December 13, 2012

To Whom It May Concern:

Thank you for considering the following fellowship application materials. They comprise Sara Steele's proposal for the F31 Ruth L. Kirschstein National Research Service Awards for Individual Predoctoral Fellowships to Promote Diversity in Health-Related Research (PA-11-112). The proposal is entitled "A novel stochastic-dynamical account of buildup and perceptual bistability of auditory grouping." This research is multidisciplinary and falls under both auditory psychophysics and computational neuroscience.

Please assign this fellowship application to the National Institute on Deafness and Other Communication Disorders (NIDCD).

There are no individuals to whom this proposal should not be sent for review.

The following referees have submitted letters of support:

Eero Simoncelli, PhD. New York University, Center for Neural Science

Daniel Tranchina, PhD. New York University, Department of Mathematics, CIMS

Jonathon Viventi, PhD. Polytechnic University

Thank you for your consideration of this fellowship application.

Sincerely,

Sara Steele
Predoctoral Fellow
Center for Neural Science
New York University

APPLICATION FOR FEDERAL ASSISTANCE

SF 424 (R&R)

2. DATE SUBMITTED	**Applicant Identifier**
3. DATE RECEIVED BY STATE	**State Application Identifier**
4. a. Federal Identifier	**b. Agency Routing Number**

1. * TYPE OF SUBMISSION

❍ Pre-application ● Application
❍ Changed/Corrected Application

5. APPLICANT INFORMATION *** Organizational DUNS:**041968306

* Legal Name: New York University

Department:	Division:	
* Street1: 665 Broadway, Suite 801	Street2:	
* City: New York	County/Parish: New York	* State: NY: New York
Province:	* Country: USA: UNITED STATES	* ZIP / Postal Code: 10012-2331

Person to be contacted on matters involving this application

Prefix:	* First Name:	Middle Name:	* Last Name:	Suffix:
Mr.	Richard	L.	Louth	

* Phone Number: 212-998-2121 Fax Number: 212-995-4029 Email: osp.agency@nyu.edu

6. * EMPLOYER IDENTIFICATION NUMBER *(EIN) or (TIN)*:
1-135562308-A1

7. * TYPE OF APPLICANT
O: Private Institution of Higher Education

8. * TYPE OF APPLICATION: ● New
❍ Resubmission ❍ Renewal ❍ Continuation ❍ Revision

Other (Specify):

Small Business Organization Type
❍ Women Owned ❍ Socially and Economically Disadvantaged

If Revision, mark appropriate box(es).
❍ A. Increase Award ❍ B. Decrease Award ❍ C. Increase Duration
❍ D. Decrease Duration ❍ E. Other *(specify)*:

* Is this application being submitted to other agencies? ❍ Yes ● No
What other Agencies?

9. * NAME OF FEDERAL AGENCY:
National Institutes of Health

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER:
TITLE:

11. * DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:
A novel stochastic-dynamical account of buildup and perceptual bistability of auditory grouping

12. PROPOSED PROJECT:

* Start Date	* Ending Date
09/01/2013	08/31/2016

13. CONGRESSIONAL DISTRICT OF THE APPLICANT:
NY-008

14. PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR CONTACT INFORMATION

Prefix:	* First Name:	Middle Name:	* Last Name:	Suffix:
	Sara		Steele	

Position/Title:	* Organization Name: New York University	
Department: Center for Neural Science	Division: FAS	
* Street1: 4 Washington Place	Street2: Room 1023	
* City: New York	County/Parish: New York	* State: NY: New York
Province:	* Country: USA: UNITED STATES	* ZIP / Postal Code: 10003-6603
* Phone Number: 2129983920	Fax Number:	* Email: sas756@nyu.edu

SF 424 (R&R) APPLICATION FOR FEDERAL ASSISTANCE

15. ESTIMATED PROJECT FUNDING

a. * Total Federal Funds Requested	$126,996.00
b. Total Non-Federal Funds	$0.00
c. * Total Federal & Non-Federal Funds	$126,996.00
d. * Estimated Program Income	$0.00

16. * IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES ○ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE:

b. NO ● PROGRAM IS NOT COVERED BY E.O. 12372; OR

○ PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. By signing this application, I certify (1) to the statements contained in the list of certifications* and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances * and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

● * I agree

** The list of certifications and assurances, or an Internet site where you may obtain this list, is contained in the announcement or agency specific instructions.*

18. SFLLL or other Explanatory Documentation. File Name: Mime Type:

19. Authorized Representative

Prefix:	* First Name:	Middle Name:	* Last Name:	Suffix:
Mr.	Richard	L.	Louth	

* Position/Title: Director
* Organization Name: New York University
Department: PROVOST
Division: Provost
* Street1: 665 Broadway, Suite 801
Street2:
* City: New York
County/Parish:
* State: NY: New York
Province:
* Country: USA: UNITED STATES
* ZIP / Postal Code: 10012-2331
* Phone Number: 212-998-2121
Fax Number: 212-995-4029
* Email: osp.agency@nyu.edu

*** Signature of Authorized Representative** *** Date Signed**

20. Pre-application File Name: Mime Type:

Project/Performance Site Location(s)

Project/Performance Site Primary Location

Organization Name: New York University		
* Street1: 665 Broadway, Suite 801		Street2:
* City: New York	County: New York	* State: NY: New York
Province:	* Country: USA: UNITED STATES	* Zip / Postal Code: 10012-2331
DUNS Number: 041968306	* Project/Performance Site Congressional District: NY-008	

File Name	Mime Type

Additional Location(s)

RESEARCH & RELATED Other Project Information

1. * Are Human Subjects Involved?	● **Yes** ❍ **No**	
1.a. If YES to Human Subjects		
Is the Project Exempt from Federal regulations?	❍ **Yes** ● **No**	
If yes, check appropriate exemption number		
Exemption Number:	__ 1 __ 2 __ 3 __ 4 __ 5 __ 6	
If no, is the IRB review Pending?	❍ **Yes** ● **No**	
IRB Approval Date:	02-02-2012	
Human Subject Assurance Number	00006386	
2. * Are Vertebrate Animals Used?	❍ **Yes** ● **No**	
2.a. If YES to Vertebrate Animals		
Is the IACUC review Pending?	❍ **Yes** ❍ **No**	
IACUC Approval Date:		
Animal Welfare Assurance Number		
3. * Is proprietary/privileged information included in the application?	❍ **Yes** ● **No**	
4.a. * Does this project have an actual or potential impact on the environment?	❍ **Yes** ● **No**	
4.b. If yes, please explain:		
4.c. If this project has an actual or potential impact on the environment, has an exemption been authorized or an environmental assessment (EA) or environmental impact statement (EIS) been performed?	❍ **Yes** ❍ **No**	
4.d. If yes, please explain:		
5.a. * Is the research performance site designated, or eligible to be designated, as a historic place?	❍ **Yes** ● **No**	
5.b. If yes, please explain:		
6.a. * Does this project involve activities outside the U.S. or partnership with International Collaborators?	❍ **Yes** ● **No**	
6.b. If yes, identify countries:		
6.c. Optional Explanation:		
7. * Project Summary/Abstract	projectSummaryFNL1011214293.pdf	Mime Type: application/pdf
8. * Project Narrative	projectNarrative1011214255.pdf	Mime Type: application/pdf
9. Bibliography & References Cited	Bibliography1011214400.pdf	Mime Type: application/pdf
10. Facilities & Other Resources	Facilities_resources1011214385.pdf	Mime Type: application/pdf
11. Equipment	Equipment1011214384.pdf	Mime Type: application/pdf
12. Other Attachments	Steele_eligibility_letter1011214369.pdf	Mime Type: application/pdf
12. Other Attachments	description_of_doctoral_program1011214394.pdf	Mime Type: application/pdf

Project Summary:

The long term goal of this project is to understand how the brain performs stream segregation, the grouping of the components of sounds emanating from different sources into distinct perceptual representation. Deficits in auditory grouping are quite common, even when basic hearing sensitivity is intact or assisted. Indeed, one common complaint for hearing aid users is an inability to distinguish sounds in noisy environments. This problem is unique to hearing – most visually impaired people don't experience difficulty with visual grouping or object recognition once basic acuity is restored, unless they have experienced a specific problem in development.

Unlike visual stimuli, which typically have a static representation, auditory stimuli typically must be coded in the time dimension – they are *dynamic*. The formation of auditory streams, similarly, is carried out over time. When listening to an auditory mixture with multiple components, for instance, one of Bach's fugues, it will typically take someone some time to be able to distinguish the different “voices” or streams composing it. With reduced stimuli developed for laboratory investigation of human perception, as in the well-known van Noorden ABA_ stimulus, researchers been able to identify some of the features that influence grouping. When the difference in frequency between A and B tones is small, and when the presentation rate is slow, subjects typically hear the pattern as an integrated stream composed of repeating triplets in a galloping rhythm. However, when the tones are sped up or the frequencies are far apart, subjects will hear the tones split into two segregated streams. Importantly, for intermediate stimulus features, the appropriate perceptual grouping is ambiguous. Segregation is not immediate, but rather seems to take time to “build up.” And, with long presentations of an ambiguous stimulus sequence, subjects will experience alternations between percepts.

