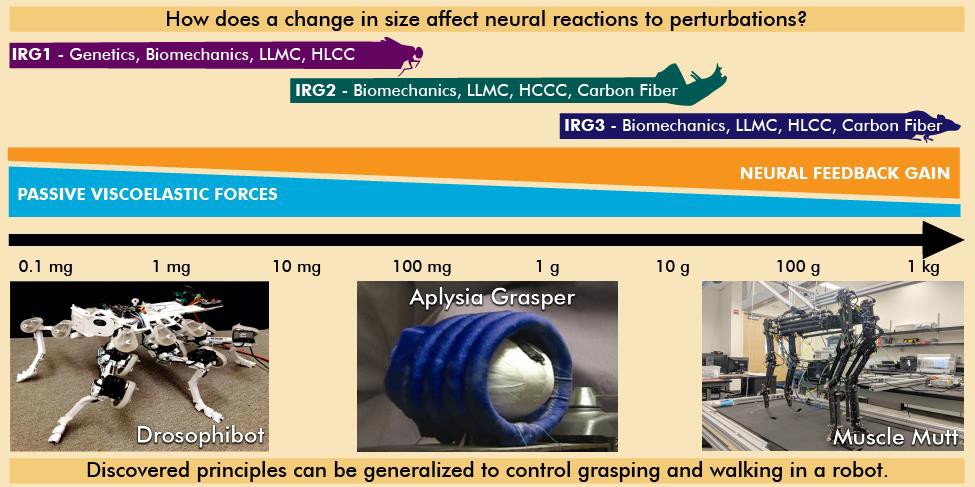
*Achieving interactive, interdisciplinary team science in IRG3:*

Experimentalists will have several meetings to share techniques as described above. Hunt, Quinn and students in their labs will travel to the labs in Chicago, Jena, and Atlanta to work side-by-side with experimentalists to develop biologically plausible models and to suggest computationally relevant experiments. Similar interactions across all labs in the Network, including regular meetings and visits, will help ensure tight integration between all research efforts.

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*IRG4 – Consolidating knowledge gained into a species-agnostic model of motor control*

IRG4’s goal is to build a general model of how higher-level command centers (HLCCs) interface with lower-level motor centers (LLMCs) to perform motions that require interaction with the environment, such as walking or grasping objects. IRG4 consists of modelers from all of the other IRGs. IRG4 will compare and generalize what is uncovered by IRGs 1-3, and explore how mechanics of the animals in question may affect these mechanisms. IRG4 will model and analyze how the dynamical structure of LLMCs and the body itself simplify what information must be shared between the HLCC and LLMC, by considering a series of questions: How does the size of an animal affect its passive mechanics? Does an animal’s passive mechanics change the gain or form of feedback necessary for control? How does the combination of these effects simplify the descending control of behavior? The general principles uncovered will be validated by their use in controlling the walking and grasping of a general-purpose robotic platform. These ideas are summarized in the figure below.



*Hypothesis 1:* There is a fundamental set of reflexes that exist across phyla that stabilize interactions with the environment. These consist of reflexes within the LLMC, as well as motor responses mediated via ascending pathways to the HLCC and descending commands back to the LLMC. The efficacy of such pathways is enhanced by a simple, abstract code for communicating information. The “length,” latency, and gain of the pathway are correlated.

*Hypothesis 2:* The mechanics of the body make a critical contribution to motor control by filtering the mechanical forces generated by the nervous system into controlled motion. The ratio of resistive forces to inertial forces increases as animals become smaller. Small animals evolved a reduction in the gain of negative feedback reflexes as compared to larger animals.

*Research goals and intellectual focus:*

*Goal 1:* Understand and model organismal commonalities in how ascending information and descending commands are encoded, transmitted, and decoded by higher and lower level networks.

*Goal 2:* Extend the continuum of scale down to the fruit fly by incorporating biomechanical data into existing models. Model how the body’s passive mechanics filter motor output and how such forces modify the gain of neural feedback pathways.

*Goal 3:* Construct a set of stabilizing reflexes common to C3NS’s model organisms, and use our

neuromechanical models to examine how their gain and latency affect each behavior’s stability.

*Goal 4:* Test our generalized model of multi-level motor control in simulation and in robots.

*Relationship to the overall Network goals:*

*Relationship 1:* This IRG seeks to generalize the knowledge acquired by IRGs 1-3 into a theoretical framework of the hierarchical control of motion. This includes understanding how information is encoded and transmitted, and how feedback gain and latency scale with organism size and dynamics.

*Relationship 2:* This IRG will produce generalized neuromechanical models and a real-world robotic implementation of the scale-dependent passive forces and multi-level neural control laws learned from IRGs 1-3. This robot will demonstrate the robustness and stability of the control principles learned in the Network.

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*Planned research activities:*

*Goal 1:* To construct an initial modeling framework for IRG4, Quinn and Szczecinski will use knowledge gained by IRGs 1-3 and their prior work related to the descending control of locomotion [21], [77], [78] to generalize the form of descending commands needed to modify a given periodic behavior “indirectly” (e.g. modulating phase between different muscles’ contractions). Together with Sutton and Hunt, they will explore how processing in the LLMC might abstract sensory information for efficient communication to the HLCC. They will expand their insect-like architectures to include pathways from across phyla, as found both in the literature and from the experiments of IRGs 1-3. This will serve as the groundwork for Goals 2 and 3, which will further explore how local circuits modify these descending commands.

*Goal 2:* To test theories of how scale affects passive body forces, Blanke will perform high throughput nano-CT scans of the legs of *Drosophila* from several genetic strains, and together with voxel precise material properties, construct multibody dynamics and finite element models to simulate the kinematics, kinetics, and strains present in the legs of freely walking animals. Blanke has expertise in evolutionary biomechanics [29]–[32], with an emphasis on how mechanical form and function relate to one another [33], [79]. Therefore, Blanke will also perform μCT scans of legs from vertebrates in IRG3, and apply the same modeling techniques. Such models will provide insight into the physiological strains present in the leg during a given movement task together with an accurate estimate of the 3D sensory feedback to the HLCC. Sutton, who also has expertise in biomechanics [80], [81], will work with Blanke to translate the quantitative morphology data into mechanical models that approximate the passive forces in the body using material properties. Comparing these measurements across fruit flies, sea slugs, mice, and rats will help clarify how passive forces dynamically scale [8], [82], [83], and is necessary for the models and robots in Goals 3 and 4.

*Goal 3:* To construct a set of stabilizing reflexes common to C3NS’s model organisms, Hunt will leverage his experience building neuromechanical [57], [84] and neurorobotic [55] models of mammalian locomotion. Hunt has experience applying insect-like pathways to his models in order to fill gaps in the mammalian neuroscience knowledge [57]. Hunt will expand this work with data from IRGs 1-3 to generate a set of intra-limb and inter-limb reflexes necessary to stabilize the posture of an arbitrary body. Sutton will assist this effort by modifying the scaling laws from Goal 2 to predict the strength of active reflexes of larger animals or robots.

*Goal 4:* To validate the generalized model of the control of interaction with the environment, IRG4 will construct a testbed robot with legs and a flexible grasper. Quinn, Hunt, and Szczecinski will leverage their experience building robotic models of insects [85]–[87], robotic models of mammals [55] and dynamical neural controllers [14], [20]–[22] to construct a species-agnostic legged robot with which to test the general principles extracted by this IRG. They will first construct a dynamic simulation of the robot’s mechanics in which the robot’s overall scale, the proportions of its leg segments, and the relative orientation of the legs (radial, bilateral, etc.) will be configurable. For each configuration, they will apply the scaled set of generalized passive forces, reflexes, and descending commands in order to control its walking in simulation. One configuration will be selected as the template for a physical robot. Sutton and Webster-Wood will modify the soft robotic grasper from IRG2 to interface with this robot, enabling the robot to interact with the world via several modalities.

IRG4’s control models will be successful because of its functional subnetwork approach to constructing neural controllers [18]. This method enables the direct assembly of dynamical neural networks based on observed neuronal activity, as well as quantifying their stability [88]. Quinn, Hunt, and Szczecinski will leverage their experience building neural models and sensory input maps, the gain of reflexes, and the latency of postural control loops (as determined by the work in Goals 1-3) to control the robot. Robot testing will ensure that the generalized principles apply to the real world’s physics, noise, and limited communication bandwidth. The hierarchy of control determined in Goal 3 may increase the efficacy of this control system versus the state of the art, because it will not depend on high communication bandwidth.

*Achieving interactive, interdisciplinary team-science:*

This IRG will achieve interactive team-science because all of its members are experts in mechanics as well as neural systems. This shared background will enable them to frame questions of neural control from a mechanical perspective; the purpose of the nervous system is to control behavior, and without understanding mechanics, the nervous system cannot be understood. This overlap, coupled with otherwise diverse backgrounds, ensures that each investigator will bring a unique perspective to the data collected, contributing to an unbiased, broad generalization of neural and mechanical data from this and other IRGs.

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* 1. Broader Impacts

*Contributions to Society:*

The research of our Network, C3NS, will have broad impacts in biology, health, and robotics. C3NS’s exploration of convergent mechanisms of communication between levels of the nervous system and its interaction with the environment across phyla will lead to a better understanding of the diversity of life on Earth, and may suggest general organizing principles for the nervous system.

Understanding the language of communication between different levels of the nervous system will aid in the investigation of motor disorders that disrupt locomotion and grasping, such as Parkinson’s. Additionally, it could provide insights into what processes are most affected by aging and injuries, and how we may work to overcome natural deterioration. In addition, it will assist in the development of neurally- controlled prostheses and orthoses that can effectively process descending neuronal signals from the brain, and report sensory feedback to the brain, making these devices easier to use.

Finally, our research will improve the state of the art in robot control by applying the generalized principles uncovered by this research to develop a method for designing and tuning neural controllers for robots. This research will lead to locomotion that is more reliable and robust to perturbations, increasing robots’ autonomy and mobility for work in challenging terrains such as on farms, mines, undersea, disaster sites, and other planets. In addition, this research will lead to smarter, biomimetic machines that can more safely and reliably interact with people around them and their environment, increasing their safety.

*Education and Training, Human Resource Development, Broadening Participation:*

The diversity of experimental techniques and organisms will act as a great educational strength in C3NS as scientists will extend their research capabilities by learning new techniques utilized by different labs and different IRGs. Additionally, modelers will visit experimental labs and vice versa to learn more about the technical limits of discovery, in order to develop more testable hypotheses. Some of our team members have already established mechanisms for exchanging students. All of these experiences will broaden our trainees’ education. PhD students and postdocs will spend at least 1 month per year at host labs within C3NS and will often travel more often as needed to learn skills and share data and hypotheses. C3NS seeks to flip the typical workflow of neuroscience by leveraging our strengths in neuromechanical modeling to build concrete, hypothetical networks to guide experimental research. This translates to exceptional opportunities for interdisciplinary education for undergraduate students, PhD students and post-docs that will greatly broaden their education in diverse ways. Post-docs and students will be exchanged between laboratories within IRGs and within the Network as a whole, providing them opportunities to work with a number of experts in distinct disciplines. They will learn various technologies and different skills. A critical skill that they will master is team work with different personalities in different lab and national cultures. They will learn how to experiment with and model different organisms, leading to

better generalization of neuroscience principles.

We expect to train approximately 25 PhD students and postdocs and dozens of undergraduate students. C3NS will recruit students and postdocs concentrating on broadening participation of minorities and women in science. A number of our PIs have an outstanding record in this endeavor and we expect to improve upon this by consolidating our resources and encouraging our undergraduate students to apply to our Network universities for graduate school.

*Outreach Activities, Broadening Participation:*

We will expand our many existing outreach programs and enrich them with C3NS’s research and the presence of international, interdisciplinary collaborators. Public demonstrations, day camps and internships will expose primary and secondary (K-12) students, primarily from underserved communities, to interdisciplinary research and international collaborators’ ideas and culture.

C3NS will conduct three new major Network-wide outreach activities that promise to encourage thousands of K-12 students to consider Science, Technology, Engineering, and Mathematics (STEM) in higher education. First, we propose to construct exhibits at science museums in C3NS’s major cities. This is possible because most of the PIs have contacts and previous collaborations with local museums. In fact, Fischer is the Director of the Phyletic Museum in Jena. We will develop an exhibit that will be copied and displayed concurrently at museums in Network cities. The exhibits will include QR-code tags that will lead the visitor to our second major initiative, an interactive website. Third, these exhibits will be shown at the IK [https://[www.interdisciplinary-college.de/](http://www.interdisciplinary-college.de/)]. This “interdisciplinary college” fosters education and research between modelers, engineers, and experimentalists. All of these efforts will describe how very different animals solve similar problems in similar ways with emphasis on how animals control behavior.

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* 1. Network Coordination and Management Plan

*Specific roles of the collaborating PIs, co-PIs, other Senior Personnel at all participating organizations:*

The figure below shows the PIs, co-PIs and other senior personnel in each of the four IRGs. IRGs 1- 3 are arranged as columns and are each associated with a particular animal. IRG4 is shown as the orange row on the bottom and includes modelers/engineers from each of the other three IRGs. The pink row indicates that Ache, Ito, Chiel, and Perreault will study head ganglia/midbrain in their particular animal and exchange their findings. The green row indicates that Ache, Ito, Chestek, and Heckman will study ascending/descending signals in their particular animal, and compare their results across phyla. The blue row indicates that Büschges, Blanke, Chiel, Webster-Wood, Fischer, Andrada, and Tresch will study body ganglia/spinal cord. Andrada works with Fischer. Szczecinski works with Quinn and Büschges.

*Leadership and organizational structure of the Network:*

Each IRG has 5 or 6 co-PIs and will be led by a PI indicated by bold font in the figure. Quinn is the PI of IRG4 and of the entire Network. The organization of each IRG is indicated in the figure. What is not shown in the figure is that we plan to hire a full-time manager who will work with the PIs to organize Network events and meetings, maintain Network data and sharing resources, maintain the Network research website and the interactive learning website, and compile progress reports.

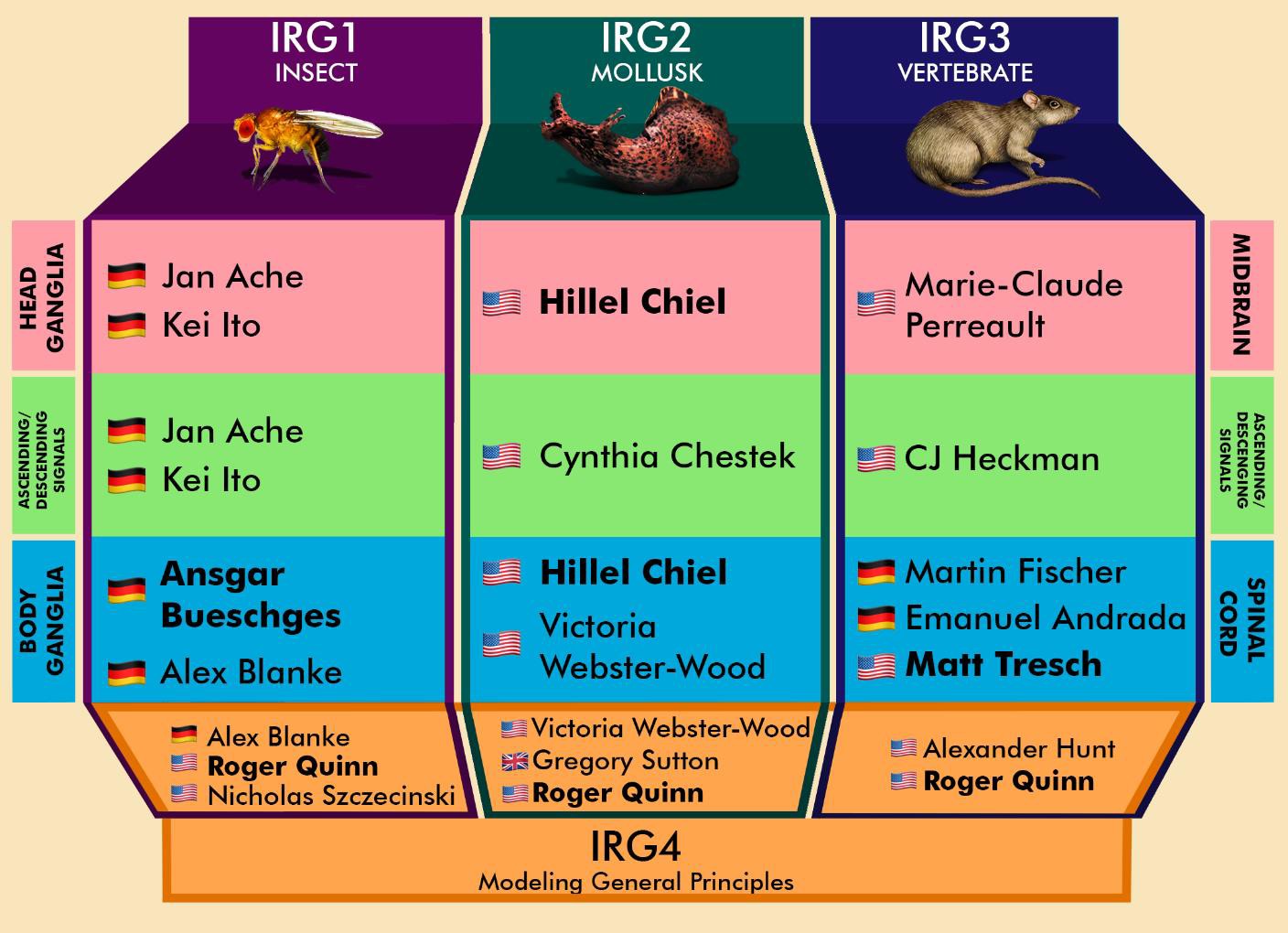
*Coordination mechanisms enabling cross-organizational and/or cross-discipline scientific integration:*

**Organizational**: IRG4 consists of the modelers from the other IRGs, which ensures cross IRG integration. Each IRG is interdisciplinary for cross-discipline integration.

**Student exchange**: Every PhD student and postdoc will spend at least 1 month/year at another lab.

**Data sharing**: All IRG plans, projects, data, and other documents will be shared through a cloud- based Network website.

**Meetings**: There will be quarterly meetings of the entire Network: In person meetings twice per year, one during the annual SFN meeting and the other in Europe, and two teleconferences. Each IRG will teleconference twice per month and meet in person during sidebars at the Network meetings. In addition, the head ganglia group (pink row), the inter-level communications group (green row) and the body ganglia group (blue row) will also meet at sidebars. This provides cross disciplinary and cross organism integration.



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* 1. Data and Computing Resource Management Plan

*Introduction:*

Throughout the duration of the proposed research, data and software will be created and saved as they are generated. Software will consist of synthetic nervous system (SNS) models, neuromechanical models, toolkits for SNS design, and other computational models and optimization strategies. Data will consist of measurements recorded from computational models, animal experiments, and robotic experiments appropriate for each IRG as detailed in the project description. Experimental data will be recorded via data acquisition software with essential metadata present as headers in the relevant electronic files, and video analysis with accompanying charts. Software development and testing will follow common conventions and revision enumeration. These data will be of interest to the computational neuroscience, robotics, autonomous controls, and neurobiology communities. Conference and journal publication information will be submitted to the appropriate repositories at each participating institution for sharing in concert with copyright privileges from the conferences and journals. We will make our software freely available through GitHub, a collaborative software development website, and will develop a public wiki geared towards dissemination to the general public.

*IRG and Network Coordination:*

To facilitate IRG coordination and communication of results and software between IRGs, a cloud repository will be established through a commercially available platform accessible internationally to all researchers (e.g., Dropbox). Appropriate funds will be requested to support this repository for the duration of the proposed work. The repository will be organized with folders for each IRG and subfolders for each project within the IRGs. Additionally, official versions of software packages developed will be maintained and made available to all IRG members through a controlled GitHub repository to ensure proper version control and revision enumeration.

*Data and Software Dissemination:*

To support dissemination of research products to the community, C3NS will maintain a public GitHub repository. Software packages maintained in the private repository will be released to this public repository in a timely manner. Software developed will be easily accessed by researchers and educators in the non- profit sector and available to cooperating commercial entities through contact with the PIs and our website. The terms of software availability will be developed in accordance with local data protection regulations to permit and encourage the dissemination and commercialization of enhanced or customized versions of the software, or incorporation of the software or pieces of it into other computational and robotics systems. The software source code will be transferable such that others can continue to enhance its development. We will take responsibility for creating the original and subsequent official versions of the software. If requested, access to all other data will be provided via contact with the PIs. Data will be available for access and sharing as soon as is reasonably possible. All data dissemination will be performed in accordance with national export control and data protection regulations. We do not anticipate generation of any personally identifiable information (PII) as a result of the proposed research. In the event that PII is generated, such data will not be disseminated publicly and will be stored and processed in accordance with the General Data Protection Regulation (European Union), and the respective Privacy Acts of the USA and Canada. Data will be preserved for at least three years beyond the award period, as required by NSF guidelines.

*Local Electronic Data Storage:*

In individual laboratories, all local electronic data, and local software copies for backup will be preserved in multiple on-site backups in the form of local RAID arrays and redundant hard drive storage as well as in the cloud repository.

*Intellectual Property:*

We do not anticipate that there will be any significant intellectual property issues involved with the acquisition of the data. In the event that inventions are made in direct connection with this data, access to the data will be granted upon request once appropriate invention disclosures and/or patent filings are made. The data acquired and preserved in the context of this proposal will be further governed by our universities and national policies pertaining to intellectual property, record retention, and data management.

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References

1. T. Buschmann, A. Ewald, A. Von Twickel, and A. Büschges, “Controlling legs for locomotion - insights from robotics and neurobiology,” *Bioinspiration and Biomimetics*, vol. 10, no. 4, p. 41001, 2015.
2. A. G. Varga, N. D. Kathman, J. P. Martin, P. Guo, and R. E. Ritzmann, “Spatial Navigation and the Central Complex: Sensory Acquisition, Orientation, and Motor Control,” *Front. Behav. Neurosci.*, vol. 11, no. January, 2017.
3. S. S. Bidaye, T. Bockemühl, and A. Büschges, “Six-legged walking in insects: how CPGs, peripheral feedback, and descending signals generate coordinated and adaptive motor rhythms,” *J. Neurophysiol.*, 2017.
4. J. C. Tuthill and R. I. Wilson, “Mechanosensation and Adaptive Motor Control in Insects,” *Curr. Biol.*, vol. 26, no. 20, pp. R1022–R1038, 2016.
5. A. Mamiya, P. Gurung, and J. C. Tuthill, “Neural Coding of Leg Proprioception in Drosophila,”

*Neuron*, vol. 100, no. 3, pp. 636–650, 2018.