The presence of perceptual bistability in extreme cases of ambiguity suggests that stream segregation is not a one-way process of accumulation of evidence toward segregation, but rather that alternative interpretations of the scene are maintained by the auditory system in neural networks that can undergo bistability. In fact, by studying the stochastic properties of alternations between auditory groupings, it is possible to obtain a very accurate prediction of the timecourse of segregation. By employing modeling techniques that are explicitly dynamic, we can elucidate the unique auditory processes that enable listeners to track objects in the auditory scene as they change over time. This project engages a three-pronged approach--stochastic modeling, in conjunction with mechanistic/neuronal modeling, in conjunction with psychophysics. Our approach is conceptually novel, challenging previous accounts of the buildup of stream segregation. Furthermore, this platform will enable the consideration of how dynamic changes in the auditory environment, e.g. context and the influence of previous exposure get encoded and maintained by the auditory system.

Project Narrative

Despite advances in interventions to improve hearing sensitivity-- e.g. hearing aids and cochlear implants-- deficits in stream segregation, e.g. listening in the presence of background noise, are extremely persistent, and in general these processes are not well understood. Problems with auditory grouping in general are present in non-hearing related communication disorders, such as dyslexia, and even in schizophrenia. This project will develop inexpensive, computationally driven techniques for describing and explaining listeners' dynamic abilities to segregate sounds in auditory scenes that change over time, and the neurobiological mechanisms that enable these abilities.

Facilities and resources:

John Rinzel will obtain a sound booth for his lab space, a 450 square foot office on the interior of the Meyer building. Installation is expected to be completed by mid-January. Until then, experiments are conducted in the sound booth in the Simoncelli laboratory space with Sennheiser headphones. This lab space is also where subject-related materials in the form of screening data and consent forms will be securely stored. I have access to this lab space at all times.

Proprietary software and technical support is available through Paul Fan, dedicated computer technician for the Center for Neural Science. A standalone MATLAB license has been issued for my personal computer.

Equipment:

The Rinzel lab will be delivered a 4x6 sound proof booth (equipped with monitor, dedicated computer and quality head phones) for auditory psychoacoustic experiments in January 2013; until then, experiments are conducted in the soundproof booth in the Simoncelli lab with Sennheiser headphones. I have a Rinzel lab computer, a Macbook Pro, for personal use with a standalone copy of MATLAB for developing experiments and analyzing data.

New York University
A private university in the public service

Richard Louth
Director, Office of Sponsored Programs
665 Broadway, Suite 801
New York, NY 10012-2331
Telephone: (212) 998-2121
Fax: (212) 995-4029
E-mail: osp.agencv@nyu.edu

December 13, 2012

National Institutes of Health
6001 Executive Boulevard
Room 5213, MSC 9561
Bethesda, Maryland 20892-9561

Re: PA-11-112, Ruth L. Kirschstein National Service Awards for Individual Predoctoral Fellowships to Promote Diversity in Health-Related Research for **Sara Steele**

Dear Review Committee,

On behalf of New York University, I confirm that Ms. Sara Steele is eligible to apply for Ruth L. Kirschstein National Service Awards for Individual Predoctoral Fellowships to Promote Diversity in Health-Related Research.

Please contact me if you have any questions or require additional clarification.

Sincerely,

Richard L. Louth
Authorized Official
Director, NYU Office of Sponsored Programs

Description of Graduate Program:

New York University, Center for Neural Science

Philosophy

The Center for Neural Science is the focus for teaching and research in the brain sciences at the Washington Square Campus of New York University. Formed in 1987, the Center has been a department of the Faculty of Arts and Science since 1994.

Neural science is a collection of disciplines unified by a concern for the function of the brain. Experimental approaches in neural science vary from analyses of molecular and cellular mechanisms in nerve cells and groups of nerve cells to behavioral and psychological studies of whole organisms. Theoretical tools include mathematical and computational modeling approaches that have proved useful in other areas of science. Experimental questions include issues related to biophysical and neurochemical mechanisms within single nerve cells, functional neural circuits consisting of small numbers of neurons, the behavior of large systems of neurons, and the relationship between the activity of elements of the nervous system and the behavior of organisms.

Empirical work at every level of investigation benefits from fruitful interaction with a unique and distinguished group of theorists, including a visual science group associated with the Sloan-Swartz Center for Theoretical Visual Neuroscience. The Center also benefits from the outstanding academic environment at the Washington Square Campus, including major research programs in the Courant Institute of Mathematical Sciences, and in the Departments of Biology, Chemistry, Physics, and Psychology. (Adapted from www.cns.nyu.edu/doctoral)

Core Curriculum

All students are required to take the 28-credit core curriculum, normally in the two semesters of the first year. This curriculum consists of lecture and laboratory courses taught by a team of Center faculty members who provide in-depth treatment of all major areas in neuroscience.

This core consists of Math Tools for Neural Scientists, Cell and Molecular Neuroscience, Cell/Molecular Neuroscience lab, Sensory and Motor Systems, Cognitive Neuroscience, and Laboratory in Anatomy and Systems Neuroscience.

Advanced Curriculum

CNS requires 3 advanced courses that are individually tailored to help the student gain expertise specifically in his or her research field. Courses are chosen in collaboration with an advisory committee the student forms during his/her second year of graduate training, and they can be within any NYU or NYU Medical Center department, or from another university in Manhattan (through an Inter-University Consortium) if it benefits the research project. I have taken “Introduction to computational modeling of neural systems” with John Rinzel, “Perception” with David Heeger and Mike Landy, and “Special topics in signal processing: Brain-computer interfaces,” and I am currently sitting in on and informally assisting with Rinzel's “Perceptual Dynamics” course.

Seminar series, student oral and written presentations

Graduate students participate in a weekly seminar series during the academic year in which invited guest speakers present their research. Students present their own research to the department in a formal talk of 10-15 minutes after their first and third years. At the end of the second year of graduate training, students write a 15-page research proposal and literature review indicating the direction his/her thesis will be taken. This proposal will be refined to later become the thesis proposal.

Doctoral Dissertation

At the end of the first year, students form an advisory committee including at least 3 professors other than the thesis advisor. This committee meets once per semester and tracks the students’ progress in both the academic and research realm. Once the thesis focus is clarified, the student presents an oral and written presentation of their research plan, preliminary data, and an outline detailing how they will proceed to complete the thesis in a timely manner. At this time, a thesis committee is formed, which can be the same or different from the advisory committee depending on who has the expertise to best guide the student through his/her research. The final examination is the oral defense of the thesis. The thesis committee and 2 additional members must vote to accept the thesis and its defense. The thesis defense is passed if at least all but one of the examiners votes to accept.

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

PROFILE - Project Director/Principal Investigator

Prefix	* First Name	Middle Name	* Last Name	Suffix
	Sara		Steele	

Position/Title:

Department: Center for Neural Science

Organization Name: New York University

Division: FAS

* Street1: 4 Washington Place

Street2: Room 1023

* City: New York

County: New York

* State: NY: New York Province:

* Country: USA: UNITED STATES

* Zip / Postal Code: 10003-6603

*Phone Number	Fax Number	* E-Mail
2129983920		sas756@nyu.edu

Credential, e.g., agency login: SAS756.NYU

*** Project Role:** PD/PI

Other Project Role Category:

Degree Type:

Degree Year:

	File Name	Mime Type
***Attach Biographical Sketch**	biosketch_Steele1011214219.pdf	application/pdf
Attach Current & Pending Support		

PROFILE - Senior/Key Person

Prefix	* First Name	Middle Name	* Last Name	Suffix
	John		Rinzel	

Position/Title: Professor

Department: Center for Neural Science

Organization Name: New York University

Division: FAS

* Street1: 4 Washington Place

Street2: Room 521

* City: New York

County: New York

* State: NY: New York Province:

* Country: USA: UNITED STATES

* Zip / Postal Code: 10003-6603

*Phone Number	Fax Number	* E-Mail
212-998-3308	212-995-4011	rinzel@cns.nyu.edu

Credential, e.g., agency login: rinzeljm

*** Project Role:** Other (Specify)

Other Project Role Category: Sponsor

Degree Type: PhD

Degree Year:

	File Name	Mime Type
***Attach Biographical Sketch**	bios- ketch_JR_NRSA_20121011214298.pdf	application/pdf
Attach Current & Pending Support		

PROFILE - Senior/Key Person

Prefix	* First Name	Middle Name	* Last Name	Suffix
	Elyse	Suzanne	Sussman	PhD

Position/Title: Professor

Department: Neuroscience & Otorhinolaryngo

Organization Name: Albert Einstein College of Medicine | Division:

* Street1: 1410 Pelham Parkway South | Street2: Room 210

* City: Bronx | County: | * State: NY: New York Province:

* Country: USA: UNITED STATES | * Zip / Postal Code: 10461-1116

*Phone Number	Fax Number	* E-Mail
718.430.3313		elyse.sussman@einstein.yu.edu

Credential, e.g., agency login: esussman

*** Project Role:** Other (Specify) | **Other Project Role Category:** Co-Sponsor

Degree Type:
Degree Year:

	File Name	Mime Type
***Attach Biographical Sketch**	Biosketch_Sussman_Steele1011214251.pdf	application/pdf
Attach Current & Pending Support		

RESEARCH & RELATED Senior/Key Person Profile (Expanded)

Additional Senior/Key Person Form Attachments

When submitting senior/key persons in excess of 8 individuals, please attach additional senior/key person forms here. Each additional form attached here, will provide you with the ability to identify another 8 individuals, up to a maximum of 4 attachments (32 people).