1. V. Dürr, L. M. Theunissen, C. J. Dallmann, T. Hoinville, and J. Schmitz, “Motor flexibility in insects: adaptive coordination of limbs in locomotion and near-range exploration,” *Behav. Ecol. Sociobiol.*, vol. 72, no. 1, 2018.
2. R. Full and A. Ahn, “Static forces and moments generated in the insect leg: comparison of a three- dimensional musculo-skeletal computer model with experimental measurements,” *J. Exp. Biol.*, vol. 198, no. Pt 6, pp. 1285–98, Jan. 1995.
3. S. L. Hooper *et al.*, “Neural control of unloaded leg posture and of leg swing in stick insect, cockroach, and mouse differs from that in larger animals.,” *J. Neurosci.*, vol. 29, no. 13, pp. 4109– 19, Apr. 2009.
4. E. Loeb, E. Brown, and J. Cheng, “A hierarchical foundation for models of sensorimotor control,”

*Exp. Brain Res.*, pp. 1–18, 1999.

1. C. L. Chen *et al.*, “Imaging neural activity in the ventral nerve cord of behaving adult Drosophila,”

*Nat. Commun.*, vol. 9, no. 1, 2018.

1. S. J. Kiebel, J. Daunizeau, and K. J. Friston, “A hierarchy of time-scales and the brain,” *PLoS Comput. Biol.*, vol. 4, no. 11, 2008.
2. R. R. Flanagan, P. Vetter, R. S. Johansson, and D. M. Wolpert, “Prediction precedes control in motor learning,” *Curr. Biol.*, vol. 13, no. 2, pp. 146–150, 2003.
3. N. S. Szczecinski and R. D. Quinn, “Leg-local neural mechanisms for searching and learning enhance robotic locomotion,” *Biol. Cybern.*, pp. 1–14, 2017.
4. S. Rubeo, N. Szczecinski, and R. Quinn, “A Synthetic Nervous System Controls a Simulated Cockroach,” *Appl. Sci.*, vol. 8, no. 1, p. 6, 2017.
5. N. S. Szczecinski, J. P. Martin, D. J. Bertsch, R. E. Ritzmann, and R. D. Quinn, “Neuromechanical model of praying mantis explores the role of descending commands in pre-strike pivots.,” *Bioinspir. Biomim.*, vol. 10, no. 6, pp. 1–18, 2015.
6. R. E. Ritzmann *et al.*, “Deciding which way to go: How do insects alter movements to negotiate barriers?,” *Front. Neurosci.*, vol. 6, no. JULY, pp. 1–10, 2012.
7. J. P. Martin, P. Guo, L. Mu, C. M. Harley, and R. E. Ritzmann, “Central-complex control of movement in the freely walking cockroach,” *Curr. Biol.*, vol. 25, no. 21, pp. 2795–2803, 2015.
8. N. S. Szczecinski, A. J. Hunt, and R. D. Quinn, “A functional subnetwork approach to designing synthetic nervous systems that control legged robot locomotion,” *Front. Neurorobot.*, vol. 11, no. AUG, 2017.
9. C. Goldsmith, N. Szczecinski, and R. Quinn, “Drosophibot: A Fruit Fly Inspired Bio-Robot,” in

*Accepted to Conference on Biomimetic and Biohybrid Systems*, 2019, pp. 1–12.

1. N. S. Szczecinski, A. E. Brown, J. A. Bender, R. D. Quinn, and R. E. Ritzmann, “A neuromechanical simulation of insect walking and transition to turning of the cockroach Blaberus discoidalis,” *Biol. Cybern.*, vol. 108, no. 1, pp. 1–21, 2014.
2. N. S. Szczecinski, A. P. Getsy, J. P. Martin, R. E. Ritzmann, and R. D. Quinn, “MantisBot is a Robotic Model of Visually Guided Motion in the Praying Mantis,” *Arthropod Struct. Dev.*, 2017.
3. S. C. Pickard, R. D. Quinn, and N. S. Szczecinski, “Simulation of the Arthropod Central Complex: Moving Towards Bioinspired Robotic Navigation Control,” in *Biomimetic and Biohybrid Systems*, 2018, pp. 370–381.
4. E. M. Berg, S. L. Hooper, J. Schmidt, and A. Büschges, “A Leg-Local Neural Mechanism Mediates

1

the Decision to Search in Stick Insects,” *Curr. Biol.*, vol. 25, no. 15, pp. 2012–2017, 2015.

1. A. Büschges, H. Scholz, and A. El Manira, “New moves in motor control.,” *Curr. Biol.*, vol. 21, no. 13, pp. R513-24, Jul. 2011.
2. A. Borgmann and A. Büschges, “Insect motor control: methodological advances, descending control and inter-leg coordination on the move.,” *Curr. Opin. Neurobiol.*, vol. 33C, pp. 8–15, Jan. 2015.
3. A. Wosnitza, T. Bockemühl, M. Dübbert, H. Scholz, and A. Büschges, “Inter-leg coordination in the control of walking speed in Drosophila,” *J. Exp. Biol.*, vol. 216, no. 3, pp. 480–491, 2013.
4. V. Berendes, S. N. Zill, A. Büschges, and T. Bockemühl, “Speed-dependent interplay between local pattern-generating activity and sensory signals during walking in Drosophila,” *J. Exp. Biol.*, no. September, p. jeb.146720, 2016.
5. N. S. Szczecinski, T. Bockemühl, A. S. Chockley, and A. Büschges, “Static stability predicts the continuum of interleg coordination patterns in Drosophila,” *J. Exp. Biol.*, no. October, p. jeb.189142, 2018.
6. A. Blanke, M. Pinheiro, P. J. Watson, and M. J. Fagan, “A biomechanical analysis of prognathous and orthognathous insect head capsules: evidence for a many-to-one mapping of form to function,” *J. Evol. Biol.*, vol. 31, no. 5, pp. 665–674, May 2018.
7. S. David, J. Funken, W. Potthast, and A. Blanke, “Musculoskeletal modelling of the dragonfly mandible system as an aid to understanding the role of single muscles in an evolutionary context,” *J. Exp. Biol.*, vol. 219, no. 7, pp. 1041–1049, 2016.
8. A. Blanke, P. J. Watson, R. Holbrey, and M. J. Fagan, “Computational biomechanics changes our view on insect head evolution,” *Proc. R. Soc. B Biol. Sci.*, vol. 284, no. 1848, 2017.
9. A. Blanke, “Analysis of modularity and integration suggests evolution of dragonfly wing venation mainly in response to functional demands,” *J. R. Soc. Interface*, vol. 15, no. 145, 2018.
10. A. Blanke, H. Schmitz, A. Patera, H. Dutel, and M. J. Fagan, “Form–function relationships in dragonfly mandibles under an evolutionary perspective,” *J. R. Soc. Interface*, vol. 14, no. 128, p. 20161038, Mar. 2017.
11. K. Ito, T. Yano, T. K. Yokoyama, and A. Tsubouchi, “Understanding neuronal circuits and their functions using expression driver systems of the fruit fly Drosophila melanogaster,” in *Neural Coding*, 2016, pp. 26–27.
12. K. Ito *et al.*, “A systematic nomenclature for the insect brain,” *Neuron*, vol. 81, no. 4, pp. 755–765, 2014.
13. J. M. Ache, S. Namiki, A. Lee, K. Branson, and G. M. Card, “State-dependent decoupling of sensory and motor circuits underlies behavioral flexibility in Drosophila,” *Nat. Neurosci.*, 2019.
14. J. M. Ache, S. S. Haupt, and V. Dürr, “A Direct Descending Pathway Informing Locomotor Networks about Tactile Sensor Movement,” *J. Neurosci.*, vol. 35, no. 9, pp. 4081–4091, 2015.
15. J. M. Ache *et al.*, “Neural Basis for Looming Size and Velocity Encoding in the Drosophila Giant Fiber Escape Pathway,” *Curr. Biol.*, vol. 29, no. 6, pp. 1073-1081.e4, 2019.
16. N. S. Szczecinski, A. Büschges, and T. Bockemühl, “Direction-Specific Footpaths Can Be Predicted by the Motion of a Single Point on the Body of the Fruit Fly Drosophila Melanogaster,” in *Conference on Biomimetic and Biohybrid Systems*, 2018, pp. 477–489.
17. C. C. Horn and I. Kupfermann, “Egestive feeding responses in Aplysia persist after sectioning of the cerebral–buccal connectives: evidence for multiple sites of control of motor programs,” *Neurosci. Lett.*, vol. 323, no. 3, pp. 175–178, May 2002.
18. E. V Mangan, D. A. Kingsley, R. D. Quinn, G. P. Sutton, J. M. Mansour, and H. J. Chiel, “A biologically inspired gripping device,” *Ind. Robot An Int. J.*, vol. 32, no. 1, pp. 49–54, Feb. 2005.
19. V. A. Novakovic, G. P. Sutton, D. M. Neustadter, R. D. Beer, and H. J. Chiel, “Mechanical reconfiguration mediates swallowing and rejection in Aplysia californica,” *J. Comp. Physiol. A Neuroethol. Sensory, Neural, Behav. Physiol.*, vol. 192, no. 8, pp. 857–870, 2006.
20. M. Schaffner, J. A. Faber, L. Pianegonda, P. A. Rühs, F. Coulter, and A. R. Studart, “3D printing of robotic soft actuators with programmable bioinspired architectures,” *Nat. Commun.*, vol. 9, no. 1, p. 878, Dec. 2018.
21. S. Kurumaya, H. Nabae, G. Endo, and K. Suzumori, “Design of thin McKibben muscle and multifilament structure,” *Sensors Actuators A Phys.*, vol. 261, pp. 66–74, Jul. 2017.
22. S. Nagels and W. Deferme, “Fabrication Approaches to Interconnect Based Devices for Stretchable Electronics: A Review,” *Materials (Basel).*, vol. 11, no. 3, p. 375, Mar. 2018.
23. J. M. McManus, H. Lu, and H. J. Chiel, “An In Vitro Preparation for Eliciting and Recording Feeding

2

Motor Programs with Physiological Movements in Aplysia californica,” *J. Vis. Exp.*, no. 70, Dec. 2012.

1. V. Gilja *et al.*, “A high-performance neural prosthesis enabled by control algorithm design,” *Nat. Neurosci.*, vol. 15, no. 12, pp. 1752–1757, Dec. 2012.
2. J. L. Collinger *et al.*, “High-performance neuroprosthetic control by an individual with tetraplegia,”

*Lancet*, vol. 381, no. 9866, pp. 557–564, Feb. 2013.

1. C. A. Chestek, P. Samsukha, M. Tabib-Azar, R. R. Harrison, H. J. Chiel, and S. L. Garverick, “Microcontroller-Based Wireless Recording Unit for Neurodynamic Studies in Saltwater,” *IEEE Sens. J.*, vol. 6, no. 5, pp. 1105–1114, Oct. 2006.
2. E. Jankowska, “Spinal interneuronal networks in the cat: Elementary components,” *Brain Res. Rev.*, vol. 57, no. 1, pp. 46–55, 2008.
3. O. Kiehn, “Development and functional organization of spinal locomotor circuits.,” *Curr. Opin. Neurobiol.*, vol. 21, no. 1, pp. 100–9, Mar. 2011.
4. R. M. Brownstone and J. W. Chopek, “Reticulospinal Systems for Tuning Motor Commands,” *Front. Neural Circuits*, vol. 12, no. April, pp. 1–10, 2018.
5. M. C. Perreault and A. Giorgi, “Diversity of reticulospinal systems in mammals,” *Curr. Opin. Physiol.*, vol. 8, pp. 161–169, 2019.
6. C. Scharzenburger, J. Mendoza, and A. Hunt, “Design of a Canine Inspired Quadruped Robot as a Platform for Synthetic Neural Network Control,” in *Accepted to Conference on Biomimetic and Biohybrid Systems*, 2019.
7. A. Hunt, N. Szczecinski, and R. Quinn, “Development and Training of a Neural Controller for Hind Leg Walking in a Dog Robot,” *Front. Neurorobot.*, vol. 11, 2017.
8. A. J. Hunt, N. S. Szczecinski, E. Andrada, M. S. Fischer, and R. D. Quinn, “Using animal data and neural dynamics to reverse engineer a neuromechanical rat model,” in *Biomimetic and Biohybrid Systems*, 2015, vol. 9222, pp. 211–222.
9. A. J. Hunt, M. Schmidt, M. S. Fischer, and R. D. Quinn, “A biologically based neural system coordinates the joints and legs of a tetrapod,” *Bioinspir. Biomim.*, vol. 10, no. 5, p. 055004, 2015.
10. M. S. Fischer, “Crouched posture and high fulcrum, a principle in the locomotion of small mammals: the example of the rock hyrax (Procavia capensis)(Mammalia: Hyracoidea),” *J. Hum. Evol.*, vol. 26, pp. 501–24, 1994.
11. M. S. Fischer and R. Blickhan, “The tri-segmented limbs of therian mammals: kinematics, dynamics, and self-stabilization—a review,” *J. Exp. Zool. Part A Comp. Exp. Biol.*, vol. 305, no. 11, pp. 935– 952, 2006.
12. R. E. Ritzmann, R. D. Quinn, and M. S. Fischer, “Convergent evolution and locomotion through complex terrain by insects, vertebrates and robots,” *Arthropod Struct. Dev.*, vol. 33, no. 3, pp. 361– 379, 2004.
13. J. A. Nyakatura *et al.*, “Reverse-engineering the locomotion of a stem amniote,” *Nature*, vol. 565, no. 7739, pp. 351–355, 2019.
14. M. S. Fischer, “Kinematics, EMG, and inverse dynamics of the therian forelimb-a synthetic approach,” *Zool. Anz.*, vol. 238, no. 1, pp. 41–54, 1999.
15. E. Andrada, L. Reinhardt, K. Lucas, and M. S. Fischer, “Three-dimensional inverse dynamics of the forelimb of beagles at a walk and trot,” *Am. J. Vet. Res.*, vol. 78, no. 7, pp. 804–817, 2017.
16. R. H. Lee and C. J. Heckman, “Bistability in Spinal Motoneurons In Vivo: Systematic Variations in Persistent Inward Currents,” *J. Neurophysiol.*, vol. 80, no. 2, pp. 583–593, 2017.
17. C. J. Heckman, M. A. Gorassini, and D. J. Bennett, “Persistent inward currents in motoneuron dendrites: Implications for motor output,” *Muscle and Nerve*, vol. 31, no. 2, pp. 135–156, 2005.
18. C. J. Heckman and R. M. Enoka, “Motor Unit,” in *Comprehensive Physiology*, Hoboken, NJ, USA: John Wiley & Sons, Inc., 2012.
19. C. K. Thompson *et al.*, “Robust and accurate decoding of motoneuron behaviour and prediction of the resulting force output,” *J. Physiol.*, vol. 596, no. 14, pp. 2643–2659, 2018.
20. M. Manuel, M. Chardon, V. Tysseling, and C. J. Heckman, “Scaling of Motor Output, From Mouse to Humans,” *Physiology*, vol. 34, no. 1, pp. 5–13, 2018.
21. M. Berniker, A. Jarc, E. Bizzi, and M. C. Tresch, “Simplified and effective motor control based on muscle synergies to exploit musculoskeletal dynamics.,” *Proc. Natl. Acad. Sci. U. S. A.*, vol. 106, no. 18, pp. 7601–6, May 2009.
22. M. C. Tresch and A. Jarc, “The case for and against muscle synergies,” *Curr. Opin. Neurobiol.*, vol.

3

19, no. 6, pp. 601–607, 2009.

1. R. H. Chowdhury, M. C. Tresch, and L. E. Miller, “Musculoskeletal geometry accounts for apparent extrinsic representation of paw position in dorsal spinocerebellar tract,” *J. Neurophysiol.*, vol. 118, no. 1, pp. 234–242, 2017.
2. C. Alessandro, B. A. Rellinger, F. O. Barroso, and M. C. Tresch, “Adaptation after vastus lateralis denervation in rats demonstrates neural regulation of joint stresses and strains,” *Elife*, vol. 7, pp. 1– 18, 2018.
3. M. C. Perreault, T. Drew, and S. Rossignol, “Activity of medullary reticulospinal neurons during fictive locomotion,” *J. Neurophysiol.*, vol. 69, no. 6, pp. 2232–2247, 2017.
4. C. Jean-Xavier and M. C. Perreault, “Influence of brain stem on axial and hindlimb spinal locomotor rhythm generating circuits of the neonatal mouse,” *Front. Neurosci.*, vol. 12, no. FEB, pp. 1–14, 2018.
5. M. S. Sivertsen, M. C. Perreault, and J. C. Glover, “Pontine reticulospinal projections in the neonatal mouse: Internal organization and axon trajectories,” *J. Comp. Neurol.*, vol. 524, no. 6, pp. 1270– 1291, 2016.
6. N. Kasumacic *et al.*, “Segmental Organization of Vestibulospinal Inputs to Spinal Interneurons Mediating Crossed Activation of Thoracolumbar Motoneurons in the Neonatal Mouse,” *J. Neurosci.*, vol. 35, no. 21, pp. 8158–8169, 2015.
7. N. S. Szczecinski and R. D. Quinn, “MantisBot Changes Stepping Speed by Entraining CPGs to Positive Velocity Feedback,” in *Lecture Notes in Artificial Intelligence 10384*, 2017, pp. 440–52.
8. N. S. Szczecinski and R. D. Quinn, “Template for the Neural Control of Directed Walking Generalized to All Legs of MantisBot,” *Bioinspiration and Biomimetics*, 2017.
9. S. David, J. Funken, W. Potthast, and A. Blanke, “Musculoskeletal modelling under an evolutionary perspective: Deciphering the role of single muscle regions in closely related insects,” *J. R. Soc. Interface*, vol. 13, no. 123, 2016.
10. M. Burrows and G. Sutton, “Interacting Gears Synchronize Propulsive Leg Movements in a Jumping Insect,” *Science (80-. ).*, vol. 341, no. 6151, pp. 1254–1256, Sep. 2013.
11. M. Burrows, D. A. Cullen, M. Dorosenko, and G. P. Sutton, “Mantises exchange angular momentum between three rotating body parts to jump precisely to targets,” *Curr. Biol.*, vol. 25, no. 6, pp. 786– 789, 2015.
12. M. Ilton *et al.*, “The principles of cascading power limits in small, fast biological and engineered systems,” *Science (80-. ).*, vol. 360, no. 6387, 2018.
13. M. S. Garcia, A. D. Kuo, A. Peattie, P. Wang, and R. J. Full, “Damping And Size: Insights And Biological Inspiration,” *Int. Symp. Adapt. Motion Anim. Mach.*, pp. 1–7, 2000.
14. K. Deng *et al.*, “Neuromechanical Model of Rat Hindlimb Walking with Two-Layer CPGs,”

*Biomimetics*, vol. 4, no. 1, p. 21, 2019.

1. K. S. Espenschied, R. D. Quinn, R. D. Beer, and H. J. Chiel, “Biologically based distributed control and local reflexes improve rough terrain locomotion in a hexapod robot,” *Rob. Auton. Syst.*, vol. 18, no. 1–2, pp. 59–64, Jul. 1996.
2. G. M. Nelson, R. D. Quinn, R. J. Bachmann, W. C. Flannigan, R. E. Ritzmann, and J. T. Watson, “Design and simulation of a cockroach-like hexapod robot,” *Proc. Int. Conf. Robot. Autom.*, vol. 2, no. April, pp. 3–8, 1997.
3. N. S. Szczecinski *et al.*, “Introducing MantisBot: Hexapod robot controlled by a high-fidelity, real- time neural simulation,” in *IEEE International Conference on Intelligent Robots and Systems*, 2015, pp. 3875–3881.
4. N. S. Szczecinski, A. J. Hunt, and R. D. Quinn, “Design process and tools for dynamic neuromechanical models and robot controllers,” *Biol. Cybern.*, vol. 111, no. 1, 2017.

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%,2\*5$3+,&$/ 6.(7&+

5RJHU '. 4XLQQ, 3K'

$UWKXU 3. $UPLQJWRQ 3URIHVVRU RI (QJLQHHULQJ 'HSDUWPHQW RI 0HFKDQLFDO DQG $HURVSDFH (QJLQHHULQJ &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\

&OHYHODQG, 2KLR 44106-7222 UGT#FDVH.HGX KWWS://ELRURERWV.FDVH.HGX

$. 3URIHVVLRQDO 3UHSDUDWLRQ

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| --- | --- | --- | --- |
| ,QVWLWXWLRQ | /RFDWLRQ | 0DMRU | 'HJUHH &<HDU |
| 7KH 8QLYHUVLW\ RI $NURQ | $NURQ, 2KLR | 0HFKDQLFDO (QJLQHHULQJ | %.6., 1980 |
| 7KH 8QLYHUVLW\ RI $NURQ | $NURQ, 2KLR | 0HFKDQLFDO (QJLQHHULQJ | 0.6., 1983 |
| 9LUJLQLD 7HFK | %ODFNVEXUJ, 9LUJLQLD | (QJLQHHULQJ 0HFKDQLFV | 3K.'., 1985 |

%. $SSRLQWPHQWV

2003-3UHVHQW $UWKXU 3. $UPLQJWRQ 3URIHVVRU RI (QJLQHHULQJ, &DVH

1997-3UHVHQW 3URIHVVRU, 0HFKDQLFDO DQG $HURVSDFH (QJLQHHULQJ, &DVH

1992-3UHVHQW 'LUHFWRU RI &:58 %LRURERWLFV &RPSOH[ (KWWS://ELRURERWV.FZUX.HGX )

1992-97 $VVRFLDWH 3URIHVVRU, 0HFKDQLFDO DQG $HURVSDFH (QJLQHHULQJ, &DVH

1986-92 \*HQHUDO 0RWRUV $VVLVWDQW 3URIHVVRU, &DVH

&. 3URGXFWV

)LYH PRVW UHOHYDQW SXEOLFDWLRQV (RXW RI PRUH WKDQ 200 UHIHUHHG SXEOLFDWLRQV):

1. 6]F]HFLQVNL, 1. 6., +XQW, $. -., 4XLQQ, 5. '. (2017). $ IXQFWLRQDO VXEQHWZRUN DSSURDFK WR GHVLJQLQJ V\QWKHWLF QHUYRXV V\VWHPV WKDW FRQWURO OHJJHG URERW ORFRPRWLRQ. )URQWLHUV LQ 1HXURURERWLFV. '2,: 10.3389/IQERW.2017.00037.

2. +XQW, $. -., 6]F]HFLQVNL, 1. 6., 4XLQQ, 5. '. (2017). 'HYHORSPHQW DQG WUDLQLQJ RI D QHXUDO FRQWUROOHU IRU KLQG OHJ ZDONLQJ LQ D GRJ URERW. )URQWLHUV LQ 1HXURURERWLFV 11(18). '2,: 0.3389/IQERW.2017.00018.

1. 6]F]HFLQVNL, 1. 6., 4XLQQ, 5. '. (2017). 7HPSODWH IRU WKH QHXUDO FRQWURO RI GLUHFWHG ZDONLQJ JHQHUDOL]HG WR DOO OHJV RI 0DQWLV%RW. %LRLQVSLUDWLRQ DQG %LRPLPHWLFV 12(4). '2,: 10.1088/1748- 3190/DD6GG9. *Featured by* %LRLQVSLUDWLRQ DQG %LRPLPHWLFV.
2. $OH[DQGHU +XQW, 0DQXHOD 6FKPLGW, 0DUWLQ )LVFKHU DQG 5RJHU 4XLQQ (2015) $ ELRORJLFDOO\ EDVHG QHXUDO V\VWHP FRRUGLQDWHV WKH MRLQWV DQG OHJV RI D WHWUDSRG *Bioinspir. Biomim.* 10 055004, GRL:10.1088/1748-3190/10/5/055004.
3. 5XEHR, 6., 6]F]HFLQVNL, 1., 4XLQQ, 5. '. (2017). $ 6\QWKHWLF 1HUYRXV 6\VWHP &RQWUROV D 6LPXODWHG &RFNURDFK. *Applied Sciences, 8*(1), 6.

)LYH RWKHU UHOHYDQW SXEOLFDWLRQV

1. .DL\X 'HQJ, 1LFKRODV 6. 6]F]HFLQVNL, 'LUN $UQROG, (PDQXHO $QGUDGD, 0DUWLQ )LVFKHU, 5RJHU '. 4XLQQ, $OH[DQGHU -. +XQW (2019) 1HXURPHFKDQLFDO 0RGHO RI 5DW +LQG /LPE :DONLQJ ZLWK 7ZR-

/D\HU &3\*V, *Biomimetics* 2019, *4*(1), 21; KWWSV://GRL.RUJ/10.3390/ELRPLPHWLFV4010021

1. 6]F]HFLQVNL, 1. 6., 4XLQQ, 5. '. (2018). /HJ-ORFDO QHXUDO PHFKDQLVPV IRU VHDUFKLQJ DQG OHDUQLQJ HQKDQFH URERWLF ORFRPRWLRQ. %LRORJLFDO &\EHUQHWLFV. 112 (1-2), SS. 99-12, 2018/4/1, '2,: 10.1007/V00422-017-0726-[.

%,2\*5$3+,&$/ 6.(7&+

3. 6]F]HFLQVNL, 1. 6., 0DUWLQ, -. 3., %HUWVFK, '. -., 5LW]PDQQ, 5. (., 4XLQQ, 5. '. (2015).

1HXURPHFKDQLFDO PRGHO RI SUD\LQJ PDQWLV H[SORUHV WKH UROH RI GHVFHQGLQJ FRPPDQGV LQ SUH-VWULNH

SLYRWV. *Bioinspiration & Biomimetics, 10*(6), 065005.

1. )OHWFKHU <RXQJ, &KULVWLDQ 5RGH, $OH[ +XQW, 5RJHU 4XLQQ (2019) $QDO\]LQJ 0RPHQW $UP 3URILOHV LQ D )XOO-0XVFOH 5DW +LQGOLPE 0RGHO, *Biomimetics* 2019, *4*(1), 10; KWWSV://GRL.RUJ/10.3390/ELRPLPHWLFV4010010

5. 0DQJDQ, (.9., .LQJVOH\ '.$., 4XLQQ, 5.'., 6XWWRQ, \*.3., 0DQVRXU, -.0., &KLHO, +.-. (2005) $

ELRORJLFDOO\ LQVSLUHG JULSSLQJ GHYLFH. *Industrial Robot: An International Journal,* 9RO. 32, 1R. 1. SS 49-54.

'. 6\QHUJLVWLF $FWLYLWLHV

x 3, (2008- ) $XWRQRPRXV ODZQPRZHU, VQRZ SORZ GHYHORSPHQW ZLWK XQGHUJUDGXDWH UHVHDUFKHUV

* + :RQ ,21 $XWRQRPRXV /DZQPRZHU &RPSHWLWLRQ 2009-11
  + :RQ ,21 $XWRQRPRXV 6QRZ 3ORZ &RPSHWLWLRQ 2017, 2019

x &R-&KDLU 2UJDQL]LQJ FRPPLWWHH, $GDSWLYH 0RWLRQ RI $QLPDOV DQG 0DFKLQHV ($0$02008), &OHYHODQG

x &R-,QYHVWLJDWRU IRU ,\*(57 SURJUDP LQ 1HXURPHFKDQLFV (1999-2006)

x &R-'HYHORSHG XQGHUJUDGXDWH FRXUVH ³%LRURERWLFV 7HDP 5HVHDUFK´ (2005 ± 3UHVHQW)

x 8QGHUJUDGXDWH DQG +LJK 6FKRRO 2XWUHDFK: +RVW ODE IRU XQGHUJUDGXDWH DQG KLJK VFKRRO UHVHDUFKHUV LQ URERWLFV (1992 - 3UHVHQW); W\SLFDOO\ 30-40 XQGHUJUDGXDWH UHVHDUFKHUV LQ %LRURERWLFV ODE DQQXDOO\; PXOWLSOH KLJK VFKRRO VWXGHQWV ZRUN LQ WKH ODE HDFK VXPPHU; DIWHU-VFKRRO SURJUDP DW ORFDO KLJK VFKRRO

&\QWKLD $. &KHVWHN, $VVRFLDWH 3URIHVVRU

%LRJUDSKLFDO 6NHWFK

1RUWK &DPSXV 5HVHDUFK &RPSOH[, %XLOGLQJ 10, 5RRP $171

2800 3O\PRXWK 5G. $QQ $UERU, 0, 48105

734-707-3356, FFKHVWHN#XPLFK.HGX

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| --- | --- | --- |
| &ROOHJH/8QLYHUVLW\ | 0DMRU | 'HJUHH &<HDU |
| &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\ | (OHFWULFDO (QJLQHHULQJ | %.6., 2003 |
| &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\ | (OHFWULFDO (QJLQHHULQJ | 0.6., 2005 |
| 6WDQIRUG 8QLYHUVLW\  6WDQIRUG 8QLYHUVLW\ | (OHFWULFDO (QJLQHHULQJ 1HXURVXUJHU\ 5HVHDUFK | 3K.'., 2010  2010-2012 |

%. $&$'(0,&/352)(66,21$/ $332,170(176

$VVLVWDQW 3URIHVVRU, 'HSDUWPHQW RI %LRPHGLFDO (QJLQHHULQJ, 8QLYHUVLW\ RI 0LFKLJDQ 2012-2018

$VVRFLDWH 3URIHVVRU, 'HSDUWPHQW RI %LRPHGLFDO (QJLQHHULQJ, 8QLYHUVLW\ RI 0LFKLJDQ 2018-FXUUHQW (&RXUWHV\ DSSRLQWPHQWV LQ (OHFWULFDO (QJLQHHULQJ, 1HXURVFLHQFH, DQG 5RERWLFV)

&. 38%/,&$7,216

3XEOLFDWLRQV 0RVW &ORVHO\ 5HODWHG WR 3URSRVDO

3. 3. 9X, =. 7. ,UZLQ, $. -. %XOODUG, 6. /. :RR, ,. &. 6DQGR, 0. \*. 8UEDQFKHN, 3. 6. &HGHUQD, &. $. &KHVWHN. &ORVHG-ORRS FRQWLQXRXV KDQG FRQWURO YLD FKURQLF UHFRUGLQJ RI UHJHQHUDWLYH SHULSKHUDO QHUYH LQWHUIDFHV DQG LQWDFW PXVFOH. *IEEE TNSRE,* 26(2):

10.1109/7165(.2017.2772961

.. (. 6FKURHGHU, =. 7. ,UZLQ, 0. \*DLGLFD, -. 1. %HQWOH\, 3. \*. 3DWLO, \*. $. 0DVKRXU\* DQG &. $. &KHVWHN\*. 'LUHFW HYLGHQFH IRU GLVUXSWHG FRUWLFDO FRPPXQLFDWLRQ GXULQJ JHQHUDO DQHVWKHVLD LQ WKH SULPDWH EUDLQ,

*Neuroimage*, 134: 459-465, 2016. /LQN

=. 7. ,UZLQ, .. (. 6FKURHGHU, 3. 9X, '. 0. 7DW, $. %XOODUG, 6. :RR, ,. 6DQGR, 0. 8UEDQFKHN, 3. &HGHUQD DQG &. $. &KHVWHN. &KURQLF UHFRUGLQJ RI KDQG SURVWKHVLV FRQWURO VLJQDOV YLD D UHJHQHUDWLYH SHULSKHUDO QHUYH LQWHUIDFH LQ D UKHVXV PDFDTXH, *J Neural Eng,* 2016. /LQN

=. 7. ,UZLQ, '. (. 7KRPSVRQ, .. (. 6FKURHGHU, '. 0. 7DW, $. +DVVDQL, $. -. %XOODUG, 6. /. :RR, $. -. 6DFKV, 0. \*. 8UEDQFKHN, :. &. 6WDFH\, 3. 6. &HGHUQD, 3. \*. 3DWLO DQG &. $. &KHVWHN. (QDEOLQJ ORZ-SRZHU PXOWL-PRGDO QHXUDO LQWHUIDFHV WKURXJK D FRPPRQ ORZ-EDQGZLGWK IHDWXUH VSDFH, *IEEE Trans Neural*

*Systems Rehabil Eng*, 99:1-11, 2015. /LQN

9. \*LOMD\*. 3. 1X\XMXNLDQ\*, &. &KHVWHN, -. 3. &XQQLQJKDP, %. 0. <X, -. 0. )DQ, 0. 0. &KXUFKODQG, 0. 7.

.DXIPDQ, -. &. .DR, 6. ,. 5\X, DQG .. 9. 6KHQR\. ³$ KLJK-SHUIRUPDQFH QHXUDO SURVWKHVLV HQDEOHG E\ FRQWURO DOJRULWKP GHVLJQ.´ 1DWXUH 1HXURVFLHQFH, 15: 1752-1757. /LQN

2WKHU 6LJQLILFDQW 3XEOLFDWLRQV

3. 5. 3DWHO, .. 1D, +. =KDQJ, 7. '. .R]DL, 1. $. .RWRY, (. <RRQ, DQG &. $. &KHVWHN. ,QVHUWLRQ RI OLQHDU

8.5 XP GLDPHWHU 16 FKDQQHO FDUERQ ILEHU HOHFWURGH DUUD\V IRU VLQJOH XQLW UHFRUGLQJV, *J Neural Eng*, 12(4):046009, 2015. /LQN

3. 5. 3DWHO, +. =KDQJ, 0. 7. 5REELQV, -. %. 1RIDU, 6. 3. 0DUVKDOO, 0. -. .RE\ODUHN, 7. '. .R]DL, 1. $.

.RWRY DQG &. $. &KHVWHN. &KURQLF *in vivo* VWDELOLW\ DVVHVVPHQW RI FDUERQ ILEHU PLFURHOHFWURGH DUUD\V. *J Neural Eng*, 13(6):066002, 2016. /LQN

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&. &KHVWHN, 9. \*LOMD, 3. 1X\XMXNLDQ, -. )RVWHU, -. )DQ, 0. .DXIPDQ, 0. &KXUFKODQG, =. 5LYHUD-$OYLGUH], -. &XQQLQJKDP, 6. 5\X, DQG .. 6KHQR\. ³/RQJ-WHUP VWDELOLW\ RI QHXUDO SURVWKHWLF FRQWURO VLJQDOV IURP VLOLFRQ FRUWLFDO DUUD\V LQ UKHVXV PDFDTXH PRWRU FRUWH[,´ -. RI 1HXUDO (QJ., 8: 1-11, 2011. /LQN

&. &KHVWHN\*, $. 3. %DWLVWD\*, \*. 6DQWKDQDP, %. 0. <X, $. $IVKDU, -. 3. &XQQLQJKDP, 9. \*LOMD, 6. ,. 5\X,

0. 0. &KXUFKODQG, DQG .. 9. 6KHQR\. "6LQJOH-1HXURQ 6WDELOLW\ 'XULQJ 5HSHDWHG 5HDFKLQJ LQ 0DFDTXH 3UHPRWRU &RUWH[," *J Neurosci*, 27:10742-10750, 2007. /LQN

&. &KHVWHN, 9. \*LOMD, &. +. %ODEH, %. /. )RVWHU, .. 9. 6KHQR\, -. 3DUYL]L, DQG -. 0. +HQGHUVRQ. ³+DQG SRVWXUH FODVVLILFDWLRQ XVLQJ HOHFWURFRUWLFRJUDSK\ VLJQDOV LQ WKH JDPPD EDQG RYHU VHQVRULPRWRU EUDLQ DUHDV.´ - 1HXUDO (QJ, 10:1-11, 2013. /LQN

'. 6<1(5\*,67,& $&7,9,7,(6

-RXUQDO 5HYLHZHU, ,((( 7165(, ,((( 7%LR&$6, ,((( (0%6, - 1HXURSK\VLRORJ\, 1DWXUH 1HXURVFLHQFH, 1HXUDO &RPSXWDWLRQ

0HPEHUVKLS, ,(((, ,((( :RPHQ LQ (QJLQHHULQJ, 6RFLHW\ IRU 1HXURVFLHQFH

:RPHQ LQ 6FLHQFH DQG (QJLQHHULQJ ± 6XPPHU SURVWKHWLFV ZRUNVKRS &RPPLWWHH PHPEHU ± 5RERWLFV 'D\ (3 \UV)

2

**+LOOHO -. &KLHO**

3URIHVVRU RI %LRORJ\ &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\

1. **3URIHVVLRQDO 3UHSDUDWLRQ**

|  |  |  |  |
| --- | --- | --- | --- |
| <DOH 8QLYHUVLW\ | (1HZ +DYHQ, &RQQ.) | (QJOLVK | %.$. 1974 |
| 0DVV. ,QVW. 7HFKQRORJ\ (&DPEULGJH, 0DVV.) | | 1XWULWLRQ DQG 0HWDEROLVP | 0.6. 1976 |
| 0DVV. ,QVW. 7HFKQRORJ\ (&DPEULGJH, 0DVV.) | | 1HXUDO DQG (QGRFULQH 5HJXODWLRQ | 3K.'. 1980 |
| &ROXPELD 8QLYHUVLW\ (1HZ <RUN, 1<) | | 1HXURELRORJ\ DQG %HKDYLRU | 1980-1985 |

1. **$SSRLQWPHQWV**

1999- 3URIHVVRU, 'HSDUWPHQWV RI %LRORJ\, 1HXURVFLHQFHV, DQG %LRPHGLFDO (QJLQHHULQJ, &DVH

:HVWHUQ 5HVHUYH 8QLYHUVLW\, &OHYHODQG 2KLR.

|  |  |
| --- | --- |
| 1992-1999 | $VVRFLDWH 3URIHVVRU, 'HSW. %LRORJ\, &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\, &OHYHODQG 2KLR. |
| 1989-1992 | $VVLVWDQW 3URIHVVRU, 'HSW. 1HXURVFLHQFHV, &DVH :HVWHUQ 5HVHUYH, &OHYHODQG, 2KLR. |
| 1987-1992 | $VVLVWDQW 3URIHVVRU, 'HSW. %LRORJ\, &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\, &OHYHODQG 2KLR. |
| 1985-1987 | &RQVXOWDQW LQ 1HXURELRORJ\, 'HSDUWPHQW RI 0ROHFXODU %LRSK\VLFV, $7&7 %HOO /DERUDWRULHV, |
|  | 0XUUD\ +LOO, 1HZ -HUVH\. |

#### 3XEOLFDWLRQV. (\* ,QGLFDWHV SXEOLFDWLRQV UHVXOWLQJ IURP SULRU 16) VXSSRUW.)

)LYH SXEOLFDWLRQV FORVHO\ UHODWHG WR WKH SUHVHQW SURSRVDO:

\*1. 0F0DQXV, -.0., **&KLHO**, +.-., 6XVVZHLQ, $.-. (2019) 6XFFHVVIXO DQG XQVXFFHVVIXO DWWHPSWV WR VZDOORZ LQ D UHGXFHG *Aplysia* SUHSDUDWLRQ UHJXODWH IHHGLQJ UHVSRQVHV DQG SURGXFH PHPRU\ DW GLIIHUHQW QHXUDO VLWHV. /HDUQ 0HP. 26(5):151-165. GRL: 10.1101/OP.048983.118.

\*2. 3DUN, <., 6KDZ, .., **&KLHO, +.,** DQG 7KRPDV, 3. (2018). 7KH LQILQLWHVLPDO SKDVH UHVSRQVH FXUYHV RI

RVFLOODWRUV LQ SLHFHZLVH VPRRWK G\QDPLFDO V\VWHPV. *European Journal of Applied Mathematics,* 1-36. GRL:10.1017/60956792518000128.

\*3. /\WWOH, '. 1., \*LOO, -. 3., 6KDZ, .. 0., 7KRPDV, 3. -. DQG **&KLHO, +. -.** (2017) 5REXVWQHVV, IOH[LELOLW\ DQG VHQVLWLYLW\ LQ D PXOWLIXQFWLRQDO PRWRU FRQWURO PRGHO. %LRORJLFDO &\EHUQHWLFV. 111: 25 ± 47.

\*4. &XOOLQV, 0. -., \*LOO, -. 3., 0F0DQXV, -. 0., /X, +., 6KDZ, .. 0. DQG **&KLHO, +. -.** (2015) 6HQVRU\ IHHGEDFN UHGXFHV LQGLYLGXDOLW\ E\ LQFUHDVLQJ YDULDELOLW\ ZLWKLQ VXEMHFWV. &XUUHQW %LRORJ\. 25:2672-2676.

\*5. /X, +., 0F0DQXV, -.0., &XOOLQV, 0. -. DQG **&KLHO, +. -.** (2015) 3UHSDULQJ WKH SHULSKHU\ IRU D VXEVHTXHQW EHKDYLRU: 0RWRU QHXURQDO DFWLYLW\ GXULQJ ELWLQJ JHQHUDWHV OLWWOH IRUFH EXW SUHSDUHV D UHWUDFWRU PXVFOH WR JHQHUDWH ODUJHU IRUFHV GXULQJ VZDOORZLQJ LQ *Aplysia* -RXUQDO RI 1HXURVFLHQFH, 35:5051 ± 5066.

)LYH DGGLWLRQDO SXEOLFDWLRQV:

\*1. \*DQJXO\, 0., -HQNLQV, 0.:., -DQVHQ, (.'., **&KLHO, +.-.** (2019) 7KHUPDO EORFN RI DFWLRQ SRWHQWLDOV LV SULPDULO\ GXH WR YROWDJH-GHSHQGHQW SRWDVVLXP FXUUHQWV: D PRGHOLQJ VWXG\. - 1HXUDO (QJ. 16(3):036020. GRL: 10.1088/1741-2552/DE131E.

\*2. .DQGKDUL, $., +XDQJ, <., . $ 'DOWRULR, ..$., **&KLHO, +.-.** DQG 4XLQQ, 5.'. (2018) %RG\ VWLIIQHVV LQ RUWKRJRQDO GLUHFWLRQV RSSRVLWHO\ DIIHFWV ZRUP-OLNH URERW WXUQLQJ DQG VWUDLJKW-OLQH ORFRPRWLRQ. %LRPLPHWLFV DQG %LRLQVSLUDWLRQ. 13: 026003, GRL: KWWSV://GRL.RUJ/10.1088/1748-3190/DDD342.

3. .RGDPD, 1. ;., )HQJ, 7., 8OOHWW, -. -., **&KLHO, +. -.,** 6LYDNXPDU, 6. 6., \*DOiQ, 5. ). (2018) $QWL-FRUUHODWHG FRUWLFDO QHWZRUNV DULVH IURP VSRQWDQHRXV QHXURQDO G\QDPLFV DW VORZ WLPHVFDOHV. 6FLHQWLILF 5HSRUWV 8:

$UWLFOH 1XPEHU 666, GRL:10.1038/V41598-017-18097-0.

4. /RWKHW, (. +., 6KDZ, .. 0., /X, +., =KXR, -., :DQJ, <. 7., \*X, 6., 6WRO], '. %., -DQVHQ, (. '., +RUQ, &.&., **&KLHO, +. -.** DQG -HQNLQV, 0. :. (2017) 6HOHFWLYH LQKLELWLRQ RI VPDOO-GLDPHWHU D[RQV XVLQJ LQIUDUHG OLJKW. 6FLHQWLILF 5HSRUWV 7:3275, SS. 1 - 8. '2,:10.1038/V41598-017-03374-9.

\*5. &XOOLQV, 0. -., 6KDZ, .. 0., \*LOO, -. 3., DQG **&KLHO, +. -.** (2015) 0RWRU QHXURQDO DFWLYLW\ YDULHV OHDVW DPRQJ LQGLYLGXDOV ZKHQ LW PDWWHUV PRVW IRU EHKDYLRU. -RXUQDO RI 1HXURSK\VLRORJ\, 113: 981 - 1000.

#### 6\QHUJLVWLF $FWLYLWLHV

**(L)** 'HYHORSHG D FRXUVH, *Dynamics of Biological Systems*, WKDW WHDFKHV XQGHUJUDGXDWHV WKH SULQFLSOHV RI PRGHOLQJ ELRORJLFDO V\VWHPV XVLQJ *Mathematica* DQG SULQFLSOHV IURP QRQOLQHDU G\QDPLFDO V\VWHPV WKHRU\. &RXUVH LV D FRUH UHTXLUHPHQW IRU %6 GHJUHH LQ 6\VWHPV %LRORJ\. 7KLV FRXUVH UHFHLYHG WKH *Science* SUL]H IRU ,QTXLU\-%DVHG ,QVWUXFWLRQ (2012).

**(LL)** (OHFWHG )HOORZ RI WKH ,QVWLWXWH RI 3K\VLFV, (QJODQG (2004). **(LLL)** :LWWNH $ZDUG IRU ([FHOOHQFH LQ 8QGHUJUDGXDWH 7HDFKLQJ (2004). **(LY)** 'LHNKRII $ZDUG IRU ([FHOOHQFH LQ \*UDGXDWH 7HDFKLQJ (2009).