The means to obtain a supplementary form is provided here on this form, by the button below. In order to extract, fill, and attach each additional form, simply follow these steps:

- Select the "Select to Extract the R&R Additional Senior/Key Person Form" button, which appears below.
- Save the file using a descriptive name, that will help you remember the content of the supplemental form that you are creating. When assigning a name to the file, please remember to give it the extension ".xfd" (for example, "My_Senior_Key.xfd"). If you do not name your file with the ".xfd" extension you will be unable to open it later, using your PureEdge viewer software.
- Using the "Open Form" tool on your PureEdge viewer, open the new form that you have just saved.
- Enter your additional Senior/Key Person information in this supplemental form. It is essentially the same as the Senior/Key person form that you see in the main body of your application.
- When you have completed entering information in the supplemental form, save it and close it.
- Return to this "Additional Senior/Key Person Form Attachments" page.
- Attach the saved supplemental form, that you just filled in, to one of the blocks provided on this "attachments" form.

Important: Please attach additional Senior/Key Person forms, using the blocks below. Please remember that the files you attach must be Senior/Key Person Pure Edge forms, which were previously extracted using the process outlined above. Attaching any other type of file may result in the inability to submit your application to Grants.gov.

1) Please attach Attachment 1

2) Please attach Attachment 2

3) Please attach Attachment 3

4) Please attach Attachment 4

ADDITIONAL SENIOR/KEY PERSON PROFILE(S)	**Filename**	
	MimeType	
Additional Biographical Sketch(es) (Senior/Key Person)	**Filename**	
	MimeType	
Additional Current and Pending Support(s)	**Filename**	
	MimeType	

Tracking Number:

FELLOWSHIP APPLICANT BIOGRAPHICAL SKETCH

USE ONLY FOR INDIVIDUAL PREDOCTORAL and POSTDOCTORAL FELLOWSHIPS. DO NOT EXCEED FOUR PAGES.

NAME OF FELLOWSHIP APPLICANT	POSITION TITLE
Sara A. Steele	PhD Candidate
eRA COMMONS USER NAME (credential, e.g., agency login) SAS756.NYU	

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Columbia University, New York, NY	BA	2006-2010	Neuroscience & Behavior
New York University, New York, NY	PhD	2010-now	Center for Neural Science

A. Personal Statement

My intent in seeking a doctoral training at NYU and pursuing a research career is to be able to explain how perceptual experience arises as a consequence of the computations of neural systems. In particular, I am compelled by the idea that perception is not simply a hard translation of physical signals into a neural code, but rather that the same physical world can result in a variety of perceptual experiences depending on time, previous experience, attention, and motivation. Perception, therefore, requires a framework for unifying the contributions of many complex processes. I believe that this framework, the key to understanding the link between the world, the activity of neurons and the behavior of organisms, is computation.

My specific interest is developing statistical and mechanistic models that simulate the behavior of listeners engaged in a stream segregation task, in which subjects must use the information provided to the auditory system to determine how many sources are producing the sound mixtures in an auditory scene. This work will provide a better understanding of how the auditory system works in dynamically changing auditory scenes. Our novel quantitative explanations of stream segregation should provide a common framework for the influence of different factors, such as previous perceptual state and context, on auditory perception.

I believe my training and research will be successful on account of my current expertise, my diverse abilities, and my motivation. I can demonstrate an excellent academic record with coursework in language and music alongside neuroscience. In addition, I have ample research experience, having designed and completed my own psychophysical experiments in both undergraduate and graduate research groups. Although this is the beginning of my career and my training is yet incomplete, my work with my sponsor has already begun to be productive, with my first poster at SfN this year. Another strength that I believe will contribute to my immediate and long-term success is my ability to create and engage in community, collaboration and interdisciplinary discourse. Alongside my own virtues, I have the advantage of an excellent community within my department, my institution, and with neighboring institutions and organizations.

I aspire to a long and productive research career, and have been extremely fortunate to receive the opportunities I have in terms of education and mentors. I am deeply excited about the training plan laid out herein, and look forward to carrying it out to the best of my ability.

B. Positions and Honors

ACTIVITY/OCCUPATION	BEGINNING DATE (mm/yy)	ENDING DATE (mm/yy)	FIELD	INSTITUTION/COMPANY	SUPERVISOR/ EMPLOYER
Teaching Assistant	09/2011	12/2011	Non-major undergrad	NYU Morse Academic Plan	Wendy Suzuki, PhD
Research Assistant	06/2010	9/2010	Computational vision	Lab for Computational Vision, NYU	Eero Simoncelli, PhD (HHMI)
Teaching Assistant	09/2008	5/2010	Computer Lab	Columbia University Psychology Dept.	Lois Putnam, PhD

Other Professional Memberships

2006- Member, Columbia Neuroscience Society
2008- Founding member, New York Consciousness Collective (musical association)
2010- Member, Society for Neuroscience
2010- Founding member, The Space Clamps
2010- Curator, Center for Neural Science Film Society
2010- Founding member, CNS Computational Workshop

Academic and Professional Honors

McCracken Fellow
National Merit Scholar
James E Casey Scholarship recipient

C. Publications

Steele S.A., Tranchina D., Rinzel J. (2012). A statistical dynamic model for buildup of stream segregation with an ambiguous ABA auditory stimulus. In *Society for Neuroscience Abstracts. Poster.*

Bornstein A.M., Nylen E.L., **Steele S.A.** (2011). Unblocking the neural substrates of model-based value. Journal of Neuroscience, 31(28):10117-10118.

Steele S. A., Lau H. *In prep.* The function of consciousness in controlling behavior. *Joint Attention and Agency*. Eds H. Terrace & J. Metcalfe. Oxford University Press

D. Scholastic Performance

Graduate: NYU

YEAR	SCIENCE COURSE TITLE	GRADE	YEAR	OTHER COURSE TITLE	GRADE
2012	Brain Computer Interfaces (Polytechnic)	A	**2010**	Math Tools for Neuroscientists	A
2012	Special topics: Computational Models	A-	**2011**	Ethics Workshop for Emerging Scientists	Pass
2011	Perception	A			
2011	Sensory & Motor Systems	A			
2011	Behavioral & Cognitive Neuroscience	A-			
2011	Lab in Neural Science II	A-			
2010	Cellular, Molecular, Developmental Ns	A			
2010	Lab Neural Science I	A			

Undergraduate: Columbia

YEAR	SCIENCE COURSE TITLE	GRADE	YEAR	OTHER COURSE TITLE	GRADE
2010	Supervised Individual Research	A	**2010**	Russian theater workshop	A-
2009	Organic Chemistry	B+	**2010**	Third Year Russian II	B+
2009	Developmental Biology	A	**2010**	Discourse Analysis	A+

YEAR	SCIENCE COURSE TITLE	GRADE	YEAR	OTHER COURSE TITLE	GRADE
2009	Language & Music	A-	**2010**	Masterpieces of Western Art	A-
2009	Neurobio II: Development & Systems	A-	**2010**	Novel in the US/USSR 1925	C
2009	Supervised Individual Research	A+	**2010**	Linear Algebra	D
2008	Philosophical/Empirical Issues in Consciousness (NYU)	A	**2009**	Third Year Russian I	B+
2008	Social/Cognitive Neuroscience	B+	**2009**	Masterpieces of Western Music	A
2008	Neurobio I: Cell & Molecular	B-	**2009**	Theatricality in Russian Culture	A
2008	Evolution of Cognition	A	**2009**	Second Year Russian II	B
2008	Intro- Cellular/Molecular Biology II	A-	**2009**	Buddhism: East Asian	A-
2007	The Science of Psychology	A	**2009**	Ear Training I	A+
2007	Intro-Cellular/Molecular Biology I	B+	**2008**	Second Year Russian I	B
2007	Frontiers of Science	A-	**2008**	Principles of Economics	Pass
2007	General Chemistry II	B-	**2008**	First Year Russian II	B
2006	General Chemistry I	A	**2008**	Fundamentals of Western Music	A
2006	Mind, Brain, & Behavior	A+	**2007**	Contemporary Western Civilization II	A-
			2007	Calculus III	B
			2007	Creative Writing: Structure & Style	A+
			2007	First Year Russian I	B
			2007	Contemporary Western Civilization I	A
			2007	Statistics for Behavioral Scientists	A-
			2007	Literature Humanities II	A
			2007	Intro to East Asian Civilization: Japan	A-
			2006	Literature Humanities I	A
			2006	University Writing	A-
			2006	Russian Literature & Empire	A-

GRE scores (2010): 770 Verbal, 790 Quantitative, 4.5 Writing

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME John Rinzel	POSITION TITLE Professor of Neural Science & Mathematics (NYU)
eRA COMMONS USER NAME (credential, e.g., agency login) rinzeljm	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	MM/YY	FIELD OF STUDY
University of Florida, Gainesville, FL	B.S.	05/67	Engineering Science
New York University, New York NY	M.S.	10/68	Applied Mathematics
New York University, New York NY	Ph.D.	05/73	Applied Mathematics

A. Personal Statement

The goals of the proposed training are to develop skills and knowledge for the PhD student, Sara Steele, in computational modeling and psychoacoustics so that she can formulate, implement and analyze, models and experimental protocols for auditory scene analysis. The propose research will focus on the dynamics of auditory perception for ambiguous scenes. We will develop computational and mechanistic models in parallel with performing psychophysical experiments on human subjects for a widely-studied paradigm, the alternating triplet pattern of ABA_ABA_ tone sequences. I have 40 years of research and training experience, as a computational neuroscientist, investigating and modeling the dynamics of neuronal systems, and, continuously, in auditory processing for the past 15 years. I have sponsored over 40 postdocs and PhD students in computational and experimental neuroscience (including in vitro electrophysiology of auditory brainstem, since 1999, and psychophysics of visual perceptual bistability, since 2004). In 2011, I dedicated my sabbatical year (supported by a K-18 NIDCD Research Career Development award) to developing skills and knowledge in auditory psychoacoustics and perception, mentored by Dr. E Sussman and Dr. S Shamma. I developed software, performed experiments and gathered data on the bistability dynamics for ABA_ABA_ and formulated models and ran simulations on the dynamics. I have worked successfully with S Steele over the recent months in applying a novel model to already publish and to our preliminary behavioral data for the buildup phenomena. We are setting up a sound booth in my lab for the behavioral experiments. We have the resources and skills for the training of Steele and for the research that she proposes. The co-sponsoring by Dr. E Sussman (Albert Einstein College of Medicine) will complement and enhance both the training and research components of the endeavor. I have established a fruitful working relationship with Dr. Sussman during my sabbatical year.