#### &KDUOHV -. +HFNPDQ, 3K'

'HSDUWPHQW RI 3K\VLRORJ\

**1RUWKZHVWHUQ 8QLYHUVLW\ )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR ,/ 60611**

**3URIHVVLRQDO 3UHSDUDWLRQ**

2EHUOLQ &ROOHJH, 2+ %LRORJ\ $.%. 1975

8QLYHUVLW\ RI :DVKLQJWRQ, :$ .LQHVLRORJ\ 0.6. 1983

8QLYHUVLW\ RI :DVKLQJWRQ, :$ 3K\VLRORJ\ & %LRSK\VLFV 3K.'. 1986

/DE RI 1HXUDO &RQWURO, 1,+, 0' 1HXURSK\VLRORJ\ 3RVW-GRF 1988

1RUWKZHVWHUQ 8QLYHUVLW\, ,/ 1HXURSK\VLRORJ\ 3RVW-GRF 1990

**$SSRLQWPHQWV**

05/88 - 11/90 5HVHDUFK $VVRFLDWH, 'HSDUWPHQW RI 3K\VLRORJ\, 1RUWKZHVWHUQ 8QLYHUVLW\,

)HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR, ,/

12/90 - 12/96 5HVHDUFK $VVLVWDQW 3URIHVVRU, 'HSDUWPHQW RI 3K\VLRORJ\, 1RUWKZHVWHUQ

8QLYHUVLW\, )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR, ,/

12/96 - 08/98 5HVHDUFK $VVRFLDWH 3URIHVVRU, 'HSDUWPHQW RI 3K\VLRORJ\, 1RUWKZHVWHUQ

8QLYHUVLW\, )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR, ,/

09/98 - 08/05 $VVRFLDWH 3URIHVVRU, 'HSDUWPHQWV RI 3K\VLRORJ\ DQG 3K\VLFDO 0HGLFLQH DQG

5HKDELOLWDWLRQ, 1RUWKZHVWHUQ 8QLYHUVLW\, )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR DQG WKH 5HKDELOLWDWLRQ ,QVWLWXWH RI &KLFDJR, ,/

09/05 - 3URIHVVRU, 'HSDUWPHQWV RI 3K\VLRORJ\ DQG 3K\VLFDO 0HGLFLQH DQG

5HKDELOLWDWLRQ, 1RUWKZHVWHUQ 8QLYHUVLW\, )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR DQG WKH 5HKDELOLWDWLRQ ,QVWLWXWH RI &KLFDJR, ,/

01/10 - $GMXQFW 3URIHVVRU, 'HSDUWPHQW RI 3K\VLFDO 7KHUDS\ DQG +XPDQ 0RYHPHQW

6FLHQFH, 1RUWKZHVWHUQ 8QLYHUVLW\ )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR ,/

01/10 - $VVRFLDWH &KDLU IRU 5HVHDUFK, 'HSDUWPHQW RI 3K\VLFDO 7KHUDS\ DQG +XPDQ

0RYHPHQW 6FLHQFH, 1RUWKZHVWHUQ 8QLYHUVLW\ )HLQEHUJ 6FKRRO RI 0HGLFLQH, &KLFDJR ,/

**)LYH SXEOLFDWLRQV PRVW FORVHO\ UHODWHG WR WKH SURSRVHG SURMHFW**

/HH, 5.+. DQG +HFNPDQ, &.-. $GMXVWDEOH DPSOLILFDWLRQ RI V\QDSWLF LQSXW LQ WKH GHQGULWHV RI VSLQDO PRWRQHXURQV LQ YLYR. *J. Neurosci.* 20: 6734-6740, 2000. 30,': 10964980

-RKQVRQ, 0.', .DMWD], (., &DLQ, &.0., DQG +HFNPDQ, &.-. 0RWRQHXURQ LQWULQVLF SURSHUWLHV, EXW QRW WKHLU UHFHSWLYH ILHOGV, UHFRYHU LQ FKURQLF VSLQDO LQMXU\. *J. Neurosci.* 33(48): 18806-18813, 2013. 30&3841450

+\QJVWURP, $.6., -RKQVRQ, 0.'., 6FKXVWHU, -. DQG +HFNPDQ, &.-. 0RYHPHQW-UHODWHG UHFHSWLYH ILHOGV RI VSLQDO PRWRQHXURQHV ZLWK DFWLYH GHQGULWHV. *J. Physiol.* 586, 1581-93, 2008. 30&2375694

0DQXHO, 0. DQG +HFNPDQ, &.-. $GXOW PRXVH PRWRU XQLWV GHYHORS DOPRVW DOO RI WKHLU IRUFH LQ WKH VXE- SULPDU\ UDQJH: D QHZ DOO-RU-QRQH VWUDWHJ\ IRU IRUFH UHFUXLWPHQW" *J. Neurosci*. 31(42): 15188-15194, 2011. 30&3210508

3RZHUV, 5... DQG +HFNPDQ, &.-. 6\QDSWLF FRQWURO RI WKH VKDSH RI WKH PRWRQHXURQ SRRO LQSXW-RXWSXW IXQFWLRQ. *J. Neurophysiol*. 117:1171-1184, 2017. 30&5350877

**)LYH RWKHU VLJQLILFDQW SXEOLFDWLRQV**

+\QJVWURP, $.6., -RKQVRQ, 0.'., 0LOOHU, -.). DQG +HFNPDQ, &.-. ,QWULQVLF HOHFWULFDO SURSHUWLHV RI VSLQDO PRWRQHXURQV YDU\ ZLWK MRLQW DQJOH. *Nature Neuroscience*, 10: 363-9, 2007. 30,': 17293858

0XUUD\ .&, 1DNDH $, 6WHSKHQV 0-, 5DQN 0, ''$PLFR -, +DUYH\ 3-, /L ;, +DUULV 5/, %DOORX (:,

$QHOOL 5, +HFNPDQ &-, 0DVKLPR 7, 9DYUHN 5, 6DQHOOL /, \*RUDVVLQL 0$, %HQQHWW '-, )RXDG, 5HFRYHU\ RI PRWRQHXURQ DQG ORFRPRWRU IXQFWLRQ DIWHU VSLQDO FRUG LQMXU\ GHSHQGV RQ FRQVWLWXWLYH DFWLYLW\ LQ 5-+72& UHFHSWRUV. *Nature Med.* 2010 16(6): 694-700. 30&3107820

-RKQVRQ, 0.'., +\QJVWURP, $.6., 0DQXHO, 0., +HFNPDQ, &.-. 3XVK-SXOO FRQWURO RI PRWRU RXWSXW. *J. Neurosci.* 32(13): 4592:4599, 2012. 30&3335194

:HL, ., \*ODVHU, -.,., 'HQJ, /., 7KRPSVRQ, &..., 6WHYHQVRQ, ,.+., :DQJ, 4., +RUQE\, 7.\*., +HFNPDQ, &.-., .RUGLQJ, ..3. 6HURWRQLQ DIIHFWV PRYHPHQW JDLQ FRQWURO LQ WKH VSLQDO FRUG. *J. Neurosci. 34: 12690-700*, 2014. 30&4166156

7KRPSVRQ, &..., 1HJUR, )., -RKQVRQ, 0.'., +ROPHV, 0.5., 0F3KHUVRQ, /.0., 3RZHUV, 5..., )DULQD, '., DQG +HFNPDQ, &.-. 5REXVW DQG DFFXUDWH GHFRGLQJ RI PRWRQHXURQ EHKDYLRU DQG SUHGLFWLRQ RI WKH UHVXOWLQJ IRUFH RXWSXW. *J. Physio*O. 596: 2643-59, 2018. 30&6046070

**6\QHUJLVW DFWLYLWLHV**

*Promoting collaborative environments

*Promoting research collaborations*: 3, (LQLWLDO YHUVLRQ) DQG WKHQ 0-3, (UHQHZDO) RQ D PDMRU 1,+/1,1'6 JUDQWV WR VWXG\ WKH PHFKDQLVPV RI $/6 XVLQJ D PRXVH PRGHO. 7KLV FROODERUDWLRQ LQYROYHV WKH 8QLYHUVLW\ RI :DVKLQJWRQ (6HDWWOH), 1RUWKZHVWHUQ 8QLYHUVLW\ (&KLFDJR) DQG 'HVFDUWHV 8QLYHUVLWLH (3DULV). 7KH IRFXV LV XQLTXH, RQ G\VUHJXODWLRQ RI KRPHRVWDVLV IRU H[FLWDELOLW\ RI PRWRQHXURQV.

*Service to the neuroscience community:* 0HPEHU RI RYHU 50 1,+ DQG 16) UHYLHZ SDQHOV RYHU WKH SDVW 25 \HDUV, DV ERWK DQ DG KRF PHPEHU DQG UHJXODU PHPEHU (%197, 2013-16, &KDLU 2014-16).

*Service for ethics in science:* 0HPEHU RI WKH 1RUWKZHVWHUQ ,$&8& VLQFH 2000, 9LFH &KDLU IURP 2002-5, &KDLU VLQFH 2005. 'XULQJ WKLV WLPH, OHG WKH HIIRUWV WR WUDQVLWLRQ WR HOHFWURQLFV IRUPV DQG SURYLGHG FRQVLVWHQW JXLGDQFH DQG WR KHOS FROOHDJXHV WR PDLQWDLQ JRRG TXDOLW\ DQLPDO FDUH.

*Graduate education:* 0HPEHU RI WKH %RDUG RI WKH 1RUWKZHVWHUQ 8QLYHUVLW\ ,QWHUGHSDUWPHQWDO 1HXURVFLHQFH SURJUDP (18,1), IURP 2012 RQZDUGV. 3ULPDU\ UROH DW SUHVHQW LV DV DQ DGYLVRU WR ILUVW

\HDU JUDGXDWH VWXGHQWV LQ WKLV SURJUDP. ,Q DGGLWLRQ, LQLWLDWHG D QHZ FRUH FRXUVH IRU 18,1, ZLWK WKH JRDO RI WHDFKLQJ PDWK, VWDWLVWLFV DQG HQJLQHHULQJ FRQFHSWV WR V\VWHPV QHXURVFLHQFH JUDGXDWHV WKDW ODFN WKLV EDFNJURXQG. 7KH FRXUVH KDV EHHQ VXFFHVVIXO DQG LV LQ LWV 5WK \HDU.

0DWWKHZ 7UHVFK

3URIHVVRU

'HSDUWPHQW RI %LRPHGLFDO (QJLQHHULQJ, 3K\VLFDO 0HGLFLQH DQG 5HKDELOLWDWLRQ, 3K\VLRORJ\ 1RUWKZHVWHUQ 8QLYHUVLW\, 6KLUOH\ 5\DQ $ELOLW\/DE

&KLFDJR, ,/ 60611

312-503-1373

P-WUHVFK#QRUWKZHVWHUQ.HGX

1. 3URIHVVLRQDO 3UHSDUDWLRQ

,QVWLWXWLRQ /RFDWLRQ 0DMRU/DUHD 'HJUHH &<HDU

:HVOH\DQ 8QLYHUVLW\ 0LGGOHWRZQ, &7 SV\FKRORJ\ %$, 1992 0DVVDFKXVHWWV ,QVWLWXWH RI 7HFKQRORJ\ &DPEULGJH, 0$ QHXURVFLHQFH 3K', 1997

8QLYHUVLW\ RI &RSHQKDJHQ &RSHQKDJHQ, 'HQPDUN VSLQDO FRUG 2001

1. $SSRLQWPHQWV

2019-SUHVHQW 3URIHVVRU, %LRPHGLFDO (QJLQHHULQJ/3K\VLFDO 0HGLFLQH DQG 5HKDELOLWDWLRQ/3K\VLRORJ\,

1RUWKZHVWHUQ

2011-2019 $VVRFLDWH 3URIHVVRU, %LRPHGLFDO (QJLQHHULQJ/3K\VLFDO 0HGLFLQH DQG

5HKDELOLWDWLRQ/3K\VLRORJ\, 1RUWKZHVWHUQ

2005-2011 $VVLVWDQW 3URIHVVRU, %LRPHGLFDO (QJLQHHULQJ/3K\VLFDO 0HGLFLQH DQG

5HKDELOLWDWLRQ/3K\VLRORJ\, 1RUWKZHVWHUQ

2001-2005 5HVHDUFK 6FLHQWLVW, 0DVVDFKXVHWWV ,QVWLWXWH RI 7HFKQRORJ\

1. 3XEOLFDWLRQV

(L) /LVW XS WR ILYH (5) SXEOLFDWLRQV/SURGXFWV PRVW FORVHO\ UHODWHG WR WKH SURSRVHG SURMHFW

1. $OHVVDQGUR &, 5HOOLQJHU %$, %DUURVR )2, 7UHVFK 0& (2018) $GDSWDWLRQ DIWHU YDVWXV ODWHUDOLV GHQHUYDWLRQ LQ UDWV GHPRQVWUDWHV QHXUDO UHJXODWLRQ RI MRLQW VWUHVVHV DQG VWUDLQV. (OLIH, 7, H38215.
2. 6DQGHUFRFN 7\*, :HL 4, 'KDKHU <<, 3DL '., 7UHVFK 0& (2018) 9DVWXV ODWHUDOLV DQG YDVWXV PHGLDOLV SURGXFH GLVWLQFW PHGLRODWHUDO IRUFHV RQ WKH SDWHOOD EXW VLPLODU IRUFHV RQ WKH WLELD LQ WKH UDW. -.

%LRPHFK, 81:45-51.

1. :HL 4, 3DL '., 7UHVFK 0& (2018) 8QFHUWDLQW\ LQ OLPE FRQILJXUDWLRQ PDNHV PLQLPDO FRQWULEXWLRQ WR HUURUV EHWZHHQ REVHUYHG DQG SUHGLFWHG IRUFHV LQ D PXVFXORVNHOHWDO PRGHO RI WKH UDW KLQGOLPE, 7UDQV. %LRPHG. (QJ. 65(2):469-476.
2. 7\VVHOLQJ 90, .OHLQ '$, ,PKRII-0DQXHO 5, 0DQXHO 0, +HFNPDQ &-, 7UHVFK 0&. (2017) &RQVWLWXWLYH DFWLYLW\ RI 5-+72F UHFHSWRUV LV SUHVHQW IROORZLQJ LQFRPSOHWH VSLQDO FRUG LQMXU\ EXW LV QRW PRGLILHG DIWHU FKURQLF 665, RU EDFORIHQ WUHDWPHQW. - 1HXURSK\VLRO. 118(5):2944-2952.
3. &KRZGKXU\ 5+, 7UHVFK 0&, 0LOOHU /(. (2017) 0XVFXORVNHOHWDO JHRPHWU\ DFFRXQWV IRU DSSDUHQW H[WULQVLF UHSUHVHQWDWLRQ RI SDZ SRVLWLRQ LQ GRUVDO VSLQRFHUHEHOODU WUDFW. - 1HXURSK\VLRO. 118(1):234-242.

(LL) /LVW XS WR ILYH (5) RWKHU VLJQLILFDQW SXEOLFDWLRQV/SURGXFWV, ZKHWKHU RU QRW UHODWHG WR WKH SURSRVHG SURMHFW.

1. %HUQLNHU 0, -DUF $, .RUGLQJ ., 7UHVFK 0. (2016) $ SUREDELOLVWLF DQDO\VLV RI PXVFOH IRUFH XQFHUWDLQW\ IRU FRQWURO. ,((( 7UDQV %LRPHG (QJ. 63: 2359-2367.
2. :X 0, 3DL '., 7UHVFK 0&, 6DQGHUFRFN 7\* (2012) 3DVVLYH HODVWLF SURSHUWLHV RI WKH UDW DQNOH. -.

%LRPHFK. 1;45(9):1728-32.

1

1. 7UHVFK 0&, -DUF $ (2009) 7KH FDVH IRU DQG DJDLQVW PXVFOH V\QHUJLHV &XUU 2SLQ 1HXURELRO. 19(6):601-7.
2. 7UHVFK 0& DQG .LHKQ 2 (2000) 0RWRU FRRUGLQDWLRQ ZLWKRXW DFWLRQ SRWHQWLDOV LQ WKH PDPPDOLDQ VSLQDO FRUG. 1DWXUH 1HXURVFLHQFH 3: 593-599.
3. 7UHVFK 0&, 6DOWLHO 3, DQG %L]]L ( (1999) 7KH FRQVWUXFWLRQ RI PRYHPHQW E\ WKH VSLQDO FRUG. 1DWXUH 1HXURVFLHQFH, 2:162-167.

(G) 6\QHUJLVWLF $FWLYLWLHV

1. $VVRFLDWH (GLWRU, -RXUQDO RI 1HXURSK\VLRORJ\, 2018-SUHVHQW
2. &KDLU RI 6FLHQWLILF 5HYLHZ , 3DUDO\]HG 9HWHUDQV RI $PHULFD , 2014-2016
3. 1RUWKZHVWHUQ 8QLYHUVLW\ 3UHVLGHQWLDO )HOORZV 5HYLHZ 3DQHO, 2014-SUHVHQW
4. ,QWHUQDWLRQDO 6RFLHW\ IRU (OHFWURSK\VLRORJ\ DQG .LQHPDWLFV, 6FLHQWLILF &KDLU, 2016
5. &R-GLUHFWRU IRU 16)-5(8 IRU 6XPPHU ,QWHUQVKLSV LQ 1HXUDO (QJLQHHULQJ (6,1() DW WKH 5HKDELOLWDWLRQ ,QVWLWXWH RI &KLFDJR DQG 1RUWKZHVWHUQ, 2007-2009.

2

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**$QVJDU %VFKJHV, 'U. UHU. QDW.**

)XOO 3URIHVVRU IRU $QLPDO 3K\VLRORJ\ DQG 1HXURELRORJ\ 'HSDUWPHQW RI %LRORJ\, ,QVWLWXWH RI =RRORJ\

)DFXOW\ RI 0DWKHPDWLFV DQG 1DWXUDO 6FLHQFHV 8QLYHUVLW\ RI &RORJQH

=OSLFKHU 6WUDVVH 47E, 50674 &RORJQH, \*(5 DQVJDU.EXHVFKJHV#XQL-NRHOQ.GH KWWS://ZZZ.]RRORJLH.XQL-NRHOQ.GH/EXHVFKJHV.KWPO"&/ 1

**$. 3URIHVVLRQDO 3UHSDUDWLRQ**

|  |  |  |  |
| --- | --- | --- | --- |
| **,QVWLWXWLRQ** | **/RFDWLRQ** | **0DMRU** | **'HJUHH &<HDU** |
| 8QLYHUVLW\ RI %LHOHIHOG | %LHOHIHOG, \*(5 | %LRORJ\ | 'LSO.%LRO., 1986 |
| 8QLYHUVLW\ RI .DLVHUVODXWHUQ | .DLVHUVODXWHUQ, \*(5 | %LRORJ\ | 'U.UHU.QDW. 1989 |
| 8QLYHUVLW\ RI .DLVHUVODXWHUQ | .DLVHUVODXWHUQ, \*(5 | =RRORJ\ | +DELOLWDWLRQ, 1995 |

**%. $SSRLQWPHQWV**

1998-SUHVHQW )XOO 3URIHVVRU IRU $QLPDO 3K\VLRORJ\ & 1HXURELRORJ\, 8QLYHUVLW\ RI &RORJQH, &RORJQH, \*(5

1997-1998 ')\* +HLVHQEHUJ )HOORZ, 8QLYHUVLW\ RI .DLVHUVODXWHUQ, .DLVHUVODXWHUQ, \*(5 DQG

.DUROLQVND ,QVWLWXWHW, 6WRFNKROP, 6:(

|  |  |
| --- | --- |
| 1991-1997 | 5HVHDUFK $VVRFLDWH, 8QLYHUVLW\ RI .DLVHUVODXWHUQ, .DLVHUVODXWHUQ, \*(5 |
| 1989-91 | 3RVWGRFWRUDO )HOORZ, $+)05, 8QLYHUVLW\ RI $OEHUWD, (GPRQWRQ $OEHUWD, &'1 |
| 1986-89 | 3K' VWXGHQW, 8QLYHUVLW\ RI .DLVHUVODXWHUQ, .DLVHUVODXWHUQ, \*(5 |

**&. 3URGXFWV**

**)LYH PRVW UHOHYDQW SXEOLFDWLRQV (RXW RI PRUH WKDQ 110 UHIHUHHG SXEOLFDWLRQV):**

1. YRQ 7ZLFNHO, $., \*XVFKOEDXHU, &., +RRSHU, 6./., %VFKJHV, $. (2019). 6ZLQJ YHORFLW\ SURILOHV RI VPDOO OLPEV FDQ DULVH IURP WUDQVLHQW SDVVLYH WRUTXHV RI WKH DQWDJRQLVW PXVFOH DORQH. &XUUHQW %LRORJ\

-DQ 7;29(1):1-12.H7.

1. 6]F]HFLQVNL, 1.6., %RFNHPKO, 7., &KRFNOH\, $.6., %VFKJHV, $. (2018). 6WDWLF VWDELOLW\ SUHGLFWV WKH FRQWLQXXP RI LQWHUOHJ FRRUGLQDWLRQ SDWWHUQV LQ *Drosophila.* -. ([S. %LRO. 221, (3W 22). SLL: MHE189142. GRL: 10.1242/MHE.189142.
2. 0DQW]LDULV &., %RFNHPKO, 7., +ROPHV, 3., 'DXQ, 6., %VFKJHV, $. (2017). ,QWHUVHJPHQWDO LQIOXHQFHV EHWZHHQ FHQWUDO SDWWHUQ JHQHUDWLQJ QHWZRUNV LQ WKH ZDONLQJ V\VWHP RI WKH VWLFN LQVHFW. -. 1HXURSK\VLRO. 118: 2296-2310.

4. =LOO, 6.1., 1HII, '., &KDXGU\, 6., ([WHU, $., 6FKPLW], -., %VFKJHV, $. (2017). (IIHFWV RI IRUFH GHWHFWLQJ VHQVH RUJDQV RQ PXVFOH V\QHUJLHV DUH FRUUHODWHG ZLWK WKHLU UHVSRQVH SURSHUWLHV. $UWKURSRG, 6WUXFWXUH DQG 'HYHORSPHQW 46: 564-578.

5. \*UXKQ, 0., 5RVHQEDXP, 3., %RFNHPKO, 7., %VFKJHV, $. (2016). %RG\ VLGH-VSHFLILF FRQWURO RI PRWRU DFWLYLW\ GXULQJ WXUQLQJ LQ D ZDONLQJ DQLPDO. H/LIH 10.7554/H/LIH.13799

**)LYH RWKHU UHOHYDQW SXEOLFDWLRQV**

1. %LGD\H, 6.6., %RFNHPKO, 7., %VFKJHV, $. (2018). 6L[-OHJJHG ZDONLQJ LQ LQVHFWV: KRZ &3\*V, SHULSKHUDO IHHGEDFN, DQG GHVFHQGLQJ VLJQDOV JHQHUDWH FRRUGLQDWHG DQG DGDSWLYH PRWRU UK\WKPV. -. 1HXURSK\VLRO. 119: 459-475.

2. +RRSHU, 6./., %VFKJHV $. (2017). 1HXURELRORJ\ RI 0RWRU &RQWURO ± )XQGDPHQWDO &RQFHSWV DQG 1HZ 'LUHFWLRQV. 6./. +RRSHU & $. %VFKJHV (HGV.) :LOH\ %ODFNZHOO.

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

1. %HUHQGHV, 9., =LOO, 6.1., %VFKJHV, $., %RFNHPKO, 7. (2016). 6SHHG-GHSHQGHQW LQWHUSOD\ EHWZHHQ ORFDO SDWWHUQ-JHQHUDWLQJ DFWLYLW\ DQG VHQVRU\ VLJQDOV GXULQJ ZDONLQJ LQ *Drosophila.* -. ([S. %LRO. 219: 3781-3793.
2. %XVFKPDQQ, 7K., (ZDOG, $., YRQ 7ZLFNHO, $., %VFKJHV, $. (2015). &RQWUROOLQJ /HJV IRU /RFRPRWLRQ

- ,QVLJKWV IURP 5RERWLFV DQG 1HXURELRORJ\. %LRLQVSLUDWLRQ DQG %LRPLPHWLFV 10(4): 041001.