B. Positions and Honors

<u>Positions and Employment</u>

1968-70,
1973-75 Mathematician, Division of Computer Research and Technology, National Institutes of Health
1975-97 Chief and Research Mathematician, Mathematical Research Branch, NIDDK, National Institutes of Health (Chief, '81-'97)
1997- Professor, Center for Neural Science and Courant Institute of Mathematical Sciences, New York University

<u>Adjunct/Visiting Appointments include (among others)</u>

1980 Dept Math, University of British Colombia (6-month sabbatical)

1975-1979,
1989-1997 Dept of Math, University of Maryland, College Park
1995-1997 Dept of Biomedical Engineering, Johns Hopkins University
1998- Laboratory of Biological Modeling, NIDDK, National Institutes of Health
2002 Mathematical Biosciences Institute, Ohio State University (4 month leave from NYU)
2010- Chair Professor, Center of Neural and Cognitive Computation, TNLinst, Tsinghua University, Beijing

Other Experience and Professional Memberships

AMS-SIAM Committee on Mathematics in the Life Sciences, 1983-2002.

Program Committee: Computation and Neural Systems Meetings, 1993-1995.

SIAM Activity Group on Life Sciences, Vice-Chair, 2003-2005; Chair, 2005-2007.

Organizing Committee: Year in Mathematical Neuroscience at Mathematical Biosciences Institute, Ohio State University, 2002-2003 and 2012-2012.

Board of Governors, Mathematical Biosciences Institute, Ohio State University, 2002-2005
Member of: Acoustical Society of America, American Association for the Advancement of Science, Society for Industrial and Applied Mathematics (SIAM). Society for Mathematical Biology, Society for Neuroscience

Honors

1986 USPHS, Medal of Citation; 1992 USPHS, Outstanding Service Medal

Aisenstadt Chair, Centre de Recherhces Mathematiques, Montreal, 2007.

D.G. Marquis Award as co-author of the best paper published in Behavioral Neuroscience in 2011

C. Selected peer-reviewed publications (out of 129 total peer-reviewed pubs)

Most relevant to the current application

Shpiro A, Moreno-Bote R, Rubin N, **Rinzel J:** Balance between noise and adaptation in competition models of perceptual bistability. *J Comput Neurosci* **27**: 37-54, 2009.

Moreno-Bote R, Shpiro A, **Rinzel J,** Rubin N: Alternation rate in perceptual bistability is maximal at and symmetric around equi-dominance. *J Vision* **10(11):** 1–18, 2010.

Mathews PJ, Jercog P, **Rinzel J,** Scott LL, Golding NL: Control of submillisecond synaptic timing in binaural coincidence detectors by Kv1 channels. *Nature Neurosci* **13**: 601-609, 2010. PMC3375691.

Jercog P, Svirskis G, Kotak V, Sanes D, **Rinzel J:** Asymmetric excitatory synaptic dynamics underlie interaural time difference processing in the auditory system. *PLoS Biology* **8**: 6, e1000406, 2010. PMC2893945

Matell MS, Shea-Brown E, Gooch C, Wilson AG, **Rinzel J**: A heterogeneous population code for elapsed time in rat medial agranular cortex. *Behav Neurosci*. **125**:54-73, 2011. PMC3078766

Additional recent publications of importance to the field (in chronological order)

Rinzel J, Terman D, Wang X-J, Ermentrout B: Propagating activity patterns in large-scale inhibitory neuronal networks, *Science* **279**:1351-1355, 1998.

Agmon-Snir H, Carr CE, **Rinzel J**: A case study for dendritic function: improving the performance of auditory coincidence detectors, *Nature* **393**:268-272, 1998.

Svirskis G, Kotak V, Sanes DH, **Rinzel J:** Enhancement of signal-to-noise ratio and phase locking by a low threshold outward current in auditory neurons. *J Neurosci* **22**:11019-11025, 2002.

Svirskis G, Kotak V, Sanes D, **Rinzel J:** Sodium along with low threshold potassium currents enhance coincidence detection of subthreshold noisy signals in MSO neurons. *J Neurophys* **91**:2465-2473, 2004.

Shea-Brown ET, **Rinzel J**, Rakitin BC, Malapani C: A firing-rate model of Parkinsonian deficits in interval timing. *Brain Res* **1070**: 189-201, 2006.

Moreno-Bote R, **Rinzel J,** Rubin N: Noise-induced alternations in an attractor network model of perceptual bistability. *J Neurophysiol* **98**: 1125-1139, 2007.
Shpiro A, Curtu R, **Rinzel J**, Rubin N: Dynamical characteristics common to neuronal competition models. *J Neurophysiol* **97**: 462-73, 2007. PMC2702527
Gai Y, Doiron B, Kotak V, **Rinzel J:** Noise-gated encoding of slow inputs by auditory brainstem neurons with a low-threshold K+ current. *J Neurophysiol*, **102**: 3447-3460, 2009. PMC2804414
Gai Y, Doiron B, Kotak V, **Rinzel J:** Slope-based stochastic resonance: How noise enables phasic neurons to encode slow signals. *PLoS Comput Biology*, **6(6):**1-15, e1000825, 2010.
Marti D, **Rinzel J:** Dynamics of Perceptual Categorization. *Neural Computation* in press.

D. Research Support

Ongoing Research Support

R01 DC008543-01 Rinzel (PI) 09/01/07 - 08/31/12, NCE to 8/31/13
Biophysical Specializations Enrich Temporal Selectivity of MSO Neurons
Goals are to test hypotheses about dynamical and biophysical mechanisms at the cellular level for neuronal temporal processing in the auditory brain stem, particularly in the medial superior olive. The study includes experimental (in vitro, gerbil) and computational components (mechanistic and information processing models).
Role: PI

New York University Research Challenge Fund Rinzel (PI) 06/01/12 – 5/31/13.
Dynamics of Auditory Streaming.
This grant is supporting the purchase of a sound proof booth, and some subject compensation, for the psychophysical experiments that will be conducted in the Rinzel lab on the dynamics of streaming and perceptual alternations for ambiguous stimuli.
Role: PI

Completed Research Support

R01 MH62595-01 Rinzel (PI) 04/01/01-3/31/05
Nonlinear Dynamics of Neuronal Temporal Processing.
We tested hypotheses about dynamical and biophysical mechanisms for neuronal temporal processing in inferior colliculus auditory brain stem. The projects involved mechanistic modeling of neurons and electrophysiology (in vitro, gerbil).
Role: PI

NIH/NIDCD, DC011602-01 Rinzel (PI) 04/01/2011 - 3/31/2012
K-18 Career Development Award for Established Investigators: Bistability and alternating streams during perceptual ambiguity. Mentors: Dr. E Sussman (human psychophysics with EEG, Albert Einstein College of Medicine) and Dr. S Shamma (electrophysiology in auditory cortex of awake ferrets, performing tasks).

Swartz Foundation Grant for Computational Neuroscience Rinzel & Rubin (co-PIs) 01/25/05-01/24/08
Dynamics and Mechanistic Models of Perceptual Bistability: Binocular Rivalry and Plaids
We developed, analyzed, and tested (simulation and psychophysics) mechanistic models for the rhythmic alternation of 2 or more perceptions in visually presented ambiguous stimuli.
Role: Co-PI.

Swartz Foundation Grant for Computational Neuroscience Rinzel (PI) 11/24/08-11/23/11, 09/01/11-08/31/12
Computational Modeling of Cognitive Dynamics
Goal is to develop, analyze, and interpret mechanistic models for the dynamics of perception and cognition during various tasks: perceptual search and grouping, segmentation, and sudden-insight problem-solving.
Role: PI

BIOGRAPHICAL SKETCH

NAME Elyse Suzanne Sussman	POSITION TITLE Professor of Neuroscience and Otorhinolaryngology-HNS
eRA COMMONS USER NAME esussman	

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Hofstra University, Hempstead, NY	Bs.Ed.	1975-79	Music Education
Harvard University, Cambridge, MA	Ed.M.	1979-80	Psychology/Reading
Graduate Center of the City Univ of NY	Ph.D.	1994-1998	Psychology
Albert Einstein College of Medicine, NY	Postdoc	1998-1999	ERPs, Cog Neuro
Graduate Center of the City Univ of NY	Postdoc	1999-2000	ERPs, Cog Neuro

A. Personal Statement

My research, in the area of cognitive neuroscience, is focused on understanding the neurobiological basis of auditory scene perception, from infancy to adulthood. One of the main goals of this research is to link markers of brain function with standard behavioral measures of perception and attention during the development of auditory perceptual abilities.