1. %HUJ, (.0., +RRSHU, 6./., 6FKPLGW, -., %VFKJHV, $. (2015).. $ OHJ-ORFDO QHXUDO PHFKDQLVP PHGLDWHV WKH GHFLVLRQ WR VHDUFK LQ VWLFN LQVHFW. &XUUHQW %LRORJ\ 25 (15): 2012-7.

**'. 6\QHUJLVWLF $FWLYLWLHV**

x 2008-2016: PHPEHU RI WKH *DFG-Study Section Neurosciences* (206-05)

x 2012 ± SUHVHQW: 0HPEHU RI WKH *Academy of Science and Arts of North Rhine-Westphalia,* \*(5

x 2014 ± SUHVHQW: 6SHDNHU RI WKH ')\*-IXQGHG 57\* ³*Neural Circuit Analysis on the cellular and subcellular level*´ DW 8R& LQ WKH 1HXURVFLHQFHV ZLWK SUHVHQWO\ 14 3,V DQG 25 GRFWRUDO VWXGHQWV

x 2015 ± SUHVHQW: 0HPEHU RI WKH ([HFXWLYH %RDUG RI WKH ³\*HUPDQ $FDGHPLF 6FKRODUVKLS

)RXQGDWLRQ´

x 2016: &R-2UJDQL]HU RI WKH ,QWHUQDWLRQDO 0HHWLQJ DW ++0, -DQHOLD 5HVHDUFK &DPSXV ³*Motor*

*Control Circuits: Structure, Function and Behavior*´, $VKEXUQ, 86$

## %LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**.HL ,WR, 3K'**

)XOO 3URIHVVRU IRU ([SHULPHQWDO 0RUSKRORJ\ DQG 1HXURDQDWRP\, $;$ &KDLU 'HSDUWPHQW RI %LRORJ\, ,QVWLWXWH RI =RRORJ\

)DFXOW\ RI 0DWKHPDWLFV DQG 1DWXUDO 6FLHQFHV 8QLYHUVLW\ RI &RORJQH

=OSLFKHU 6WUDVVH 47E, 50674 &RORJQH, \*(50$1<

N.LWR#XQL-NRHOQ.GH

KWWS://ZZZ.]RRORJLH.XQL-NRHOQ.GH/LWR.KWPO

**$. 3URIHVVLRQDO 3UHSDUDWLRQ**

|  |  |  |  |
| --- | --- | --- | --- |
| **,QVWLWXWLRQ** | **/RFDWLRQ** | **0DMRU** | **'HJUHH &<HDU** |
| 7KH 8QLYHUVLW\ RI 7RN\R | 7RN\R -DSDQ | %LRSK\VLFV | %.6., 1986 |
| 7KH 8QLYHUVLW\ RI 7RN\R | 7RN\R -DSDQ | %LRSK\VLFV | 0.6., 1988 |
| 7KH 8QLYHUVLW\ RI 7RN\R | 7RN\R -DSDQ | %LRSK\VLFV | 3K.'., 1991 |

**%. $SSRLQWPHQWV**

2017-3UHVHQW $;$ &KDLU ³)URP \*HQRPH WR 6WUXFWXUH DQG )XQFWLRQ´,

,QVWLWXWH RI =RRORJ\, 8QLYHUVLW\ RI &RORJQH, \*HUPDQ\

2016-3UHVHQW )XOO 3URIHVVRU IRU ([SHULPHQWDO 0RUSKRORJ\ DQG 1HXURDQDWRP\,

,QVWLWXWH RI =RRORJ\, 8QLYHUVLW\ RI &RORJQH, \*HUPDQ\

2015-3UHVHQW 6HQLRU )HOORZ, +RZDUG +XJKHV 0HGLFDO ,QVWLWXWH (++0,) -DQHOLD 5HVHDUFK &DPSXV,

$VKEXUQ, 9$, 8QLWHG 6WDWHV

2002-2018 $VVRFLDWH 3URIHVVRU, ,QVWLWXWH RI 0ROHFXODU DQG &HOOXODU %LRVFLHQFHV,

8QLYHUVLW\ RI 7RN\R, -DSDQ

|  |  |
| --- | --- |
| 1998-2002 | $VVLVWDQW 3URIHVVRU, 1DWLRQDO ,QVWLWXWH IRU %DVLF %LRORJ\, 2ND]DNL, -DSDQ |
| 1994-1998 | 6HQLRU 5HVHDUFK )HOORZ, <DPDPRWR %HKDYLRXU \*HQHV 3URMHFW, (5$72, -67, -DSDQ |
| 1991-1994 | 3RVWGRFWRUDO 5HVHDUFK )HOORZ, ,QVWLWXWH RI \*HQHWLFV, 8QLYHUVLW\ RI 0DLQ], \*HUPDQ\ |

**&. 3URGXFWV**

**)LYH PRVW UHOHYDQW SXEOLFDWLRQV (RXW RI PRUH WKDQ 70 UHIHUHHG SXEOLFDWLRQV):**

1. 0XUWLQ, &., )ULQGHO, &., 5RXVVHDX, '., DQG ,WR, .. ,PDJH SURFHVVLQJ IRU SUHFLVH WKUHH-GLPHQVLRQDO UHJLVWUDWLRQ DQG VWLWFKLQJ RI WKLFN KLJK-UHVROXWLRQ ODVHU-VFDQQLQJ PLFURVFRS\ LPDJH VWDFNV. &RPSXWHUV LQ %LRORJ\ DQG 0HGLFLQH, 92, 22-41, 2018.
2. 7VXERXFKL, $., <DQR, 7., <RNR\DPD, 7..., 0XUWLQ, &., 2WVXQD, +., DQG ,WR, .. 7RSRORJLFDO DQG PRGDOLW\-VSHFLILF UHSUHVHQWDWLRQ RI VRPDWRVHQVRU\ LQIRUPDWLRQ LQ WKH IO\ EUDLQ. 6FLHQFH 358, 615-623, 2017.
3. ,WR. .., 6KLQRPL\D, .., ,WR, 0., $UPVWURQJ, '., %R\DQ, \*., +DUWHQVWHLQ, 9., +DU]VFK, 6., +HLVHQEHUJ, 0., +RPEHUJ, 8., -HQHWW, $., .HVKLVKLDQ. +., 5HVWLIR, /., 5|VVOHU, :., 6LPSVRQ, -., 6WUDXVIHOG, 1. -., 6WUDXVV, 5., DQG 9RVVKDOO, /.%; 7KH ,QVHFW %UDLQ 1DPH :RUNLQJ \*URXS. $ V\VWHPDWLF QRPHQFODWXUH IRU WKH LQVHFW EUDLQ. 1HXURQ, 81, 755-765, 2014.
4. ,WR, 0., 0DVXGD, 1., 6KLQRPL\D, .., (QGR, .., DQG ,WR, .. 6\VWHPDWLF DQDO\VLV RI QHXUDO SURMHFWLRQV UHYHDOV FORQDO FRPSRVLWLRQ RI WKH *Drosophila* EUDLQ. &XUU. %LRO, 23, 644±655, 2013.
5. .DPLNRXFKL, $., ,QDJDNL, +. .., (IIHUW], 7., )LDOD, $., +HQGULFK, 2., \*RSIHUW, 0. &. DQG ,WR, .. 7KH QHXUDO EDVLV RI *Drosophila* JUDYLW\ VHQVLQJ DQG KHDULQJ. 1DWXUH, 458, 165-171, 2009.

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**)LYH RWKHU UHOHYDQW SXEOLFDWLRQV**

1. 0DWVXR, (., 6HNL, +., $VDL, 7., 0RULPRWR, 7., 0L\DNDZD, +., ,WR, .., DQG .DPLNRXFKL, $. 2UJDQL]DWLRQ RI SURMHFWLRQ QHXURQV DQG ORFDO QHXURQV RI WKH SULPDU\ DXGLWRU\ FHQWHU LQ WKH IUXLW IO\ *Drosophila melanogaster.* -. &RPS. 1HXURO. 524, 1099-1164, 2016.
2. )ORRG, 7., ,JXFKL, 6., \*RUF]\FD, 0., :KLWH, %., ,WR, .., DQG <RVKLKDUD, 0. $ VLQJOH SDLU RI LQWHUQHXURQV FRPPDQGV WKH *Drosophila* IHHGLQJ PRWRU SURJUDP. 1DWXUH 499, 83-87, 2013.
3. 7DQDND, 1. .., (QGR, .. DQG ,WR, .. 7KH RUJDQL]DWLRQ RI DQWHQQDO OREH-DVVRFLDWHG QHXURQV LQ WKH DGXOW

*Drosophila melanogaster* EUDLQ. - &RPS 1HXURO, 520: 4067-4130, 2012.

1. 0L\D]DNL, 7. DQG ,WR, .. 1HXUDO DUFKLWHFWXUH RI WKH SULPDU\ JXVWDWRU\ FHQWHU RI *Drosophila melanogaster* YLVXDOL]HG ZLWK \*$/4 DQG /H[$ HQKDQFHU-WUDS V\VWHPV. - &RPS 1HXURO, 518, 4147± 4181, 2010.
2. 2WVXQD, +., 6KLQRPL\D, .., DQG ,WR... 3DUDOOHO QHXUDO SDWKZD\V LQ KLJKHU YLVXDO FHQWHUV RI WKH

*Drosophila* EUDLQ WKDW PHGLDWH ZDYHOHQJWK-VSHFLILF EHKDYLRU. )URQW. 1HXUDO &LUFXLWV, 8, 8, 2014.

**'. 6\QHUJLVWLF $FWLYLWLHV**

x $GPLQLVWUDWRU RI WKH $11 $UWKURSRG 1HXURVFLHQFH 1HWZRUN (KWWSV://DQQ.XQL-NRHOQ.GH/) DQG $11 PDLOLQJ OLVW IRU DUWKURSRG QHXURVFLHQFH UHVHDUFKHUV (2017-SUHVHQW)

x $GPLQLVWUDWRU RI WKH -IO\ 'DWD GHSRVLWRU\ IRU *Drosophila* UHVHDUFKHUV (KWWS://MIO\.LDP.X- WRN\R.DF.MS) DQG -IO\ 0DLOLQJ OLVW IRU -DSDQHVH-VSHDNLQJ *Drosophila* UHVHDUFKHUV (1995-2019)

x (GLWRULDO ERDUG RI $UWKURSRG 6WUXFWXUH DQG 'HYHORSPHQW (2002-SUHVHQW)

x 6WXG\ VHFWLRQ PHPEHU IRU WKH UHVHDUFK JUDQWV RI WKH -DSDQ 6RFLHW\ IRU WKH 3URPRWLRQ RI 6FLHQFH LQ WKH ILHOG RI JHQHUDO QHXURELRORJ\ (2006-2018) DV ZHOO DV IRU WKH LQVWLWXWLRQDO JUDQWV IRU WKH SURPRWLRQ RI \RXQJ DQG IHPDOH VFLHQWLVWV LQ -DSDQ (2009-2011).

x 9LFH 3UHVLGHQW RI D QRQ-SURILW RUJDQL]DWLRQ ³&RORU 8QLYHUVDO 'HVLJQ 2UJDQL]DWLRQ´ (2004- SUHVHQW); &RQVXOWDWLRQ DQG DGYLFHV IRU FRPSDQLHV OLNH $GREH, 3DQDVRQLF, 6KDUS, 1(&, 2O\PSXV, 5LFRK, 7R\RWD, 7RN\R 6XEZD\, -DSDQ 3DLQW 0DQXIDFWXUHUV $VVRFLDWLRQ, -DSDQ 3ULQWLQJ ,QGXVWU\

$VVRFLDWLRQ, HWF.), $ZDUGHG SUL]H; -DSDQ \*RRG 'HVLJQ $ZDUG (2008), 3ULPH 0LQLVWHU¶V $ZDUG IRU WKH 3URPRWLRQ RI ,QFOXVLYH 'HVLJQ (2010)

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**3URI. 'U. 'U. K.F. 0DUWLQ 6. )LVFKHU**

3URIHVVRU RI 6\VWHPDWLF =RRORJ\ DQG (YROXWLRQDU\ %LRORJ\

,QVWLWXW IU 6SH]LHOOH =RRORJLH XQG (YROXWLRQVELRORJLH PLW 3K\OHWLVFKHP 0XVHXP

)ULHGULFK-6FKLOOHU-8QLYHUVLWlW -HQD (UEHUWVW.W 1

'- 07743 -HQD 0DUWLQ.)LVFKHU#XQL-MHQD.GH

**$. 3URIHVVLRQDO 3UHSDUDWLRQ**

**,QVWLWXWLRQ 0DMRU / $UHD 'HJUHH, <HDU RU 'DWHV**

8QGHUJUDGXDWH: 8QLYHUVLW\ RI 7ELQJHQ, \*HUPDQ\ DQG

8QLYHUVLW\ RI 3DULV 9,, )UDQFH

%LRORJ\/\*HRORJ\ 'LSORPD 1983

\*UDGXDWH: 8QLYHUVLW\ RI 7ELQJHQ, \*HUPDQ\ %LRORJ\ 'U.UHU.QDW. 1986

3RVWGRFWRUDO: 8QLYHUVLW\ RI )UDQNIXUW DQG 7ELQJHQ,

\*HUPDQ\

**%. $SSRLQWPHQWV**

$QDWRP\/=RRORJ\ 1986-1993

'LUHFWRU, ,QVWLWXWH RI =RRORJ\ DQG (YROXWLRQDU\ 5HVHDUFK ZLWK 3K\OHWLF 0XVHXP, 1993 - 3UHVHQW

)XOO 3URIHVVRU, 6\VWHPDWLF =RRORJ\ XQG (YROXWLRQDU\ %LRORJ\, 8QLYHUVLW\ -HQD 1993 ± 3UHVHQW

$VVLVWDQW 3URIHVVRU, ,QVWLWXWH RI =RRORJ\, 8QLYHUVLW\ RI 7ELQJHQ, 1987 - 1993

$VVLVWDQW 3URIHVVRU, =HQWUXP GHU 0RUSKRORJLH, 8QLYHUVLW\ RI )UDQNIXUW, 1986 - 1987

**&. 3URGXFWV**

**)LYH PRVW UHOHYDQW SXEOLFDWLRQV (RXW RI PRUH WKDQ 150 UHIHUHHG SXEOLFDWLRQV):**

**)LYH 0RVW &ORVHO\ 5HODWHG WR &XUUHQW 3URMHFW**

1. )LVFKHU, 0.6.; 1. 6FKLOOLQJ, 1.; 0. 6FKPLGW, 0. DQG +. :LWWH (2002) %DVLF OLPE NLQHPDWLFV RI VPDOO WKHULDQ PDPPDOV. *J. exp. Biol*. **205**: 1315-1338.
2. )LVFKHU, 0.6. DQG +.). :LWWH. (2007) /HJV HYROYHG RQO\ DW WKH HQG! *Phil Trans. R. Soc*. $. **365**: 185- 198.

3. +XQW, $., 6FKPLGW, 0., )LVFKHU, 0.6. DQG 5. 4XLQQ (2015) $ ELRORJLFDOO\ EDVHG QHXUDO V\VWHP FRRUGLQDWHV WKH MRLQWV DQG OHJV RI D WHWUDSRG *Bioinspir. Biomim.* **10** 055004, GRL:10.1088/1748- 3190/10/5/055004.

1. )LVFKHU, 0.6., /HKPDQQ, 6. DQG (. $QGUDGD (2018) 7KUHH-GLPHQVLRQDO NLQHPDWLFV RI FDQLQH KLQG OLPEV: LQ YLYR, ELSODQDU, KLJK-IUHTXHQF\ IOXRURVFRSLF DQDO\VLV RI IRXU EUHHGV GXULQJ ZDONLQJ DQG WURWWLQJ. *Scientific Rep.* (2018) 8:16982 \_ '2,:10.1038/V41598-018-34310-0 : 1-22
2. 1\DNDWXUD -.$., 0HOR, .., +RUYDW, 7., .DUDNDVLOLRWLV, .., $OOHQ, 9.5., $QGLNIDU, $., $QGUDGD, (.,

$UQROG, 3., /DXVWU|HU, -., +XWFKLQVRQ, -.5., )LVFKHU, 0.6. DQG $.-. ,MVSHHUW. (2019) 5HYHUVH- HQJLQHHULQJ WKH ORFRPRWLRQ RI D VWHP DPQLRWH,´ *Nature*, YRO. 565, QR. 7739, S. 351, -DQ. 2019.

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**)LYH RWKHU UHOHYDQW SXEOLFDWLRQV**

1. )LVFKHU, 0.6. (1994) &URXFKHG SRVWXUH DQG KLJK IXOFUXP, D SULQFLSOH LQ WKH ORFRPRWLRQ RI VPDOO PDPPDOV: WKH H[DPSOH RI WKH URFN K\UD[ (3URFDYLD FDSHQVLV)(0DPPDOLD: +\UDFRLGHD). *J. Human Evol.* 26 (5-6), 501-524
2. )LVFKHU, 0.6. (2001) /RFRPRWRU\ RUJDQV RI 0DPPDOV: 1HZ PHFKDQLFV DQG IHHG-EDFN SDWKZD\V EXW FRQVHUYDWLYH FHQWUDO FRQWURO. *Zoology* **103**: 230-239.
3. 5LW]PDQQ, 5.(., 5.'. 4XLQQ DQG 0.6. )LVFKHU (2004) &RQYHUJHQW (YROXWLRQ DQG /RFRPRWLRQ WKURXJK &RPSOH[ 7HUUDLQ E\ ,QVHFWV, 9HUWHEUDWHV DQG 5RERWV. *Arthopod Struct. Dev.* **33**:361-379.
4. )LVFKHU, 0.6. DQG 5. %OLFNKDQ (2006) 7KH WUL-VHJPHQWHG OLPEV RI WKHULDQ PDPPDOV: NLQHPDWLFV, G\QDPLFV, DQG VHOI-VWDELOL]DWLRQ. $ UHYLHZ. *J. exp. Zool.* **305$**: 935-952.
5. )LVFKHU, 0.6. DQG ..(. /LOMH (2011) 'RJV LQ PRWLRQ. 'RUWPXQG. 208 SDJHV.

**6\QHUJLVWLF $FWLYLWLHV**

x 0HPEHU RI 37 VHDUFK FRPPLWWHHV LQ ILYH GLIIHUHQW IDFXOWLHV LQ -HQD DQG RWKHU XQLYHUVLWLHV

x +RVWHG ,$53-:RUNVKRS: %LRORJLFDOO\ 0RWLYDWHG 6HUYLFH 5RERWLFV (ZLWK 'U. K.F. /RWKDU 6SlWK) 1999.

x +RVWHG :RUNVKRS RQ "$XWRQRPRXV :DONLQJ" (ZLWK 3URI. 'U. +. :LWWH) 2000.

x :RUNHG DFWLYHO\ LQ \*HUPDQ &RXQFLO RI 6FLHQFH DQG +XPDQLWLHV DQG \*HUPDQ 5HVHDUFK &RXQFLO

x :RUNHG ZLWK )HVWR $\* VLQFH 2006 LQ %LRQLF OHDUQLQJ QHWZRUNV VKRZLQJ IRXU WLPHV URERWV IURP FROODERUDWLRQV DW WKH +DQQRYHU IDUH

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**'U. -DQ 0. $FKH**

-XQLRU \*URXS /HDGHU 'HSDUWPHQW RI 1HXURELRORJ\ DQG \*HQHWLFV

8QLYHUVLW\ RI :U]EXUJ

97074 :U]EXUJ, \*HUPDQ\

3KRQH: +1 571-209-3380 DFKHM#MDQHOLD.KKPL.RUJ

**$. 3URIHVVLRQDO 3UHSDUDWLRQ**

|  |  |  |  |
| --- | --- | --- | --- |
| **,QVWLWXWLRQ** | **/RFDWLRQ** | **6XEMHFW** | **'HJUHH & <HDU** |
| 8QLYHUVLW\ RI &RORJQH | &RORJQH, \*HUPDQ\ | %LRORJ\ | %.6F. (2008) |
| 8QLYHUVLW\ RI &RORJQH | &RORJQH, \*HUPDQ\ | 1HXURVFLHQFH | 0.6F. (2010) |
| 8QLYHUVLW\ RI %LHOHIHOG | %LHOHIHOG, \*HUPDQ\ | %LRORJ\ | 'U. UHU. 1DW. (2015) |
| ++0,, -DQHOLD | $VKEXUQ, 9LUJLQLD, 86$ | 1HXURVFLHQFH | 3RVWGRF (2014 - 2017) |

**%. $SSRLQWPHQWV**

6WDUWLQJ 10/2019 -XQLRU \*URXS /HDGHU, 8QLYHUVLW\ RI :U]EXUJ, :U]EXUJ, \*HUPDQ\

9/2017 - SUHVHQW 5HVHDUFK 6FLHQWLVW, ++0,, -DQHOLD 5HVHDUFK &DPSXV, $VKEXUQ, 9$, 86$

**&. 3URGXFWV**

**)LYH PRVW UHOHYDQW SXEOLFDWLRQV (RQ GHVFHQGLQJ PRWRU FRQWURO):**

1. **$FKH, -0**, 1DPLNL, 6, /HH, $, %UDQVRQ, ., DQG &DUG, \* (2019): µ6WDWH-GHSHQGHQW GHFRXSOLQJ RI VHQVRU\ DQG PRWRU FLUFXLWV XQGHUOLHV EHKDYLRUDO IOH[LELOLW\ *in Drosophila*¶, **1DWXUH 1HXURVFLHQFH** (LQ SUHVV)
2. **$FKH, -0**, 3ROVN\, -, $OJKDLODQL, 6, 3DUHNK, 5, %UHDGV, 3, 3HHN, 0, %RFN, ', YRQ 5H\Q, & DQG &DUG,

\*0 (2019): µ1HXUDO EDVLV IRU ORRPLQJ VL]H DQG YHORFLW\ HQFRGLQJ LQ WKH 'URVRSKLOD \*LDQW )LEHU HVFDSH SDWKZD\¶, **&XUUHQW %LRORJ\** 29 (6), 1073-1081