B. Positions and Honors

<u>Positions and employment</u>

1995-1996	Adjunct Instructor, City College, City University of New York,
1995-1997	Research Assistant Albert Einstein College of Medicine, Bronx, NY
1998-1999	Research Associate Albert Einstein College of Medicine, Bronx, NY
1999-2000	Postdoctoral Fellow, NIH-NIDCD, City University of New York, NY
1998-2001	Visiting Researcher, Cognitive Brain Research Unit, Helsinki University, Finland
2000-2005	Assistant Professor, Albert Einstein College of Medicine, Bronx, NY
2005-2010	Associate Professor, Albert Einstein College of Medicine, Bronx, NY
2005-	Adjunct, Program in Speech-Language-Hearing Sciences, Graduate Center of the City University of New York, NY
2008-	Adjunct, Department of Otolaryngology, New York University, New York, NY
2010-	Professor, Departments of Neuroscience and Otorhinolaryngology, Albert Einstein College of Medicine, Bronx, NY

<u>Professional memberships and activities</u>

2000-pres	Member, Cognitive Neuroscience Society
2004-pres	Member, Society for Neuroscience
2002-pres	Senate of the Albert Einstein College of Medicine (AECOM)
2002-pres	Steering Committee, Institute for Human Communications, Montefiore Medical Center
2009-pres	Senate Council, AECOM
2010-2016	Member, NIH Mechanisms of Sensory, Perceptual, and Cognitive Processes (SPC) Study Section

<u>Honors and awards</u>

1994 Teacher-As-Researcher Award, Northeastern Educational Research Association

1999 Human Frontier Science Program Fellow “Developing an attention-free indicator of auditory streaming”. Hungarian Academy of Sciences, Budapest, Hungary.

2000 James A. Shannon Director's Award, National Institute on Deafness and Other Communication Disorders.

2012 National Institutes of Health (Grant R13DC012029, PI: E. Sussman), Sixth Conference on Mismatch Negativity and its Clinical and Scientific Applications. May 1-4, 2012, CUNY, New York

C. Selected Peer Review Publications (selected from 60 peer-reviewed publications**)**

<u>Most relevant to the current application</u>

1. Sussman, E. (2007). A new view on the MMN and attention debate: Auditory context effects. <u>Journal of</u> *Psychophysiology*, 21(3-4), 164-175.

2. Sussman, E. (2005). Integration and segregation in auditory scene analysis. *Journal of the Acoustical Society of America*, 117(3), 1285-1298.

3. Sussman, E. & Steinschneider, M. (2006). Neurophysiological evidence for context-dependent encoding of sensory input in human auditory cortex. *Brain Research*, 1075(1), 165-174.

4. Rahne, T. & Sussman, E. (2009). Neural representations of auditory input accommodate to the context in a dynamically changing acoustic environment. *European Journal of Neuroscience,* 29(1), 205-11.

5. Sussman, E., Bregman, A. S., Wang, W.J., & Khan, F.J. (2005). Attentional modulation of electrophysiological activity in auditory cortex for unattended sounds in multistream auditory environments. *Cognitive, Affective, & Behavioral Neuroscience*, 5(1), 93-110.

<u>Additional recent publications of importance to the field (in chronological order)</u>

1. Sussman, E. & Winkler, I. (2001). Dynamic sensory updating in the auditory system. *Cognitive Brain Research. 12*, 431-439.

2. Sussman, E., Sheridan, K., Kreuzer, J., & Winkler, I. (2003). Representation of the standard: Stimulus context effects on the process generating the mismatch negativity component of event-related brain potentials. *Psychophysiology*, 40, 465-471.

3. Sussman, E., Ritter, W., & Vaughan, H.G., Jr. (1998). Attention affects the organization of auditory input associated with the mismatch negativity system. *Brain Research*, *789*, 130-38.

4. Sussman, E., Ritter, W., & Vaughan, H.G., Jr. (1999). An investigation of the auditory streaming effect using event-related brain potentials. *Psychophysiology, 36*, 22-34.

5. Rimmele, J., Jolsvai, H., & Sussman, E. (2011). Auditory target detection is affected by implicit temporal and spatial expectations. *Journal of Cognitive Neuroscience,* 23(5), 1136–1147.

6. Näätänen, R., Tervaniemi, M., Sussman, E., Paavilainen, & Winkler, I. (2001). "Primitive intelligence" in the auditory cortex. *Trends in Neuroscience, 24,* 283-288.

7. Winkler, I., Kushnerenko, H., Horváth, J., Čeponienė, R., Fellman, V., Huotilainen, M., Näätänen, R. & Sussman, E. (2003). Newborn infants can organize the auditory world. *Proceedings of the National Academy of Sciences*, 100 (20), 1182-1185.

8. Sussman, E., Winkler, I., & Schröger, E. (2003). Top-down control over involuntary attention-switching in the auditory modality. *Psychonomic Bulletin & Review*, *10(3)*, 630-637.

PHS Fellowship Supplemental Form

OMB Number: 0925-0002

A. Application Type:

From SF424 (R&R) Cover Page. The response provided on that page, regarding the type of application being submitted, is repeated here for your reference as you provide the responses that are appropriate for this Fellowship application.

[X] New [ ] Resubmission [ ] Renewal [ ] Continuation [ ] Revision

B. Research Training Plan

1. Introduction to Application *(for RESUBMISSION applications only)*	
2. * Specific Aims	specific_aimsFNL
3. * Research Strategy	Research StrategyFNL
4. Inclusion Enrollment Report *(for RENEWAL applications only)*	
5. Progress Report Publication List *(for RENEWAL applications only)*	

Human Subjects

Please note. The following item is taken from the Research & Related Other Project Information form. The response provided on that page, regarding the involvement of human subjects, is repeated here for your reference as you provide related responses for this Fellowship application. If you wish to change the answer to the item shown below, please do so on the Research & Related Other Project Information form; you will not be able to edit the response here.

Are Human Subjects Involved? [X] Yes [ ] No

6. * Human Subjects Involvement Indefinite? [ ] Yes [X] No

7. Clinical Trial? [ ] Yes [X] No

8. Agency-Defined Phase III Clinical Trial? [ ] Yes [ ] No

9. Protection of Human Subjects	protection of human subjects
10. Inclusion of Women and Minorities	women&minorities
11. Targeted/Planned Enrollment	TPETForm
12. Inclusion of Children	Inclusion of children

Other Research Training Plan Sections

Please note. The following item is taken from the Research & Related Other Project Information form. The response provided on that page, regarding the use of vertebrate animals, is repeated here for your reference as you provide related responses for this Fellowship application. If you wish to change the answer to the item shown below, please do so on the Research & Related Other Project Information form; you will not be able to edit the response here.

Are Vertebrate Animals Used? [ ] Yes [X] No

13. * Vertebrate Animals Use Indefinite? [ ] Yes [ ] No

14. Vertebrate Animals	
15. Select Agent Research	
16. Resource Sharing Plan	
17. * Respective Contributions	respective contributions
18. * Selection of Sponsor and Institution	choice of sponsor&institution_FINA
19. * Responsible Conduct of Research	RCR

PHS Fellowship Supplemental Form

C. Additional Information

Human Embryonic Stem Cells

1. * Does the proposed project involve human embryonic stem cells? ☐ Yes ☒ No

If the proposed project involves human embryonic stem cells, list below the registration number of the specific cell line(s), using the registry information provided within the agency instructions. Or, if a specific stem cell line cannot be referenced at this time, please check the box indicating that one from the Registry will be used:

☐ Specific stem cell line cannot be referenced at this time. One from the registry will be used.

Cell Line(s):

Fellowship Applicant

2. Alternate Phone Number: 2014079451

3. Degree Sought During Proposed Award:

Degree:	If "other", please indicate degree type:	Expected Completion Date (month/year):
PHD : Doctor of Philosophy		08/2016

4. * Field of Training for Current Proposal: 2800 NEUROSCIENCE

5. * Current Or Prior Kirschstein-NRSA Support? ☐ Yes ☒ No

If yes, please identify current and prior Kirschstein-NRSA support below:

* Level	* Type	Start Date *(if known)*	End Date *(if known)*	Grant Number *(if known)*

6. * Applications for Concurrent Support? ☐ Yes ☒ No

If yes, please describe in an attached file:

7. * Goals for Fellowship Training and Career: Career & Training Goals

8. * Activities Planned Under This Award: activities planned

9. Doctoral Dissertation and Other Research Experience: research experience

10. * Citizenship:

☒ U.S. Citizen or noncitizen national

☐ Permanent Resident of U.S. Pending

☐ Permanent Resident of U.S.
(If a permanent resident of the U.S., a notarized statement must be provided by the time of award)

☐ Non-U.S. Citizen with temporary U.S. visa

PHS Fellowship Supplemental Form

C. Additional Information (continued)

Institution

11. ☐ Change of Sponsoring Institution

Name of Former Institution:

D. Sponsor(s) and Co-Sponsor(s)

* Sponsor(s) and Co-Sponsor(s) Information

SponsorInfo_JRonSteeleNRSAv2

E. Budget

All Fellowship Applicants:

1. * Tuition and Fees:

☐ None Requested ☒ Funds Requested:

Year 1	16,000
Year 2	16,000
Year 3	16,000
Year 4	
Year 5	
Year 6 *(when applicable)*	
Total Funds Requested:	48,000

Senior Fellowship Applicants Only:

	Amount	Academic Period	Number of Months
2. Present Institutional Base Salary:			

3. Stipends/Salary During First Year of Proposed Fellowship:

	Amount	Number of Months
a. Federal Stipend Requested:		
b. Supplementation from other sources:		

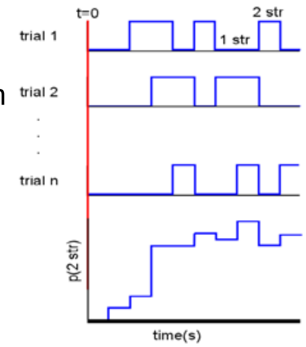
Type (sabbatical leave, salary, etc.)

Source

F. Appendix

SPECIFIC AIMS

Listening to someone's voice in a crowded room is a difficult task in many circumstances, but especially so for the hearing impaired. Behavioral and electrophysiological studies aimed at understanding how we distinguish sounds in an auditory scene have documented that segregation of distinct sound sources, stream segregation, takes time to build up. We use a well-documented ABA_ stimulus for which probability of segregation can be easily manipulated via stimulus parameters DF, the difference in frequency between A and B pure tones, and PR, presentation rate. For intermediate parameters, subjects initially hear the tones grouped in an integrated percept, and only after some time do they split into segregated streams. Importantly, these ambiguous stimuli elicit perceptual bistability, a feature we exploit to produce a novel account of buildup.



Schematic of a buildup function. The smooth increase in segregation over time is actually a consequence of averaging random switches from a fixed starting state

Our goal is to attack the stream segregation problem with new computational methods for data analysis and modeling. Our working hypothesis is that the **neural populations which subserve stream segregation can demonstrate bistability between two different representations of an auditory scene,** corresponding to integration or segregation, even though the input is not changing. We have used this feature to develop a novel statistical model to describe the dynamics of buildup. With this model, we relate the time course of a listener to achieve segregation for an ambiguous stimulus to the dominance durations for each percept. Using the tools of dynamical systems analysis, we propose neuronal-like processes that are sufficient to reproduce these properties.

The work proposed in Aims 1-3 is expected to produce novel descriptions and explanations for the dynamics of stream segregation. The positive impact of these results are many and varied; first and foremost, we reject the assumption that buildup necessarily reflects a gradual accumulative process. We demonstrate that the apparent steady increase in probability of segregation over time is really just an artifact of averaging over events which occur suddenly, but randomly. In addition to providing an alternative explanation for buildup, this research will enable new methods for identifying and measuring both stimulus-driven and central processes driving segregation, like strength of streaming cues, timescales of adaptation, context, and memory.

Aim 1: An alternating renewal process (ARP) can account for the time course of *buildup*, the increased probability of stream segregation over time. The model suffices without invoking any mechanism for evidence accumulation.

We believe that the buildup psychometric function, rather than reflecting accumulation, is just the consequence of averaging over trials of the random and independent switching between two perceptual organizations. Using the model of an alternating renewal process, we demonstrate that the independent distributions of percept durations are the determining factors for describing the buildup psychometric function. The model is consistent with preliminary results from our experiments with both long and short trials with an ambiguous auditory stimulus.

Aim 2: Neural competition networks are sufficient to reproduce psychophysical results as well as the behavior of the ARP model.

Preliminary results from an idealized neuronal-like competition model show good correspondence with the empirical behavioral data. Additionally, we were able to achieve excellent accounting of the competition model's dynamic buildup and alternations with our switching model. We will enhance the model to account for effects of context (Aim 3).

Aim 3: The effects of previous exposure and context will lead to significant changes in both buildup and alternation statistics. The models will be applied and enhanced in order to account for context effects.

With new experiments which manipulate previous context, we can measure stream segregation probability, buildup, and alternations in a dynamically changing auditory scene. We expect to see a strong effect towards maintaining the current perceptual state during changes in the stimulus, for which, using the computational models we have developed, we can make detailed measurements and propose potential mechanisms.

Background and Significance

While researchers have made significant advances in improving hearing sensitivity, the processes that allow listeners to segregate sounds belonging to different sources in a dynamically changing auditory scene are still poorly understood. Our research program, if successful, will both advance basic understanding of how the brain groups and identifies sounds and produce novel techniques that may be useful in experimental analysis and patient assessment.

A critical barrier to progress in the field of auditory scene analysis is the lack of quantitative descriptions of the *dynamic* processes that underlie stream segregation. Current models for the neural basis of stream segregation include grouping by coactivation (Pressnitzer *et al.*, 2008; Pressnitzer *et al.*, 2011), which performs segregation using a discrimination threshold for spike counts, filter-based feedforward models (McCabe and Denham, 1997), and a temporal coherence model (Elhilali *et al.*, 2009). While these methods are useful for determining the steady-state likelihood of segregation for fixed stimuli, they address neither the time-varying changes in segregation probability nor in the stimulus.

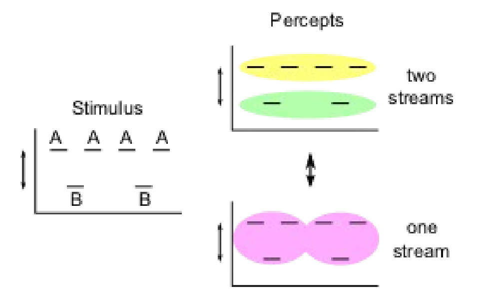


Figure 1: ABA_ stimulus and possible percepts. At the beginning of a trial, subjects hear an integrated percept with a galloping rhythm (bottom). After some time, they will hear a segregated percept (top) and then experience alternations

Of particular interest is the phenomenon called buildup, for which probability of segregation for an unchanging repeated stimulus increases with time from stimulus onset to a steady state value. The standard qualitative account of buildup cites evidence accumulation as the driving factor in the evolution of segregation probability (Bregman, 1990). We introduce novel applications of dynamical models that can quantitatively describe how buildup occurs. Our statistical model (**Aim 1**) provides an alternative to the accumulation account-- we attribute buildup to alternations between bistable perceptual states. The observation of perceptual bistability (Pressnitzer & Hupe, 2006) for ambiguous auditory stimuli enables the application of the alternating renewal process model, and is also indicative of a competitive neuronal architecture (Wilson and Cowan, 1972; Laing *et al.*, 2010). We are developing and applying ad-hoc neuronal-like models (**Aim 2**) to describe the interactions between neural populations (eventually networks) representing different groupings of the auditory scene. These simulations also reproduce the dynamic changes in likelihood of segregation for unchanging auditory input. The assumption that the neural networks involved undergo bistability allows us to predict how subjects should perceive dynamically changing auditory stimuli, and the effects of previous context (**Aim 3**)-- for instance, because of hysteresis, perception in a dynamically changing scene depends on previous stimuli and perceptual state. These results represent a conceptual overhaul of the buildup process, and advance the field's understanding of the neural bases of stream segregation.

Along with these conceptual advances, the proposed research should ease methodological difficulties in studying buildup specifically and auditory scene analysis in general. The study of neurophysiological mechanisms of stream segregation is difficult because stimuli and timescales are poorly suited for fMRI, with its loud environment and low temporal resolution. ERP/MEG are more appropriate in timescale, but requires averaging over many events and are unsuited for elucidating trial-by-trial effects. Electrophysiology on animals is useful but limited by the ability of animal models to reliably respond on the basis of their higher level perceptual state. By using subjective reports from psychophysical experiments to inform computational models, we can circumvent these difficulties. Our statistical model (**Aim 1**) allows easy interconverting between a number of data types-- from duration distributions to buildup functions, or vice versa. It allows comparison between data from short or long trials, with fixed or changing parameters. Our mechanistic models (**Aim 2**)**,** while presently remote from electrophysiological measurements, will enable better estimates for the strength of cues for segregation and integration, intrinsic noise, and characteristic timescales of processes like adaptation, inhibition, temporal integration and memory. We expect the results of our experiments (**Aim 3**) to yield techniques for estimating dynamic features of higher level auditory processing. In addition, while presently optimized for application to psychophysical data, our techniques are in principle appropriate for any measurement of a buildup function.

Approach/Innovation: Alternating Renewal Process (ARP): The central unifying theory behind the proposed research is that buildup is characterized by an alternating renewal process, as follows: Suppose that, for an ambiguous ABA_ stimulus, listeners alternate back and forth between hearing integration and segregation, that the durations of these percepts will be random and independent, and can be described by stationary gamma distributions. Thus the perceptual timecourse for a given trial with a fixed stimulus, eg the reports for being in one or the other of the possible perceptual states over time, can be approximated as alternating draws from each gamma distribution. Finally, if we assume that at the beginning of a trial, the first perceptual state will be that of integration, we can appreciate that buildup is simply the averaging over many trials of random switches out of (as well as back into) a known starting state (Figure 2). This describes an alternating renewal process (ARP).

There are a number of advantages to characterizing the buildup function in this way. First, there exists an analytical solution (Stinchcombe *et al.*, 2012) relating the parameters of the two gamma distributions for percept duration to the buildup function, if the first percept is known, so it is possible to interconvert between buildup functions and the statistics of the dominance durations for each percept. Second, using Monte Carlo simulations, it is possible to generate estimates of the segregation probability for when the initial state is not known; as when the parameters change mid-trial. The four-parameter expression relating probability of segregation over time to distributions of percept durations allows comparison of perceptual dynamics across experimental conditions. And, it challenges the viewpoint that buildup of stream segregation is a gradual accumulative process.