1. **$FKH, -0** DQG 'UU, 9 (2015): µ$ FRPSXWDWLRQDO PRGHO RI D GHVFHQGLQJ PHFKDQRVHQVRU\ SDWKZD\ LQYROYHG LQ DFWLYH WDFWLOH VHQVLQJ¶, **3/R6 &RPSXWDWLRQDO %LRORJ\** 11 (7), H1004263
2. **$FKH, -0**, +DXSW, 66 DQG 'UU, 9 (2015): µ$ GLUHFW GHVFHQGLQJ SDWKZD\ LQIRUPLQJ ORFRPRWRU QHWZRUNV DERXW WDFWLOH VHQVRU PRYHPHQW, **-RXUQDO RI 1HXURVFLHQFH** 35 (9), 4081-4091
3. **$FKH, -0** DQG 'UU, 9 (2013): µ(QFRGLQJ RI QHDU-UDQJH VSDWLDO LQIRUPDWLRQ E\ GHVFHQGLQJ LQWHUQHXURQV LQ WKH VWLFN LQVHFW DQWHQQDO PHFKDQRVHQVRU\ SDWKZD\¶, **-RXUQDO RI 1HXURSK\VLRORJ\** 110 (9), 2099-2112

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**7ZR RWKHU UHOHYDQW SXEOLFDWLRQV (RQ ELRPHFKDQLFV DQG PRWRU FRQWURO):**

1. **$FKH, -0** DQG 0DWKHVRQ, 7 (2013): µ3DVVLYH MRLQW IRUFHV DUH WXQHG WR OLPE XVH LQ LQVHFWV DQG GULYH PRYHPHQWV ZLWKRXW PRWRU DFWLYLW\¶, **&XUUHQW %LRORJ\** 23 (15), 1418-1426
2. **$FKH, -0** DQG 0DWKHVRQ, 7 (2012): µ3DVVLYH UHVWLQJ VWDWH DQG KLVWRU\ RI DQWDJRQLVW PXVFOH DFWLYLW\ VKDSH DFWLYH H[WHQVLRQV LQ DQ LQVHFW OLPE¶, **-RXUQDO RI 1HXURSK\VLRORJ\** 107 (10), 2756-2768

**'. 6\QHUJLVWLF $FWLYLWLHV**

x **)DFXOW\ PHPEHU & 7HDFKLQJ DVVLVWDQW, 0DULQH %LRORJLFDO /DERUDWRU\, 0$** (2015 & 2016)

, WDXJKW D WZR-ZHHN FRXUVH PRGXOH RQ WKH QHXUDO FRQWURO RI IOLJKW DV SDUW RI WKH 1HXUDO 6\VWHPV DQG %HKDYLRU FRXUVH, DQ LQWHUQDWLRQDO VXPPHU FRXUVH IRU JUDGXDWH VWXGHQWV, SRVWGRFV, DQG IDFXOW\ PHPEHUV IRFXVLQJ RQ GLVVHPLQDWLQJ H[SHULPHQWDO DSSURDFKHV DQG WHFKQLTXHV WR WKH QHXURVFLHQFH FRPPXQLW\. , ZDV D WHDFKLQJ DVVLVWDQW LQ 2015 DQG D IDFXOW\ PHPEHU LQ 2016.

x **0HPEHU RI WKH 'HYHORSLQJ 1HXURHWKRORJ\ $ZDUG &RPPLWWHH** (2019 - SUHVHQW)

$ZDUGLQJ JUDQWV WR VXSSRUW WKH SDUWLFLSDWLRQ RI VFLHQWLVWV IURP HPHUJLQJ DQG GHYHORSLQJ FRXQWULHV LQ WKH ,QWHUQDWLRQDO &RQJUHVV RI 1HXURHWKRORJ\, RUJDQL]HG E\ WKH 6RFLHW\ IRU 1HXURHWKRORJ\.

x **+LJK 6FKRRO 6WXGHQW PHQWRULQJ** (2016 - 2018)

, PHQWRUHG WZR KLJK VFKRRO VWXGHQWV, ZKR FDUULHG RXW EHKDYLRUDO JHQHWLFV VWXGLHV XQGHU P\ VXSHUYLVLRQ IRU D VL[-ZHHN VXPPHU LQWHUQVKLS LQ 2016. 2QH RI WKHP UHWXUQHG IRU D VHFRQG SURMHFW WKH IROORZLQJ \HDU DQG NHSW ZRUNLQJ ZLWK PH DV D VWXGHQW WHFKQLFDO DVVLVWDQW XQWLO 2018. 6KH LV QRZ DQ XQGHUJUDGXDWH DW +DUYDUG.

x **3XEOLF RXWUHDFK: 6FLHQFH 6ODPV**

, SUHVHQWHG P\ 3K' UHVHDUFK WR WKH JHQHUDO SXEOLF DV SDUW RI WKH LQWHUQDWLRQDO VFLHQFH RXWUHDFK HIIRUW µ)DPH/DE¶, RUJDQL]HG E\ WKH %ULWLVK &RXQFLO (8.) DQG GXULQJ RWKHU HYHQWV. , ZRQ VHYHUDO DZDUGV DW )DPH/DE VFLHQFH VODP FRPSHWLWLRQV LQ 2012, LQFOXGLQJ 1VW SUL]H RI WKH $XGLHQFH,

)DPH/DE \*HUPDQ\ (QDWLRQZLGH FRPSHWLWLRQ) DQG 1VW SUL]H RI WKH -XU\, )DPH/DE 1RUWK 5KLQH-

:HVWSKDOLD (VWDWHZLGH FRPSHWLWLRQ).

6HH KWWS://WLQ\XUO.FRP/T5Y4H9[ RU KWWS://WLQ\XUO.FRP/M6EPE9Y IRU H[DPSOHV (LQ \*HUPDQ).

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**\*5(\*25< 3. 687721**

3URIHVVRU

6FKRRO RI /LIH 6FLHQFHV

8QLYHUVLW\ RI /LQFROQ

%ULVWRO, 8., %68 18\*

+44 (0) 7807451914 56FHDODL#JPDLO.FRP

**352)(66,21$/ 35(3$5$7,21**

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| --- | --- | --- | --- |
| 2000 &DVH | :HVWHUQ 5HVHUYH 8QLYHUVLW\ | %.6. | 0HFKDQLFDO (QJLQHHULQJ |
| 2000 &DVH | :HVWHUQ 5HVHUYH 8QLYHUVLW\ | 0.6. | 0HFKDQLFDO (QJLQHHULQJ |
| 2006 &DVH | :HVWHUQ 5HVHUYH 8QLYHUVLW\ | 3K.'. | 0HFKDQLFDO (QJLQHHULQJ |
| **$332,170(176** |  |  |  |
| 2019 ± &XUUHQW | **3URIHVVRU ()XOO)** |  | 6FKRRO RI /LIH 6FLHQFHV  8QLYHUVLW\ RI /LQFROQ (8.) |
| 2016 ± &XUUHQW | **5HVHDUFK 6FLHQWLVW** |  | %LRORJ\ 'HSDUWPHQW 'XNH 8QLYHUVLW\ (86$) |
| 2011 ± 2018 | **5HVHDUFK )HOORZ** |  | 6FKRRO RI /LIH 6FLHQFHV  8QLYHUVLW\ RI %ULVWRO |
| 2006 - 2011 | **5HVHDUFK )HOORZ** |  | 'HSDUWPHQW RI =RRORJ\ 8QLYHUVLW\ RI &DPEULGJH |

**)LYH PRVW UHOHYDQW SXEOLFDWLRQV:**

1. **6XWWRQ \*3**, 'RURVKHQNR 0, &XOOHQ '$, %XUURZV 0 (2016) 7DNH-RII VSHHG LQ MXPSLQJ PDQWLVHV GHSHQGV RQ ERG\ VL]H DQG D SRZHU OLPLWHG PHFKDQLVP. ***Journal of Experimental Biology*** 219: 2127- 2136.
2. **6XWWRQ \*3**, &ODUNH ', 0RUOH\ (/, 5REHUW ' (2016). 0HFKDQRVHQVRU\ KDLUV LQ EXPEOH EHHV (*Bombus terrestris*) GHWHFW ZHDN HOHFWULF ILHOGV. ***Proceedings of the National Academy of Sciences of the United States of America*** 113(26) 7261-7265.

3 **6XWWRQ, \*3**, 0DQJDQ, (9, 1HXVWDGWHU, '0, %HHU, 5', &UDJR, 3(, &KLHO, +- (2004). 1HXUDO FRQWURO H[SORLWV FKDQJLQJ PHFKDQLFDO DGYDQWDJH DQG FRQWH[W GHSHQGHQFH WR JHQHUDWH GLIIHUHQW IHHGLQJ

UHVSRQVHV LQ *Aplysia*. *Biological Cybernetics* 91, 333-345.

1. 5RJHUV 60, 5LOH\ -, %ULJKWRQ &, **6XWWRQ \*3**, &XOOHQ '$, %XUURZV 0 (2016). ,QFUHDVHG PXVFXODU YROXPH DQG FXWLFXODU VSHFLDOLVDWLRQV HQKDQFH MXPS YHORFLW\ LQ VROLWDULRXV FRPSDUHG ZLWK JUHJDULRXV GHVHUW ORFXVWV, *Schistocerca gregaria*. ***Journal of Experimental Biology*** 219(5): 635-648.
2. ,OWRQ 0, %KDPOD 6, 0D ', &R[ 60, $]L]L 0, %HUJEUHLWHU 6, \*XR $, .LP <, .RK, -, .ULVKQDPXUWK\ ', .XR &, 7HPHO =), )LWFKHWW //, **6XWWRQ \*3**, &URVE\ $-, 3UDNDVK 0, :RRG 5-, DQG 3DWHN 61 (2018). 7KH SULQFLSOHV RI FDVFDGLQJ SRZHU OLPLWV LQ VPDOO, IDVW ELRORJLFDO DQG HQJLQHHUHG V\VWHPV. ***Science*** 360 (6387) HDDR1082.

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

**)LYH RWKHU VLJQLILFDQW SXEOLFDWLRQV**

1. **6XWWRQ \*3**, %XUURZV 0 (2011). 7KH ELRPHFKDQLFV RI WKH MXPS RI WKH IOHD. ***Journal of Experimental Biology*** 214, 836 - 847.
2. 5RVDULR 09, **6XWWRQ \*3**, 3DWHN 61, DQG 6DZLFNL \*6 (2016). 0XVFOH-VSULQJ G\QDPLFV LQ WLPH- OLPLWHG, HODVWLF PRYHPHQWV. ***Proceedings of the Royal Society of London B* 283**: 20161561.
3. %XUURZV 0 DQG **6XWWRQ \*3** (2013). ,QWHUDFWLQJ JHDUV V\QFKURQL]H SURSXOVLYH OHJ PRYHPHQWV LQ D MXPSLQJ LQVHFW. ***Science*** 341(6151) 1254-1256.
4. 1RYDFRYLF 9$, **6XWWRQ \*3**, 1HXVWDGWHU '0, %HHU 5', &KLHO +- (2006). 0HFKDQLFDO UHFRQILJXUDWLRQ PHGLDWHV VZDOORZLQJ DQG UHMHFWLRQ LQ *Aplysia californica*. *Journal of Comparative Physiology A*, 192: 857-870. (1RYDFRYLF DQG 6XWWRQ DUH FR-ILUVW DXWKRUV)
5. 'UXVKHO 5), **6XWWRQ \*3**, 1HXVWDGWHU '0, 0DQJDQ (9, $GDPV %:, &UDJR 3(, &KLHO +- (2002). 5DGXOD-FHQWULF DQG RGRQWRSKRUH FHQWULF NLQHPDWLF PRGHOV RI *Aplysia californica*. *Journal of Experimental Biology* 205 (14) 2029-2051.

**6<1(5\*,67,& $&7,9,7,(6**

##### $VVLVWHG LQ WKH GHYHORSPHQW RI *Dynamics of Biological Systems*, ZKLFK WHDFKHV XQGHUJUDGXDWHV WKH SULQFLSOHV RI PRGHOLQJ ELRORJLFDO V\VWHPV XVLQJ *Mathematica* DQG SULQFLSOHV IURP QRQOLQHDU G\QDPLFDO V\VWHPV WKHRU\. &RXUVH LV D FRUH UHTXLUHPHQW IRU QHZ %6 GHJUHH LQ 6\VWHPV %LRORJ\ DW &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\.

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

$OH[DQGHU %ODQNH, 3K'

(5& 5HVHDUFK \*URXS /HDGHU, ,QVWLWXWH IRU =RRORJ\, %LRFHQWHU 8QLYHUVLW\ RI &RORJQH, \*HUPDQ\

D.EODQNH#XQL-NRHOQ.GH KWWS://ZZZ.]RRORJLH.XQL-NRHOQ.GH/EODQNH.KWPO

**$. 3URIHVVLRQDO 3UHSDUDWLRQ**

|  |  |  |  |
| --- | --- | --- | --- |
| **,QVWLWXWLRQ** | **/RFDWLRQ** | **0DMRU** | **'HJUHH &<HDU** |
| 8QLYHUVLW\ RI %RQQ | %RQQ, \*HUPDQ\ | %LRORJ\ | 'LSORPD, 2007 |
| 8QLYHUVLW\ RI %RQQ | %RQQ, \*HUPDQ\ | =RRORJ\ | 3K.'., 2013 |

**%. $SSRLQWPHQWV**

VLQFH 2018 (5& \*URXS /HDGHU, 0RUSKRORJLFDO '\QDPLFV, 8QLYHUVLW\ RI &RORJQH 2015 - 17 3RVWGRF, 0HGLFDO DQG %LRORJLFDO (QJLQHHULQJ, 8QLYHUVLW\ RI +XOO, 8.

2014 - 15 3RVWGRF, &RPSDUDWLYH (PEU\RORJ\, 8QLYHUVLW\ RI 7VXNXED, -DSDQ

**&. 3URGXFWV**

**)LYH PRVW UHOHYDQW SXEOLFDWLRQV:**

1. <RVKL]DZD, .., .DPLPXUD, <., /LHQKDUG, &., )HUUHLUD, 5. /., **%ODQNH**, $. 2018. $ ELRORJLFDO VZLWFKLQJ YDOYH HYROYHG LQ WKH IHPDOH RI D VH[-UROH UHYHUVHG FDYH LQVHFW WR UHFHLYH PXOWLSOH VSHUP SDFNDJHV. H/,)( 7:H39563. '2,: KWWSV://GRL.RUJ/10.7554/H/LIH.39563.
2. **%ODQNH**, $., 3LQKHLUR, 0., :DWVRQ, 3. -., )DJDQ, 0. -. 2018. $ ELRPHFKDQLFDO DQDO\VLV RI SURJQDWKRXV DQG RUWKRJQDWKRXV LQVHFW KHDG FDSVXOHV: HYLGHQFH IRU D PDQ\ဨWRဨRQH PDSSLQJ RI IRUP WR IXQFWLRQ.

-RXUQDO RI (YROXWLRQDU\ %LRORJ\ 31: 665-674 '2,: KWWSV://GRL.RUJ/10.1111/MHE.13251.

1. **%ODQNH**, $., 6FKPLW], +., 'XWHO, +., 3DWHUD, $., )DJDQ, 0. 2017. )RUP IXQFWLRQ UHODWLRQVKLSV LQ GUDJRQIO\ PDQGLEOHV XQGHU DQ HYROXWLRQDU\ SHUVSHFWLYH. -RXUQDO RI 7KH 5R\DO 6RFLHW\ ,QWHUIDFH 14: 20161038.

>3.5@ KWWS://G[.GRL.RUJ/10.1098/UVLI.2016.1038

1. **%ODQNH**, $., :DWVRQ, 3.-., +ROEUH\, 5., )DJDQ, 0.-. 2017. &RPSXWDWLRQDO ELRPHFKDQLFV FKDQJHV RXU YLHZ RQ LQVHFW KHDG HYROXWLRQ. 3URFHHGLQJV RI WKH 5R\DO 6RFLHW\ % 284: 20162412. KWWSV://GRL.RUJ/10.1098/UVSE.2016.2412
2. 'DYLG, 6., )XQNHQ, -., 3RWWKDVW, :., **%ODQNH**, $. 2016. 0XVNXORVNHOHWDO PRGHOLQJ XQGHU DQ HYROXWLRQDU\ SHUVSHFWLYH: 'HFLSKHULQJ WKH UROH RI VLQJOH PXVFOH UHJLRQV LQ FORVHO\ UHODWHG LQVHFWV. -RXUQDO RI 7KH 5R\DO 6RFLHW\ ,QWHUIDFH 13: 20160675. KWWS://G[.GRL.RUJ/10.1098/UVLI.2016.0675

**)LYH RWKHU UHOHYDQW SXEOLFDWLRQV**

1. **%ODQNH**, $. 2018. $QDO\VLV RI PRGXODULW\ DQG LQWHJUDWLRQ VXJJHVWV HYROXWLRQ RI GUDJRQIO\ ZLQJ YHQDWLRQ PDLQO\ LQ UHVSRQVH WR IXQFWLRQDO GHPDQGV. -RXUQDO RI 7KH 5R\DO 6RFLHW\ ,QWHUIDFH. '2,: KWWSV://GRL.RUJ/10.1098/UVLI.2018.0277.
2. 'DYLG, 6., )XQNHQ, -., 3RWWKDVW, :., **%ODQNH**, $. 2016. 0XVFXORVNHOHWDO PRGHOOLQJ RI WKH GUDJRQIO\ PDQGLEOH V\VWHP DV DQ DLG WR XQGHUVWDQGLQJ WKH UROH RI VLQJOH PXVFOHV LQ DQ HYROXWLRQDU\ FRQWH[W. -RXUQDO RI ([SHULPHQWDO %LRORJ\ 216: 1041-1049. >3.2@ KWWSV://GRL.RUJ/10.1242/MHE.132399
3. 0LVRI %.; /LX 6.; 0HXVHPDQQ ..; 3HWHUV 5.6.; 'RQDWK $.; 0D\HU &.; )UDQGVHQ 3.%.; :DUH -.; )ORXUL 7.;

%HXWHO 5.\*.; 1LHKXLV 2.; 3HWHUVHQ 0.; ,]TXLHUGR-&DUUDVFR ).; :DSSOHU 7.; 5XVW -.; **%ODQNH**, $. HW.DO. 2014. 3K\ORJHQRPLFV UHVROYHV WKH WLPLQJ DQG SDWWHUQ RI LQVHFW HYROXWLRQ. 6FLHQFH 346: 763-767. KWWS://G[.GRL.RUJ/10.1126/VFLHQFH.1257570

%LRJUDSKLFDO 6NHWFKHV RI )RUHLJQ 3DUWLFLSDQWV

1. **%ODQNH**, $., \*UHYH, &., :LSIOHU, %., %HXWHO, 5.\*., +ROODQG, %., 0LVRI, %. 2013. 7KH LGHQWLILFDWLRQ RI FRQFHUWHG FRQYHUJHQFH LQ LQVHFW KHDGV FRUURERUDWHV 3DODHRSWHUD. 6\VWHPDWLF %LRORJ\ 62: 231-249. KWWS://G[.GRL.RUJ/10.1093/V\VELR/V\V091
2. 5. 0RNVR, /. 4XDURQL, ). 0DURQH, 6. ,UYLQH, -. 9LOD-&RPDPDOD, $. **%ODQNH**, 0. 6WDPSDQRQL. 2012 ;- UD\ PRVDLF QDQRWRPRJUDSK\ RI ODUJH PLFURRUJDQLVPV. -RXUQDO RI 6WUXFWXUDO %LRORJ\ 177: 233-238.

KWWS://G[.GRL.RUJ/10.1016/M.MVE.2011.12.014

**'. 6\QHUJLVWLF $FWLYLWLHV**

x &KDLU RI WKH 62QG 3K\ORJHQHWLF 6\PSRVLXP LQ 2020 (³0DFURHYROXWLRQDU\ G\QDPLFV LQ WLPH DQG VSDFH´)

x 2UJDQLVDWLRQ RI HLJKW ZRUNVKRSV VLQFH 2014 DERXW TXDQWLWDWLYH PRUSKRORJ\ DQG ELRPHFKDQLFV.

x $VVRFLDWH (GLWRU RI WKH -RXUQDO RI =RRORJLFDO 6\VWHPDWLFV DQG (YROXWLRQDU\ 5HVHDUFK (,): 3.2) (2016-3UHVHQW)

x 6HUYHG DV (5&, %%65&, 1(5&, 616), DQG $15 3HHU 5HYLHZHU (2016-3UHVHQW)

x 6HUYHG DV UHYLHZHU IRU 20+ LQGH[HG MRXUQDOV (H.J. &XUUHQW %LRORJ\, 6FLHQFH $GYDQFHV, 3/26 &RPSXWDWLRQDO %LRORJ\)

%LRJUDSKLFDO 6NHWFKHV RI 2WKHU 6HQLRU 86$ 3HUVRQQHO

AůĞǆĂŶĚĞƌ :͘ ,ƵŶƚ

AĚĚƌĞƐƐ͗ DĂƐĞĞŚ CŽůůĞŐĞ ŽĨ EŶŐŝŶĞĞƌŝŶŐ ĂŶĚ CŽŵƉƵƚĞƌ ^ĐŝĞŶĐĞ͕ WK BŽǆ ϳϱϭ DE͕ WŽƌƚůĂŶĚ͕ KZ ϵϳϮϬϳ WŚŽŶĞ͗ ϭͲϱϬϯͲϳϮϱͲϰϮϲϱ

EͲŵĂŝů͗ ĂũŚϮϲΛƉĚǆ͘ĞĚƵ

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| WƌŽĨĞƐƐŝŽŶĂů WƌĞƉĂƌĂƚŝŽŶ͗ |  | | |
| CĂƐĞ tĞƐƚĞƌŶ ZĞƐĞƌǀĞ hŶŝǀĞƌƐŝƚǇ | CůĞǀĞůĂŶĚ͕ K, | DĞĐŚĂŶŝĐĂů EŶŐŝŶĞĞƌŝŶŐ | B͘^͘ DĂǇ ϮϬϬϵ |
| CĂƐĞ tĞƐƚĞƌŶ ZĞƐĞƌǀĞ hŶŝǀĞƌƐŝƚǇ | CůĞǀĞůĂŶĚ͕ K, | DĞĐŚĂŶŝĐĂů EŶŐŝŶĞĞƌŝŶŐ | D͘^͘ DĂǇ ϮϬϭϬ |
| CĂƐĞ tĞƐƚĞƌŶ ZĞƐĞƌǀĞ hŶŝǀĞƌƐŝƚǇ | CůĞǀĞůĂŶĚ͕ K, | DĞĐŚĂŶŝĐĂů EŶŐŝŶĞĞƌŝŶŐ | WŚ͘D͘ :ĂŶ͘ ϮϬϭϲ |
| CĂƐĞ tĞƐƚĞƌŶ ZĞƐĞƌǀĞ hŶŝǀĞƌƐŝƚǇ | CůĞǀĞůĂŶĚ͕ K, | BŝŽŵĞĚŝĐĂů EŶŐŝŶĞĞƌŝŶŐ | KĐƚ͘ ϮϬϭϱͲ:ƵůǇ ϮϬϭϲ |