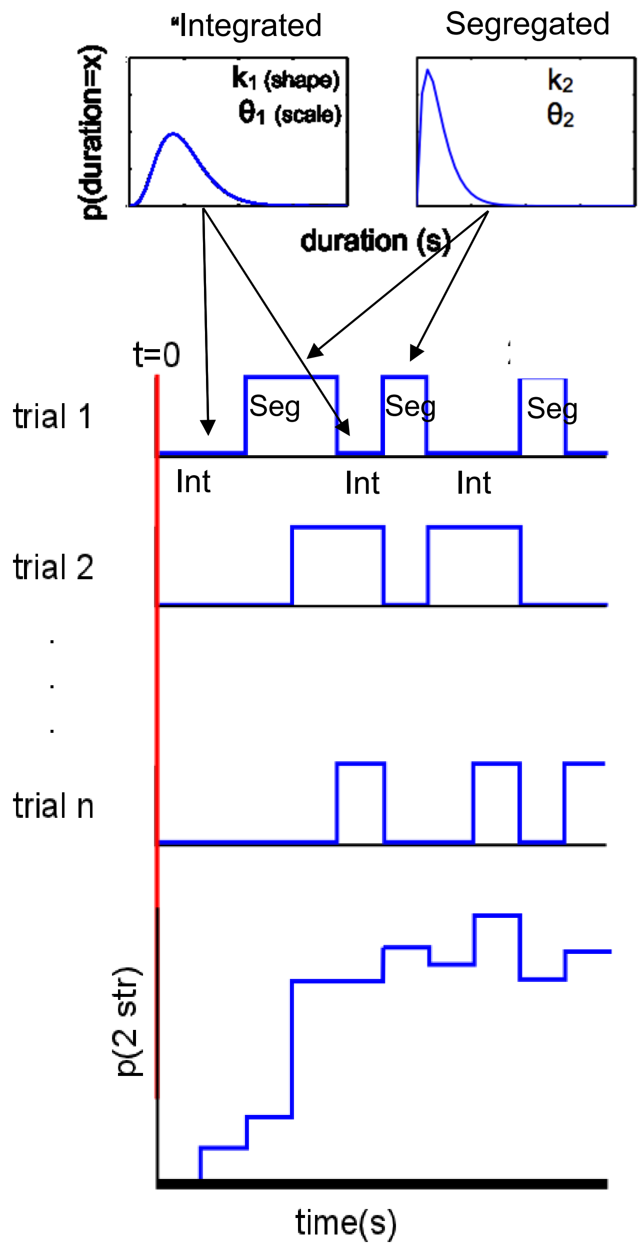


Figure 2: Illustration of alternating renewal process showing how the buildup function (bottom) arises simply by averaging over trials in which the system alternates randomly (according to gamma distributions, top) between two states, with the first state fixed

4. Preliminary Studies

The results of pilot studies in the application of this model to psychophysical data and competition model simulations were presented as a poster at Society for Neuroscience annual conference in 2012 (Steele *et al*, 2012).

Stimuli: We used a repeating ABA_ stimulus with a HLH pattern, such that the A tones were at a higher frequency than the B tones. The tones and the silent interval after each triplet were 125 ms duration, and there were no gaps between adjacent tones. The frequency difference between the tones, DF, was varied between 3 and 7 semitones (st).

Study 1- Long Presentations: To obtain an estimate of the probability distributions of the durations for both integrated and segregated percepts, as well as a characterization of steady state dynamics, repeating ABA_ sequences were presented for 4 minutes (480 triplets). Subjects were instructed to press and hold one key when they heard an integrated percept, and to hold down another key when they heard a segregated percept. Stimulus presentation and response collection were implemented in MATLAB. Two subjects completed three trials each for multiple DF conditions.

Analysis: The times of the keyholds for integrated and segregated percepts were used to obtain percept durations and experimental timecourses. Each experimental timecourse consisted of zeros and ones with 1 ms bins reflecting whether the subject was reporting integration or segregation, respectively. The percept being reported when the trial ended was not included in analysis, as it would have been artificially truncated. We obtained estimates of the parameters for the gamma distributions for integrated and segregated percept durations using maximum likelihood estimation (MLE).

To obtain an estimate of the buildup function with only three repetitions of each stimulus condition, we used a novel method we have dubbed “switch-triggered averaging” (Figure 3). Since we know that the first percept for any given trial is (nearly) always going to be that of integration, we can construct an estimate for the buildup function by averaging over switches into integration, instead of averaging over trials. This is effectively the same as treating every switch into the integrated percept as the beginning of a new trial, and allows us to estimate what the buildup function would look like for many trials (even though we only have three for each subject/condition).

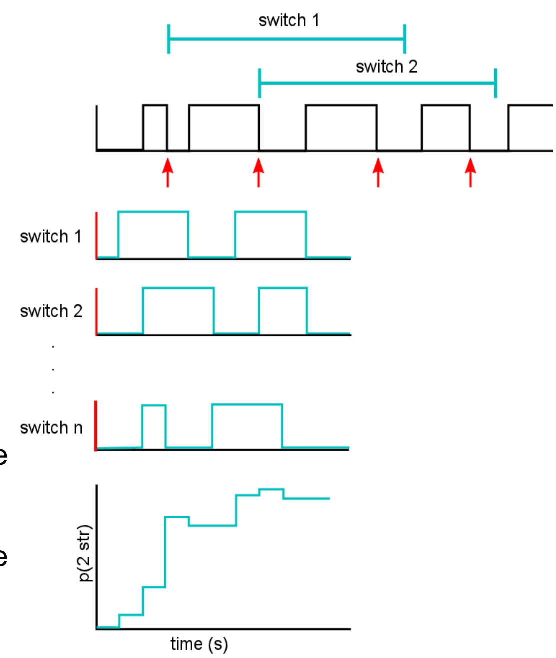


Figure 3: Illustration of switch triggered averaging method for constructing buildup functions from long trials. Averaging aligned by switch into the integrated percept.

Results: The ARP model buildup function using the MLE obtained gamma parameters provided excellent fits for the switch-triggered average obtained buildup function, so long as the listener reported a reasonable number of samples of the duration of each percept, ie, the stimulus was sufficiently ambiguous (Figure 4). Note that the ARP prediction captures not only the asymptotic likelihood of segregation, but that it also does a remarkable job of capturing the dynamics of the change in segregation likelihood over time from the beginning of integration percept epochs.

Study 2- Short presentations: We wanted to establish whether buildup functions constructed in the typical way, by averaging over trials, could be well characterized by the ARP model. To ensure that we could capture a reasonable number of alternations and full durations for both integrated and segregated percepts, we presented a strongly ambiguous repeating ABA_stimulus with DF = 5. Each trial was 20 s long, and there were 100 trials. One subject participated in this experiment (not the author or the sponsor).

Results: The buildup function obtained by both averaging across trials and by using the MLE gamma parameters for the percept duration distributions for the ARP model were very similar (Figure 5). Thus it appears that our ARP model is able to capture the dynamics of stream segregation from the beginning of the onset of an ambiguous sound sequence.

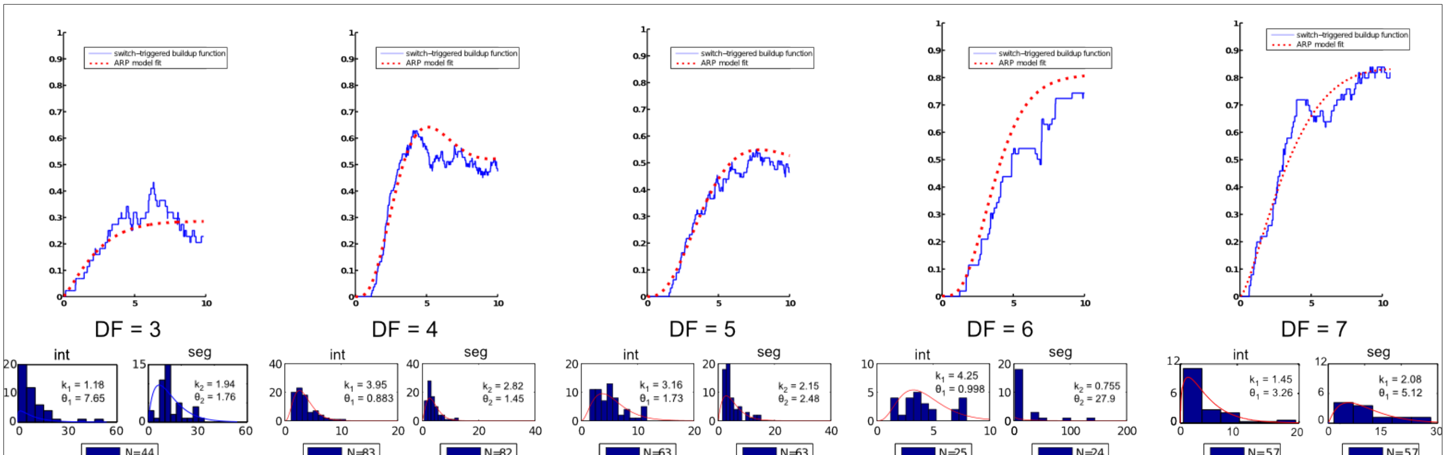


Figure 4: Results from long presentations. The blue curves show the buildup function obtained through switch-triggered averaging, while the red curves are obtained from the ARP model and maximum likelihood parameters for the duration distributions for integrated and segregated percepts (bottom, histograms). One subject was tested on DF = 3 and DF = 7, and the other conditions were tested in another subject.