AƉƉŽŝŶƚŵĞŶƚƐ

**AƐƐŝƐƚĂŶƚ WƌŽĨĞƐƐŽƌ** ^ĞƉƚĞŵďĞƌ ϮϬϭϲ ʹ WƌĞƐĞŶƚ

*WŽƌƚůĂŶĚ ^ƚĂƚĞ hŶŝǀĞƌƐŝƚǇ͖ WŽƌƚůĂŶĚ͕ KZ DĞĐŚĂŶŝĐĂů ĂŶĚ DĂƚĞƌŝĂůƐ EŶŐŝŶĞĞƌŝŶŐ DĞƉĂƌƚŵĞŶƚ*

**WŽƐƚĚŽĐƚŽƌĂů &ĞůůŽǁ** KĐƚŽďĞƌ ϮϬϭϱ ʹ :ƵůǇ ϮϬϭϲ

###### *CĂƐĞ tĞƐƚĞƌŶ ZĞƐĞƌǀĞ hŶŝǀĞƌƐŝƚǇ͖ CůĞǀĞůĂŶĚ͕ KŚŝŽ* ZĞƐĞĂƌĐŚ Ăƚ >ŽƵŝƐ ^ƚŽŬĞƐ sA DĞĚŝĐĂů CĞŶƚĞƌ͕ CůĞǀĞůĂŶĚ͕ KŚŝŽ

ZĞƉƌĞƐĞŶƚĂƚŝǀĞ ƉƌŽĚƵĐƚƐ ŵŽƐƚ ƌĞůĂƚĞĚ ƚŽ DC^D

ϭ͘ B͘ BŽůĞŶ ĂŶĚ A͘ :͘ ,ƵŶƚ͕ ͞DĞƚĞƌŵŝŶĂƚŝŽŶ ŽĨ AƌƚŝĨŝĐŝĂů DƵƐĐůĞ WůĂĐĞŵĞŶƚ ĨŽƌ BŝŽŵŝŵĞƚŝĐ ,ƵŵĂŶŽŝĚ ZŽďŽƚ >ĞŐƐ͕͟ ŝŶ BŝŽŵŝŵĞƚŝĐ ĂŶĚ BŝŽŚǇďƌŝĚ ^ǇƐƚĞŵƐ͕ EĂƌĂ͕ :ĂƉĂŶ͕ ϮϬϭϵ͘

Ϯ͘ C͘ ^ĐŚĂƌǌĞŶďĞƌŐĞƌ͕ :͘ DĞŶĚŽǌĂ͕ ĂŶĚ A͘ :͘ ,ƵŶƚ͕ ͞DĞƐŝŐŶ ŽĨ Ă CĂŶŝŶĞ /ŶƐƉŝƌĞĚ YƵĂĚƌƵƉĞĚ ZŽďŽƚ ĂƐ Ă WůĂƚĨŽƌŵ ĨŽƌ ^ǇŶƚŚĞƚŝĐ EĞƵƌĂů EĞƚǁŽƌŬ CŽŶƚƌŽů͕͟ ŝŶ BŝŽŵŝŵĞƚŝĐ ĂŶĚ BŝŽŚǇďƌŝĚ ^ǇƐƚĞŵƐ͕ EĂƌĂ͕

:ĂƉĂŶ͕ ϮϬϭϵ͘

ϯ͘ AůĞǆĂŶĚĞƌ ,ƵŶƚ͕ EŝĐŚŽůĂƐ ^ǌĐǌĞĐŝŶƐŬŝ͕ ĂŶĚ ZŽŐĞƌ YƵŝŶŶ͘ DĞǀĞůŽƉŵĞŶƚ ĂŶĚ dƌĂŝŶŝŶŐ ŽĨ Ă EĞƵƌĂů CŽŶƚƌŽůůĞƌ ĨŽƌ ,ŝŶĚ >ĞŐ tĂůŬŝŶŐ ŝŶ Ă DŽŐ ZŽďŽƚ͘ &ƌŽŶƚŝĞƌƐ ŝŶ EĞƵƌŽƌŽďŽƚŝĐƐ͕ ϭϭ͕ ϮϬϭϳ

ϰ͘ AůĞǆĂŶĚĞƌ ,ƵŶƚ͕ DĂŶƵĞůĂ ^ĐŚŵŝĚƚ͕ DĂƌƚŝŶ &ŝƐĐŚĞƌ͕ ĂŶĚ ZŽŐĞƌ YƵŝŶŶ͘ A ďŝŽůŽŐŝĐĂůůǇ ďĂƐĞĚ ŶĞƵƌĂů ƐǇƐƚĞŵ ĐŽŽƌĚŝŶĂƚĞƐ ƚŚĞ ũŽŝŶƚƐ ĂŶĚ ůĞŐƐ ŽĨ Ă ƚĞƚƌĂƉŽĚ͘ BŝŽŝŶƐƉŝƌĂƚŝŽŶ Θ BŝŽŵŝŵĞƚŝĐƐ͕ ϭϬ;ϱͿ͗ϬϱϱϬϬϰ͕ ϮϬϭϱ

ϱ͘ AůĞǆĂŶĚĞƌ :͘ ,ƵŶƚ͕ EŝĐŚŽůĂƐ ^͘ ^ǌĐǌĞĐŝŶƐŬŝ͕ EŵĂŶƵĞů AŶĚƌĂĚĂ͕ DĂƌƚŝŶ &ŝƐĐŚĞƌ͕ ĂŶĚ ZŽŐĞƌ D͘ YƵŝŶŶ͘ hƐŝŶŐ AŶŝŵĂů DĂƚĂ ĂŶĚ EĞƵƌĂů DǇŶĂŵŝĐƐ ƚŽ ZĞǀĞƌƐĞ EŶŐŝŶĞĞƌ Ă EĞƵƌŽŵĞĐŚĂŶŝĐĂů ZĂƚ

DŽĚĞů͘ /Ŷ ^ƚƵĂƌƚ W͘ tŝůƐŽŶ͕ WĂƵů &͘ D͘ :͘ sĞƌƐĐŚƵƌĞ͕ AŶŶĂ DƵƌĂ͕ ĂŶĚ dŽŶǇ :͘ WƌĞƐĐŽƚƚ͕ ĞĚŝƚŽƌƐ͕ BŝŽŵŝŵĞƚŝĐ ĂŶĚ BŝŽŚǇďƌŝĚ ^ǇƐƚĞŵƐ͕ ŶƵŵďĞƌ ϵϮϮϮ ŝŶ >ĞĐƚƵƌĞ EŽƚĞƐ ŝŶ CŽŵƉƵƚĞƌ ^ĐŝĞŶĐĞ͕ ƉĂŐĞƐ ϮϭϭʹϮϮϮ͘ ^ƉƌŝŶŐĞƌ /ŶƚĞƌŶĂƚŝŽŶĂů WƵďůŝƐŚŝŶŐ͕ :ƵůǇ ϮϬϭϱ

%LRJUDSKLFDO 6NHWFKHV RI 2WKHU 6HQLRU 86$ 3HUVRQQHO

AĚĚŝƚŝŽŶĂů ƉƌŽũĞĐƚƐ

ϭ͘ t͘ t͘ ,ŝůƚƐ͕ E͘ ^͘ ^ǌĐǌĞĐŝŶƐŬŝ͕ Z͘ D͘ YƵŝŶŶ͕ ĂŶĚ A͘ :͘ ,ƵŶƚ͕ ͞A DǇŶĂŵŝĐ EĞƵƌĂů EĞƚǁŽƌŬ DĞƐŝŐŶĞĚ hƐŝŶŐ AŶĂůǇƚŝĐĂů DĞƚŚŽĚƐ WƌŽĚƵĐĞƐ DǇŶĂŵŝĐ CŽŶƚƌŽů WƌŽƉĞƌƚŝĞƐ ^ŝŵŝůĂƌ ƚŽ ĂŶ AŶĂůŽŐŽƵƐ CůĂƐƐŝĐĂů CŽŶƚƌŽůůĞƌ͕͟ /EEE CŽŶƚƌŽů ^ǇƐƚĞŵƐ >ĞƚƚĞƌƐ͕ ǀŽů͘ ϯ͕ ŶŽ͘ Ϯ͕ ƉƉ͘ ϯϮϬʹϯϮϱ͕ KĐƚ͘ ϮϬϭϴ͘

Ϯ͘ A ^ƚĞĞůĞ͕ A ,ƵŶƚ͕ ĂŶĚ A EƚŽƵŶĚŝ͕ ͞BŝŽŵŝŵĞƚŝĐ <ŶĞĞ DĞƐŝŐŶ ƚŽ /ŵƉƌŽǀĞ :ŽŝŶƚ dŽƌƋƵĞ ĂŶĚ >ŝĨĞ ĨŽƌ BŝƉĞĚĂů ZŽďŽƚŝĐƐ͕͟ ƉƌĞƐĞŶƚĞĚ Ăƚ ƚŚĞ dŽǁĂƌĚƐ AƵƚŽŶŽŵŽƵƐ ZŽďŽƚŝĐ ^ǇƐƚĞŵƐ͕ BƌŝƐƚŽů͕ h<͕ ϮϬϭϴ͘

ϯ͘ AůĞǆĂŶĚĞƌ :͘ ,ƵŶƚ͕ BƌŽŽŬĞ D͘ KĚůĞ͕ >ŝƐĂ D͘ >ŽŵďĂƌĚŽ͕ DƵƐĂ >͘ AƵĚƵ͕ ĂŶĚ ZŽŶĂůĚ :͘ dƌŝŽůŽ͘ ZĞĂĐƚŝǀĞ ƐƚĞƉƉŝŶŐ ǁŝƚŚ ĨƵŶĐƚŝŽŶĂů ŶĞƵƌŽŵƵƐĐƵůĂƌ ƐƚŝŵƵůĂƚŝŽŶ ŝŶ ƌĞƐƉŽŶƐĞ ƚŽ ĨŽƌǁĂƌĚͲĚŝƌĞĐƚĞĚ ƉĞƌƚƵƌďĂƚŝŽŶƐ͘ :ŽƵƌŶĂů ŽĨ EĞƵƌŽEŶŐŝŶĞĞƌŝŶŐ ĂŶĚ ZĞŚĂďŝůŝƚĂƚŝŽŶ͕ ϭϰ͗ϱϰ͕ :ƵŶĞ ϮϬϭϳ

ϰ͘ A͘ :͘ ,ƵŶƚ͕ Z͘ :͘ BĂĐŚŵĂŶŶ͕ Z͘ Z͘ DƵƌƉŚǇ͕ ĂŶĚ Z͘ D͘ YƵŝŶŶ͘ A ƌĂƉŝĚůǇ ƌĞĐŽŶĨŝŐƵƌĂďůĞ ƌŽďŽƚ ĨŽƌ ĂƐƐŝƐƚĂŶĐĞ ŝŶ ƵƌďĂŶ ƐĞĂƌĐŚ ĂŶĚ ƌĞƐĐƵĞ͘ /Ŷ ϮϬϭϭ /EEEͬZ^: /ŶƚĞƌŶĂƚŝŽŶĂů CŽŶĨĞƌĞŶĐĞ ŽŶ /ŶƚĞůůŝŐĞŶƚ ZŽďŽƚƐ ĂŶĚ ^ǇƐƚĞŵƐ͕ ƉĂŐĞƐ ϮϬϵʹϮϭϰ͕ ^ĞƉƚĞŵďĞƌ ϮϬϭϭ

ϱ͘ DĞŶŐ͕ <ĂŝǇƵ͕ EŝĐŚŽůĂƐ ^ ^ǌĐǌĞĐŝŶƐŬŝ͕ DŝƌŬ AƌŶŽůĚ͕ EŵĂŶƵĞů AŶĚƌĂĚĂ͕ DĂƌƚŝŶ &ŝƐĐŚĞƌ͕ ZŽŐĞƌ D YƵŝŶŶ͕ ĂŶĚ AůĞǆĂŶĚĞƌ : ,ƵŶƚ͘ ͞EĞƵƌŽŵĞĐŚĂŶŝĐĂů DŽĚĞů ŽĨ ZĂƚ ,ŝŶĚ >ŝŵď tĂůŬŝŶŐ ǁŝƚŚ dǁŽͲ

>ĂǇĞƌ CW'Ɛ͘͟ *BŝŽŵŝŵĞƚŝĐƐ* ϮϬϭϵ͕ ϰ͕ ;ϭͿ͘

# ^ĞůĞĐƚĞĚ ^ǇŶĞƌŐŝƐƚŝĐ AĐƚŝǀŝƚŝĞƐ

1. 0HQWRULQJ: 8QGHUJUDGXDWH 5HVHDUFK DQG 0HQWRULQJ 3URJUDP 0HQWRU, 5(8 0HQWRU.
2. 3URIHVVLRQDO 0HPEHUVKLS: $PHULFDQ 6RFLHW\ RI 0HFKDQLFDO (QJLQHHUV (2010-3UHVHQW). 6RFLHW\ IRU 1HXURVFLHQFHV (2018).
3. 7HDFKLQJ: 'HYHORSHG DQG WHDFK D FRXUVH LQ URERWLFV IRU WKH 'HSDUWPHQW RI 0HFKDQLFDO DQG 0DWHULDOV (QJLQHHULQJ DW 3RUWODQG 6WDWH 8QLYHUVLW\.
4. 8QLYHUVLW\ VHUYLFH: 0HPEHU RI FXUULFXOXP FRPPLWWHH; KRVWV UHJXODU ODE WRXUV IRU SURVSHFWLYH VWXGHQWV DQG FRPPXQLW\ PHPEHUV.
5. &RPPXQLW\ VHUYLFH: 5HJXODU SUHVHQWDWLRQV WR ),567 URERWLFV WHDPV.

%LRJUDSKLFDO 6NHWFKHV RI 2WKHU 6HQLRU 86$ 3HUVRQQHO

0DULH-&ODXGH 3HUUHDXOW, 3K'

$VVLVWDQW 3URIHVVRU RI 3K\VLRORJ\ 'HSDUWPHQW RI 3K\VLRORJ\, )DFXOW\ RI 0HGLFLQH

(PRU\ 8QLYHUVLW\

$WODQWD, \*HRUJLD 30322-1047 P-F.SHUUHDXOW#HPRU\.HGX

$. 3URIHVVLRQDO 3UHSDUDWLRQ

,QVWLWXWLRQ /RFDWLRQ 0DMRU 'HJUHH &<HDU

8QLYHUVLW\ RI 0RQWUpDO 4XpEHF, &DQDGD 3K\VLTXH %.6F., 1986

8QLYHUVLWp GH 0RQWUpDO 4XpEHF, &DQDGD 1HXURVFLHQFH ($QDWRP\) 0.6F., 1987

8QLYHUVLWp GH 0RQWUpDO 4XpEHF, &DQDGD 1HXURVFLHQFH (3K\VLRORJ\) 3K.'., 1993

8QLYHUVLW\ RI 0DQLWRED 0DQLWRED, &DQDGD 1HXURSK\VLRORJ\ 1996

%. $SSRLQWPHQWV

*Primary*

2011-SUHVHQW $VVLVWDQW 3URIHVVRU, 3K\VLRORJ\, (PRU\ 8QLYHUVLW\, 86$

2009-2011 $VVLVWDQW 3URIHVVRU, 1DWLRQDO &HQWUH IRU 6WHP &HOO 5HVHDUFK, 1RUZD\

1999-2009 $VVLVWDQW 3URIHVVRU, 3K\VLRORJ\, 8QLYHUVLW\ RI 2VOR, 1RUZD\

1996-1999 5HVHDUFK $VVRFLDWH 3URIHVVRU, 3K\VLRORJ\, 8QLYHUVLW\ RI &RSHQKDJHQ, 'HQPDUN

*Secondary*

2015-SUHVHQW $GMXQFW )DFXOW\, :DOODFH +. &RXOWHU 'HSW. RI %LRPHGLFDO (QJLQHHULQJ, \*7, 86$

&. 3URGXFWV

)LYH PRVW UHOHYDQW SXEOLFDWLRQV (\* GHQRWHV WUDLQHH):

1. 3HUUHDXOW 0-& DQG \*LRUJL $ (2019) 'LYHUVLW\ RI UHWLFXORVSLQDO V\VWHPV LQ PDPPDOV. *Current Opinion in Physiology* 8:161-169. 1,+06 1523777 (30,' LQ SURFHVV)
2. -HDQ-;DYLHU & DQG 3HUUHDXOW 0-& (2018) ,QIOXHQFH RI %UDLQ 6WHP RQ $[LDO DQG +LQGOLPE 6SLQDO

/RFRPRWRU 5K\WKP \*HQHUDWLQJ &LUFXLWV RI WKH 1HRQDWDO 0RXVH. *Frontiers in Neuroscience*1 2:53. GRL: 10.3389/IQLQV.2018.00053. 30,': 29479302.

1. 6LYHUWVHQ 06\*, \*ORYHU -&, 3HUUHDXOW 0& (2014) 2UJDQL]DWLRQ RI SRQWLQH UHWLFXORVSLQDO LQSXWV WR PRWRQHXURQV FRQWUROOLQJ D[LDO DQG OLPE PXVFOHV LQ WKH QHRQDWDO PRXVH. *Journal of Neurophysiology* 112:1628-1643. 30,': 24944221
2. 6]RNRO .\*, \*ORYHU -& DQG 3HUUHDXOW 0-& (2011) 2UJDQL]DWLRQ RI IXQFWLRQDO V\QDSWLF FRQQHFWLRQV EHWZHHQ PHGXOODU\ UHWLFXORVSLQDO QHXURQV DQG OXPEDU GHVFHQGLQJ FRPPLVVXUDO LQWHUQHXURQV LQ WKH QHRQDWDO PRXVH. *Journal of Neuroscience* 31:4731-4742. 30,': 21430172

%LRJUDSKLFDO 6NHWFKHV RI 2WKHU 6HQLRU 86$ 3HUVRQQHO

1. 6]RNRO .\*, \*ORYHU -&, 3HUUHDXOW 0-& (2008) 'LIIHUHQWLDO RULJLQ RI UHWLFXORVSLQDO GULYH WR PRWRQHXURQV LQQHUYDWLQJ WUXQN DQG KLQGOLPE PXVFOHV LQ WKH PRXVH UHYHDOHG E\ RSWLFDO UHFRUGLQJ. *Journal of Physiology* 586:5259-5276. 30,': 18772205

)LYH RWKHU UHOHYDQW SXEOLFDWLRQV

1. 1LHOVHQ -%, &RQZD\ %$, +DOOLGD\ '0, 3HUUHDXOW 0-&, +XOWERUQ + (2005) 2UJDQL]DWLRQ RI FRPPRQ V\QDSWLF GULYH WR PRWRQHXURQHV GXULQJ ILFWLYH ORFRPRWLRQ LQ WKH VSLQDO FDW. *Journal of Physiology* 569:291-304. 30,': 16166163
2. 3HUUHDXOW 0-& (2002) 0RWRQHXURQV KDYH GLIIHUHQW PHPEUDQH UHVLVWDQFH GXULQJ ILFWLYH VFUDWFKLQJ DQG ZHLJKW VXSSRUW. *Journal of Neuroscience* 22:8259-65. 30,': 12223580
3. 3HUUHDXOW 0-&, (QULTXH]-'HQWRQ 0, +XOWERUQ + (1999) 3URSULRFHSWLYH FRQWURO RI H[WHQVRU DFWLYLW\ GXULQJ ILFWLYH VFUDWFKLQJ DQG ZHLJKW VXSSRUW FRPSDUHG WR ILFWLYH ORFRPRWLRQ. *Journal of Neuroscience* 19:10966-76. 30,': 10594077

4. +XOWERUQ +, &RQZD\ %$, \*RVVDUG -3, %URZQVWRQH 5, )HGLUFKXN %, 6FKRPEXUJ (', (QUtTXH]- 'HQWRQ 0, 3HUUHDXOW 0-& (1998) +RZ GR ZH DSSURDFK WKH ORFRPRWRU QHWZRUN LQ WKH PDPPDOLDQ VSLQDO FRUG" *Annuals New York Academy of Science* 860:70-82. 30,': 9928302

5. 3HUUHDXOW 0-&, $QJHO 0-, \*XHUWLQ 3, 0F&UHD '$ (1995) (IIHFWV RI VWLPXODWLRQ RI KLQGOLPE IOH[RU JURXS ,, DIIHUHQWV GXULQJ ILFWLYH ORFRPRWLRQ LQ WKH FDW. *Journal of Physiology* 487:211-20. 30,': 7473250

'. 6\QHUJLVWLF $FWLYLWLHV

x ,QWHUQDWLRQDO 6XPPHU 6FKRRO 7HDFKLQJ )HGHUDWLRQ RI (XURSHDQ 1HXURVFLHQFH 6RFLHWLHV ()(16),

,QWHJUDWLYH +XPDQ 3K\VLRORJ\-6HQVRULPRWRU &RQWURO (8QLYHUVLW\ RI &RSHQKDJHQ, 'HQPDUN) - 1999; &RPSXWDWLRQDO 0RGHOV RI &HOOXODU 6LJQDOLQJ LQ WKH 1HUYRXV 6\VWHP (.ULVWLQHEHUJ 0DULQH

5HVHDUFK 6WDWLRQ- 6ZHGHQ) - 2006

x $WODQWD &KDSWHU RI WKH 6RFLHW\ IRU 1HXURVFLHQFH , )RU SURPRWLRQ RI UHVHDUFK DQG SXEOLF XQGHUVWDQGLQJ RI WKH EUDLQ DQG QHUYRXV V\VWHP - 2013-2015

x 0HQWRULQJ RI 8QGHUJUDGXDWH VWXGHQWV (8) DQG +LJK 6FKRRO 6WXGHQWV (2), , WHDFK VWXGHQWV DERXW QHXURVFLHQFH UHVHDUFK WKURXJK VPDOO ODE SURMHFWV RU LPSOHPHQWDWLRQ RI LQGLYLGXDO VWXG\ SURJUDPV

- 2013-SUHVHQW

x \*UDQW 5HYLHZ 6HUYLFH, 6HQVRULPRWRU ,QWHJUDWLRQ (60,) 6WXG\ 6HFWLRQ, 1,+/1,1'6-2014, &HQWHUV RI %LRPHGLFDO 5HVHDUFK ([FHOOHQFH (&2%5(), 1,+/1,\*06- 3XHUWR 5LFR &HQWHU IRU 1HXUDO 3ODVWLFLW\ -2015, &RQTXHU 3DUDO\VLV 1RZ (&31), 6DP 6FKPLGW )RXQGDWLRQ - 2014-2017

x \*XHVW $FDGHPLF (GLWRU 3/26 %LRORJ\- 2017-SUHVHQW

%LRJUDSKLFDO 6NHWFKHV RI 2WKHU 6HQLRU 86$ 3HUVRQQHO

9LFWRULD $. :HEVWHU-:RRG, 3K'

$VVLVWDQW 3URIHVVRU 'HSDUWPHQW RI 0HFKDQLFDO (QJLQHHULQJ

'HSDUWPHQW RI %LRPHGLFDO (QJLQHHULQJ, E\ FRXUWHV\ &DUQHJLH 0HOORQ 8QLYHUVLW\

3LWWVEXUJK, 3$ 15116 YZHEVWHU#DQGUHZ.FPX.HGX

$. 3URIHVVLRQDO 3UHSDUDWLRQ

|  |  |  |  |
| --- | --- | --- | --- |
| ,QVWLWXWLRQ  &DVH :HVWHUQ 5HVHUYH 8QLYHUVLW\ | /RFDWLRQ  &OHYHODQG, 2KLR | 0DMRU  0HFKDQLFDO (QJLQHHULQJ | 'HJUHH &<HDU  %.6., 2012 |
|  |  |  | 0.6., 2013  3K.'., 2017 |

%. $SSRLQWPHQWV

2018-3UHVHQW $VVLVWDQW 3URIHVVRU RI 0HFKDQLFDO (QJLQHHULQJ, &DUQHJLH 0HOORQ 8QLYHUVLW\

2018-3UHVHQW $VVLVWDQW 3URIHVVRU RI %LRPHGLFDO (QJLQHHULQJ, E\ FRXUWHV\, &08

&. 3URGXFWV

)LYH PRVW UHOHYDQW SXEOLFDWLRQV:

1. :HEVWHU-:RRG, 9., $NNXV, 2., \*XUNDQ, 8., &KLHO, +., 4XLQQ, 5. "2UJDQLVPDO (QJLQHHULQJ: 7RZDUGV D 5RERWLF 7D[RQRPLF .H\ IRU 'HYLFHV 8VLQJ 2UJDQLF 0DWHULDOV´*.* 6FLHQFH 5RERWLFV. 2(12). 1RYHPEHU 2018.
2. :HEVWHU, 9., &KDSLQ, .., +DZOH\, (., 3DWHO, -., $NNXV 2., &KLHO, +., 4XLQQ, 5. "*Aplysia californica* DV D 1RYHO 6RXUFH RI 0DWHULDO IRU %LRK\EULG 5RERWV DQG 2UJDQLF 0DFKLQHV". LQ

%LRPLPHWLF DQG %LRK\EULG 6\VWHPV: 3URFHHGLQJV RI /LYLQJ 0DFKLQHV 2016. -XO\ 18-22, 2016 (GLQEXUJK, 6FRWODQG. 2QG 3ODFH LQ 3UHVHQWDWLRQ &RPSHWLWLRQ.

3. :HEVWHU, 9., <RXQJ, )., 3DWHO, -., 6FDULDQR, \*., $NNXV, 2., \*XUNDQ, 8., &KLHO, +., 4XLQQ, 5. "3'- SULQWHG %LRK\EULG 5RERWV 3RZHUHG E\ 1HXURPXVFXODU 7LVVXH &LUFXLWV IURP *Aplysia californica*". LQ %LRPLPHWLF DQG %LRK\EULG 6\VWHPV: 3URFHHGLQJV RI /LYLQJ 0DFKLQHV 2017. -XO\ 25-28, 2017 6DQ )UDQFLVFR, 86$.

1. :HEVWHU, 9., /HLEDFK, 5., +XQW, $., %DFKPDQQ, 5., 4XLQQ, 5. "'HVLJQ DQG &RQWURO RI D 7XQDEOH &RPSOLDQFH $FWXDWRU". LQ %LRPLPHWLF DQG %LRK\EULG 6\VWHPV: 3URFHHGLQJV RI /LYLQJ 0DFKLQHV 2014. -XO\ 30-$XJXVW 1. 2014. 0LODQ, ,WDO\. SS 244-255.
2. :HEVWHU, 9., /RQVEHUU\, $., +RUFKOHU, $., 6KDZ, .., &KLHO, +., 4XLQQ, 5. "$ 6HJPHQWDO 0RELOH 5RERW ZLWK $FWLYH 7HQVHJULW\ %HQGLQJ DQG 1RLVH-GULYHQ 2VFLOODWRUV". $,0 2013. :ROORQJRQJ,

$XVWUDOLD. 2013.

)RXU RWKHU UHOHYDQW SXEOLFDWLRQV

1. :HEVWHU, 9., 6]F]HFLQVNL, 1., 7LHW], %., 'DOWRULR, .., 3RUU, '., 5LFKDUGV, -., 5LW]PDQQ, 5., 4XLQQ,

5. "%DUULHU 1DYLJDWLQJ DQG 6KHOWHU 6HHNLQJ 5RERW ,QVSLUHG E\ &RFNURDFK %HKDYLRU". &/$:$5 2012, %DOWLPRUH, 0'. 2012.

%LRJUDSKLFDO 6NHWFKHV RI 2WKHU 6HQLRU 86$ 3HUVRQQHO

1. 'DOWRULR, .., 7LHW], %., %HQGHU, -., :HEVWHU, 9., 6]F]HFLQVNL, 1., %UDQLFN\, 0., 5LW]PDQQ, 5., 4XLQQ, 5. "$ 6WRFKDVWLF $OJRULWKP IRU ([SORUDWLYH \*RDO 6HHNLQJ ([WUDFWHG IURP &RFNURDFK

:DONLQJ 'DWD". ,&5$ 2012. SS 2261-2268. 0D\ 2012.

1. :HEVWHU 9$, &KDSLQ .-, $NNXV 2, &KLHO +- DQG 4XLQQ 5' (2016). *Aplysia californica* DV D VRXUFH RI DFWXDWRUV, VFDIIROGV, DQG FRQWUROOHUV IRU WKH GHYHORSPHQW RI ELRK\EULG URERWV DQG OLYLQJ PDFKLQHV. 1HXURVFLHQFH 2016. 1RYHPEHU 12-16, 2016. 6DQ 'LHJR, 86$.
2. 'DOWRULR, .., 7LHW], %., %HQGHU, -., :HEVWHU, 9., 6]F]HFLQVNL, 1., %UDQLFN\, 0., 5LW]PDQQ, 5., 4XLQQ, 5. "$ PRGHO RI H[SORUDWLRQ DQG JRDO-VHHNLQJ LQ WKH FRFNURDFK %ODEHUXV GLVFRLGDOLV".

$GDSWLYH %HKDYLRU. 21(5). 404-420. 2FW 2012.

'. 6\QHUJLVWLF $FWLYLWLHV

x 8QGHUJUDGXDWH FRXUVH ³\*DGJHWU\: 6HQVRUV, $FWXDWRUV, DQG 3URFHVVRUV´ (2018 ± 3UHVHQW)

x 8QGHUJUDGXDWH 2XWUHDFK: +RVW ODE IRU XQGHUJUDGXDWH UHVHDUFKHUV LQ URERWLFV. &XUUHQWO\ VXSSRUWLQJ D WRWDO RI 8 XQGHUJUDGXDWH VWXGHQWV LQFOXGLQJ IRXU ZRPHQ, WZR RI ZKRP DUH +LVSDQLF DQG WZR

+LVSDQLF PHQ.

x 2015 %HVW 3RVWHU $ZDUG, /LYLQJ 0DFKLQHV &RQIHUHQFH, %DUFHORQD

x &:58 0$( 3URIHVVLRQDO 6HUYLFH $ZDUG

x 1,+ 5XWK /. .LUVFKVWHLQ 156$ 3RVWGRFWRUDO )HOORZ, 2017-2018

[Pursuant to PAPPG Chapter II.C.1.e.](https://www.nsf.gov/bfa/dias/policy/coa.jsp), each PI, co-PI, and other senior project personnel identified on a proposal must provide [colla](https://www.nsf.gov/bfa/dias/policy/coa.jsp)borator and other affiliations information to help NSF identify appropriate reviewers.(v.4/21/2017)

**Please complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane Collaborators and Other Affiliations single copy doc.**

**Do not upload .pdf.**

**There are five tables:**

**A: Your Name & Affiliation(s); B: PhD Advisors/Advisees (all); C: Collaborators;**

**D: Co-Editors; E: Relationships**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department (optional) to disambiguate common names.**

**Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and abbreviate, where necessary, to make the data fit.**

**To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. "Last active" dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**Table A: List your Last Name, First Name, Middle Initial, and organizational affiliation (including considered affiliation) in the last 12 months.**

|  |  |  |  |
| --- | --- | --- | --- |
| **A** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Hunt, Alexander J | Portland State University |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table B: List names as Last Name, First Name, Middle Initial, and provide organizational affiliations, if known, for the following.**

**G: Your PhD Advisor(s)**

**T: All your PhD Thesis Advisees P: Your Graduate Advisors**

*to disambiguate common names*

|  |  |  |  |
| --- | --- | --- | --- |
| **B** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |
| G: | Quinn, Roger D | Caese Western Reserve University | Mechanical and Aerospace Eng. |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table C: List names as Last Name, First Name, Middle Initial, and provide organizational affiliations, if known, for the following.**

A: Co-authors on any book, article, report, abstract or paper (with collaboration in last 48 months; publication date may be later).

**C: Collaborators on projects, such as funded grants, graduate research or others (in last 48 months).**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **C** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| C: | Andrada, Emanuel | Fredrich Schiller University of Jena | [emanuel.andrada@uni-jena.de](mailto:emanuel.andrada@uni-jena.de) | 5/1/19 |
| C: | Arnold, Dirk | Fredrich Schiller University of Jena | [d.arnold@uni-jena.de](mailto:d.arnold@uni-jena.de) | 5/1/19 |
| A: | Audu, Musa | Case Western Reserve University | Biomedical Engineering | 6/1/17 |
| A: | Bracun, Drago | University of Ljubljana | Mechanical Engineering | 7/1/18 |
| A: | Deng, Kaiyu | Case Western Reserve University | Mechanical and Aerospace Eng. | 5/1/19 |
| A: | Etoundi, Appolonaire | University of West England | Engineering Design and Mathematic | 5/1/19 |
| C: | Fischer, Martin | Fredrich Schiller University of Jena | [Martin.Fischer@uni-jena.de](mailto:Martin.Fischer@uni-jena.de) | 5/1/19 |
| A: | Hilts, Wade | Oregon Health and Science University | Biomedical Engineering | 11/1/18 |
| C: | Horak, Fay | Oregon Health and Science University | Neurology | 5/1/19 |
| A: | Lombardo, Lisa | Cleveland Stokes VA Hospital | APT Center | 6/1/17 |
| A: | Odle, Brooke | Case Western Reserve University | Biomedical Engineering | 6/1/17 |
| C: | Peterka, Robert | Oregon Health and Science University | Biomedical Engineering | 5/1/19 |
| A: | Quinn, Roger D | Case Western Reserve University | Mechanical and Aerospace Eng. | 5/1/19 |
| C: | Rode, Christian | Fredrich Schiller University of Jena | [christian.rode@uni-jena.de](mailto:christian.rode@uni-jena.de) | 5/1/19 |
| A: | Skulj, Gasper | University of Ljubljana | Mechanical Engineering | 7/1/18 |
| A: | Steele, Alexander | Portland State University | Mechanical and Materials Engineeri | n 5/1/19 |
| A: | Szczecinski, Nicholas | Case Western Reserve University | Mechanical and Aerospace Eng. | 5/1/19 |
| A: | Triolo, Ronald | Case Western Reserve University | Biomedical Engineering | 6/1/17 |
| C: | Wildau, Julia | Fredrich Schiller University of Jena | [Julia.Wildau@gmx.de](mailto:Julia.Wildau@gmx.de) | 5/1/19 |
| A: | Young, Fletcher | Case Western Reserve University | Mechanical and Aerospace Eng. | 5/1/19 |

Table D: List editorial board, editor-in-chief and co-editors with whom you interact. An editor-in-chief should list

B: Editorial board: Name(s) of editor-in-chief and journal (in past 24 months).

**E: Other Co-Editors of journals or collections with whom you directly interacted (in past 24 months).**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
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|  |  |  |  |  |

Table E: List persons for whom a personal, family, or business relationship would otherwise preclude their service

R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
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[The following information regarding collaborators and other affiliations (COA) must be separately provided for each](https://www.nsf.gov/bfa/dias/policy/coa.jsp) [individual identified as senior project personnel. The COA information must be provided through](https://www.nsf.gov/bfa/dias/policy/coa.jsp) use of this COA template.

[**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane** [**Colla**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**borators and Other Affiliations single copy doc. Do not upload .pdf.**

[**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se note that some information requested in prior versions of the PAPPG is no longer requested. THIS IS PURPOSEFUL** [**AND**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **WE NO LONGER REQUIRE THIS INFORMATION TO BE REPORTED. Certain relationships will be reported in other sections** [**(i.e.,**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **the names of postdoctoral scholar sponsors should not be reported, however if the individual collaborated on research** [**with**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **their postdoctoral scholar sponsor, then they would be reported as a collaborator). The information in the tables is not** [**requ**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**ired to be sorted, alphabetically or otherwise.**

**There are five separate categories of information which correspond to the five tables in the COA template: COA template Table 1:**

**List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

**COA template Table 2:**

**List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**COA template Table 3:**

**List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**

* **The individual’s Ph.D. advisors; and**
* **All of the individual’s Ph.D. thesis advisees.**

**COA template Table 4:**

**List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**

* **Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be later); and**
* **Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

**COA template Table 5:**

**List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire editorial board.**

* **Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and**
* **Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

**The template has been developed to be fillable, however, the content and format requirements must not be altered by the user. This template must be saved in .xlsx or .xls format, and directly uploaded into FastLane as a Collaborators and Other Affiliations Single Copy Document. Using the .xlsx or .xls format will enable preservation of searchable text that otherwise would be lost. It is therefore imperative that this document be uploaded in .xlsx or .xls only. Uploading a document in any format other than .xlsx or .xls may delay the timely processing and review of the proposal.**

**This information is used to manage reviewer selection. See Exhibit II-2 for additional information on potential reviewer conflicts.**

1. **Note that graduate advisors are no longer required to be reported.**
2. **Editorial Board does not include Editorial Advisory Board, International Advisory Board, Scientific Editorial Board, or any other subcategory of Editorial Board. It is limited to those individuals who perform editing duties or manage the editing process (i.e., editor in chief).**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department (optional) Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and**

**To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. For "Last Active Date" and "Last Active" columns dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**“Last Active Date” and “Last Active” columns may be left blank for ongoing or current affiliations.**

**Table 1: List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Perreault, Marie-Claude | Emory University |  |
|  |  | Gerogia Tech (adjunct) |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table 2: List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2** | **Name:** | **Type of Relationship** | **Optional (email, Department)** | **Last Active** |
| R: | Raastad, Morten | Family |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Table 3: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following.

G: The individual’s Ph.D. advisors; and

**T: All of the individual’s Ph.D. thesis advisees.**

*to disambiguate common names*

|  |  |  |  |
| --- | --- | --- | --- |
| **3** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |
| G: |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| T: | Szokol, Karolina | Advisor, Research Council, Norway |  |
| T: | Kasumacic, N | Lecturer, Sonas High School, Norway |  |
| T: | Sivertsen, MS | Medical Doctor, Ulleval Hospital, Norway |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Table 4: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:

A: Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be later); and

**C: Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **4** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
| A: | Walter, Gary C | University of Arizona, USA |  |  |
| A: | Brandon, LaPallo | Teva Pharmaceuticals, USA |  |  |
| A: | Jean-Xavier, Celine | University of Calgary, Canada |  |  |
| A: | Giorgi, Andrea | Emory University, USA |  |  |
| A: | Glover, Joel C | University of Oslo, Norway |  |  |
| A: | Lambert, Francois M | Université de Bordeaux, France |  |  |
| A: | Coulon, Patrice | CNRS and Aix Marseille Université, France |  |  |
| A: | Bras, Helen | CNRS and Aix Marseille Université, France |  |  |
| A: | Vinal, Laurent | n/a |  |  |
| C: |  |  |  |  |

Table 5: List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief

B: Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and

**E: Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **5** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
| B: | Gasque, Gabriel |  | PLOS Biology | 3/25/19 |
| E: |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

[The following information regarding collaborators and other affiliations (COA) must be separately provided for each](https://www.nsf.gov/bfa/dias/policy/coa.jsp) [individual identified as senior project personnel. The COA information must be provided through](https://www.nsf.gov/bfa/dias/policy/coa.jsp) use of this COA template.

[**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se complete this template (e.g., Excel, Google Sheets, LibreOffice), save as .xlsx or .xls, and upload directly as a Fastlane** [**Colla**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**borators and Other Affiliations single copy doc. Do not upload .pdf.**

[**Plea**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**se note that some information requested in prior versions of the PAPPG is no longer requested. THIS IS PURPOSEFUL** [**AND**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **WE NO LONGER REQUIRE THIS INFORMATION TO BE REPORTED. Certain relationships will be reported in other sections** [**(i.e.,**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **the names of postdoctoral scholar sponsors should not be reported, however if the individual collaborated on research** [**with**](https://www.nsf.gov/bfa/dias/policy/coa.jsp) **their postdoctoral scholar sponsor, then they would be reported as a collaborator). The information in the tables is not** [**requ**](https://www.nsf.gov/bfa/dias/policy/coa.jsp)**ired to be sorted, alphabetically or otherwise.**

**There are five separate categories of information which correspond to the five tables in the COA template: COA template Table 1:**

**List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

**COA template Table 2:**

**List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**COA template Table 3:**

**List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**

* **The individual’s Ph.D. advisors; and**
* **All of the individual’s Ph.D. thesis advisees.**

**COA template Table 4:**

**List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:**

* **Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may be**

**later); and**

* **Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

**COA template Table 5:**

**List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief must list the entire**

**editorial board.**

* **Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and**
* **Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

**The template has been developed to be fillable, however, the content and format requirements must not be altered by the user. This template must be saved in .xlsx or .xls format, and directly uploaded into FastLane as a Collaborators and Other Affiliations Single Copy Document. Using the .xlsx or .xls format will enable preservation of searchable text that otherwise would be lost. It is therefore imperative that this document be uploaded in .xlsx or .xls only. Uploading a document in any format other than .xlsx or .xls may delay the timely processing and review of the proposal.**

**This information is used to manage reviewer selection. See Exhibit II-2 for additional information on potential reviewer**

**conflicts.**

1. **Note that graduate advisors are no longer required to be reported.**
2. **Editorial Board does not include Editorial Advisory Board, International Advisory Board, Scientific Editorial Board, or any other subcategory of Editorial Board. It is limited to those individuals who perform editing duties or manage the editing process (i.e., editor in chief).**

**List names as Last Name, First Name, Middle Initial. Additionally, provide email, organization, and department (optional) Fixed column widths keep this sheet one page wide; if you cut and paste text, set font size at 10pt or smaller, and**

**To insert *n* blank rows, select *n* row numbers to move down, right click, and choose Insert from the menu.**

**You may fill-down (crtl-D) to mark a sequence of collaborators, or copy affiliations. Excel has arrows that enable sorting. For "Last Active Date" and "Last Active" columns dates are optional, but will help NSF staff easily determine which information remains relevant for reviewer selection.**

**“Last Active Date” and “Last Active” columns may be left blank for ongoing or current affiliations.**

**Table 1: List the individual’s last name, first name, middle initial, and organizational affiliation in the last 12 months.**

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **Your Name:** | **Your Organizational Affiliation(s), last 12** | **Last Active Date** |
|  | Webster-Wood, Victoria A | Carnegie Mellon University | current |
|  |  | Case Western Reserve University (postdoc) | 6/1/2018 |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table 2: List names as last name, first name, middle initial, for whom a personal, family, or business relationship would otherwise preclude their service as a reviewer.**

**R: Additional names for whom some relationship would otherwise preclude their service as a reviewer.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2** | **Name:** | **Type of Relationship** | **Optional (email, Department)** | **Last Active** |
| R: | Webster, Robert, B. | family | Texas A&M, Nuclear Engineering | present |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Table 3: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following.

G: The individual’s Ph.D. advisors; and

**T: All of the individual’s Ph.D. thesis advisees.**

*to disambiguate common names*

|  |  |  |  |
| --- | --- | --- | --- |
| **3** | **Advisor/Advisee Name:** | **Organizational Affiliation** | **Optional (email, Department)** |
| G: | Quinn, Roger, D. | Case Western Reserve University |  |

|  |  |  |  |
| --- | --- | --- | --- |
| G: | Akkus, Ozan | Case Western Reserve University |  |
| G: | Chiel, Hillel, J. | Case Western Reserve University |  |
| T: | Sun, Wenhuan | Carnegie Mellon University |  |
| T: | Dai, Kevin | Carnegie Mellon University |  |
|  |  |  |  |
|  |  |  |  |

Table 4: List names as last name, first name, middle initial, and provide organizational affiliations, if known, for the following:

A: Co-authors on any book, article, report, abstract or paper with collaboration in the last 48 months (publication date may

**be later); and**

**C: Collaborators on projects, such as funded grants, graduate research or others in the last 48 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **4** | **Name:** | **Organizational Affiliation** | **Optional (email, Department)** | **Last Active** |
| C: | Quinn, Roger, D. | Case Western Reserve University |  | current |
| C: | Akkus, Ozan | Case Western Reserve University |  | current |
| C: | Chiel, Hillel, J. | Case Western Reserve University |  | current |
| C: | Farimani, Amir | Carnegie Mellon University |  | current |
| C: | Zhang, Jessica | Carnegie Mellon University |  | current |
| C: | Feinberg, Adam | Carnegie Mellon University |  | current |
| C: | Atkeson, Christopher | Carnegie Mellon University |  | current |
| C: | Yuan, Wenzhen | Carnegie Mellon University |  | current |
| C: | Feng, Chen | New York University |  | current |
| A: | Gurkan, Umut | Case Western Reserve University |  |  |
| A: | Abraham, Zachary | Case Western Reserve University |  |  |
| A: | Hawley, Emma | Case Western Reserve University |  |  |
| A: | Hayosh, Daniel | Case Western Reserve University |  |  |
| A: | Young, Fletcher | Case Western Reserve University |  |  |
| A: | Patel, Jill | Case Western Reserve University |  |  |
| A: | Scariano, Gabrielle | Case Western Reserve University |  |  |
| A: | Guerra Nieto, Santiago | Case Western Reserve University |  |  |
| A: | Grosberg, Anna | University of California - Irvine |  |  |
| A: | McClellan, Phillip | Case Western Reserve University |  |  |
| A: | Mbimba, Thomas |  |  |  |
| A: | Chapin, Katherine | Progressive Insurance |  |  |
| A: | Leibach, Ron | Case Western Reserve University |  |  |
| A: | Hunt, Alexander | Portland State University |  |  |
| A: | Bachmann, Richard | Case Western Reserve University |  |  |
| A: | Suzuki, Takayuki | Case Western Reserve University |  |  |

Table 5: List editorial board, editor-in chief and co-editors with whom the individual interacts. An editor-in-chief

**must list the entire editorial board.**

B: Editorial Board: List name(s) of editor-in-chief and journal in the past 24 months; and

**E: Other co-Editors of journal or collections with whom the individual has directly interacted in the last 24 months.**

*to disambiguate common names*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **5** | **Name:** | **Organizational Affiliation** | **Journal/Collection** | **Last Active** |
|  |  |  |  |  |
|  |  |  |  |  |
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|  |  |  |  |  |
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