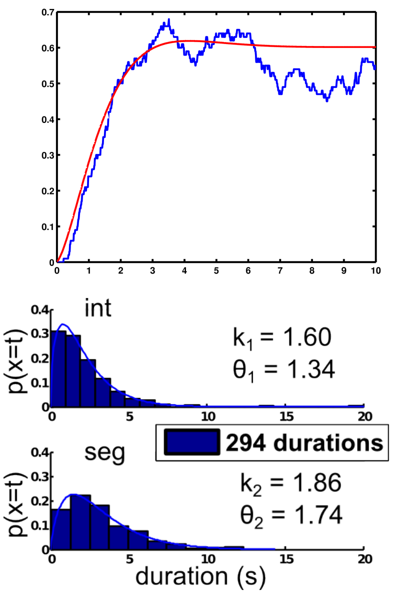


Figure 5: Results from short trials. Buildup was computed by averaging across trials (top, blue curve) as well as by analytical solution to the ARP model using MLE gamma parameter fits for duration distributions (bottom)

<u>Study 3. Competition model</u>

Previous work from our lab has produced a competition model (Shpiro et al, 2009) that produces gamma-distributed dominance durations. This model was originally created to recreate the dynamics of visual bistability, in particular, perception of ambiguous motion displays, or plaids. Plaid stimuli are made from two drifting gratings, and under ambiguous conditions will also produce alternating percepts between coherence (analogous to integration, in which the gratings appear to fuse and travel in one direction) and transparency (analogous to segregation, in which each grating's motion direction is perceived separately).

This model uses two neural populations, one which represents a "segregated" sound organization and the other representing "integrated" percept. These two populations mutually inhibit each other (Figure 6). A tacit assumption with this model is that perception corresponds to a high firing rate in one of these populations, and perceptual dominance occurs when one population's firing rate is higher than that of the other-- because of mutual inhibition, the dominant population will suppress the other. Alternations between perceptual dominance states under this model can be driven by both noise and adaptation. We conducted simulations under a number of stimulation regimes, including matched vs mismatched input currents to each population. We simulated 5000 s or enough time to collect roughly 1000 durations.

<u>Analysis:</u> The simulated timecourses of population firing rates were converted to binary timecourses relating when one population's firing rate was higher than the other's, and from these we calculated the distribution of dominance durations. The population with the first dominance epoch was arbitrarily labelled "coherent," except when the input current to each population was mismatched. In this case, one population was always labelled "coherent", and simulation runs in which the other population attained dominance first by chance were discarded. We averaged over switches into integration to produce buildup functions, and used MLE gamma parameters from the dominance duration distributions to generate ARP predictions.

<u>Results:</u> For all simulations that produced sufficient alternations, the ARP model provided a good description of the buildup function obtained from competition model simulations. This is especially impressive because in adaptation-driven alternation regimes in the competition model, first-order correlations are observed in percept-to-percept durations. The presence of dependence between the durations of successive percepts violates the assumptions of our renewal process, but the ARP model generates good descriptions anyway (Figure 6).

<u>5. Research design and methods</u>

Specific Aim 1: An alternating renewal process (ARP) can account for the time course of *buildup*, the increased probability of stream segregation over time. The model suffices without invoking any mechanism for evidence accumulation.

<u>Overview</u>: While preliminary results from studies 1 and 2 show that the gamma parameters for percept duration distributions, through the ARP model, strongly determine the buildup function obtained empirically, we wish to

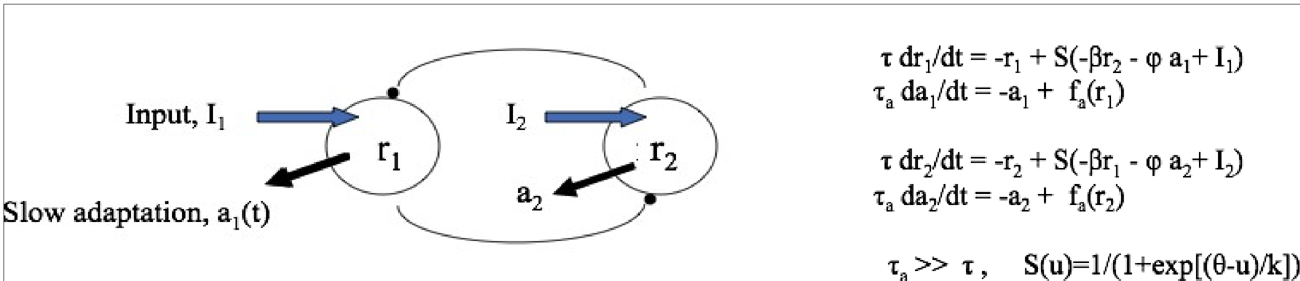


Figure 6: Mutual inhibition model framework (Hugh R Wilson, 2003).
Two populations mutually inhibit each other with connection strength Beta. Input currents I1 and I2 are supplied directly to each population, which adapt (a) at a slow timescale (tau). Phi represents gain on adaptation. Theta and k define threshold and slope of input-output function. For specific parameters see Shpiro et al, 2009.

test its analytical power, and compare different experimental conditions in the same subjects.

Subjects: Ten healthy adults will participate in the experiments. They will be screened for normal hearing thresholds and family history of hearing loss.

Stimuli: We will use the same stimuli as in preliminary studies 1 & 2 (Figure 1). We will use both short (20 s) and long (4 min) presentations.

Behavioral task and analysis: Subjects will hold down one button for "integration" and another button for "segregation". There will be 50 trials for short presentations, and 3 trials for long presentations, collected over two sessions with frequent break intervals.

We will collect responses first for short presentation, and average over trials and subjects to construct buildup curves for each DF condition. We will investigate the feasibility of applying the model in the reverse direction from our preliminary studies, searching for gamma parameters that minimize least squares error between the ARP prediction and the empirically obtained trial averaged buildup function. We will use the fits to the buildup function obtained from short trials to predict the dynamic behavior for long trials, and then test with long trials (4 minutes, 3 trials).

Subjects' reports will be converted into binary timecourses with 1 ms bins, and averaged over trials (short presentations) or over switches into integration (long presentations) to produce buildup functions. In particular, **fitting directly to the buildup function obtained by averaging over short trials should yield parameters for the gamma distributions reflecting percept durations in long trials**. Because we will have both forms of data, we will be able to directly compare the results obtained by fitting from the buildup function to derive gamma distributions as well as what we have previously demonstrated, the description obtained by fitting the gamma parameters and estimating the buildup function. Such a result would greatly extend to applicability of the ARP model, as it could be used on any buildup function to obtain estimates of the underlying percept duration distributions.

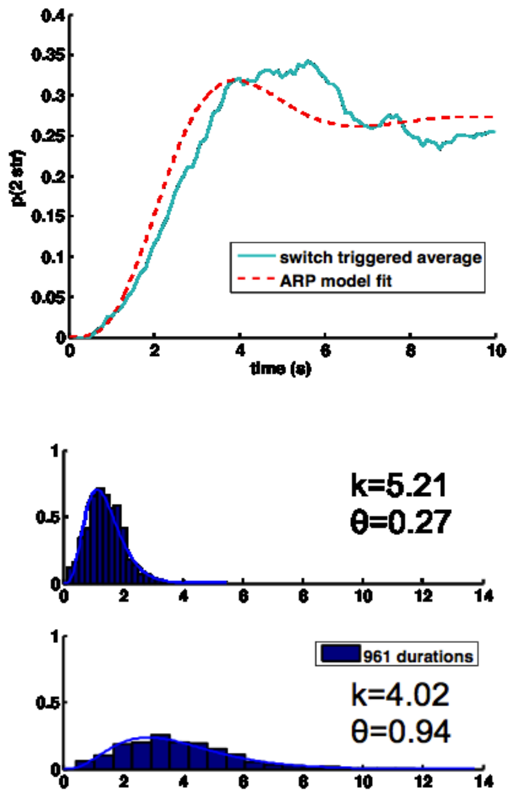


Figure 7: Competition model produces a plausible buildup function for a stimulus that biases the listener towards integration, or hearing galloping triplets.

Potential Pitfalls: We had early concerns with the application of this approach to data acquired from human listeners using ambiguous ABA_ stimuli, in particular because the assumption of stationarity might fail. A number of studies have shown that the duration of the first percept is typically longer than subsequent percept It would be relatively trivial and potentially illuminate the ARP with three distributions using Monte Carlo. It would be relatively trivial to introduce a third gamma distribution to this model, namely that describing the distribution of durations for the first integrated percept, to produce monte carlo estimates of the buildup functions. What is compelling is the degree to which the model works even without this consideration.

Specific Aim 2: Neural competition networks are sufficient to reproduce psychophysical results as well as the behavior of the ARP model.

Overview: Preliminary results from study 3 show that existing two-population competition models can capture the dynamics of buildup, even when assumptions such as independence between dominance durations are violated. This model parameterizes the connection weight of mutual inhibition between the two populations; strength, form, and timescale of adaptation within each neural population; the input driving each population; the contribution and timescale of noise; and the rate of growth and decay of neural activity. After I learn the techniques of dynamical systems analysis from my sponsor, I will be able to modify these models to pursue the following goals:

SA 2.1: Find mappings of parameters for mechanistic models onto specific gamma distributions and buildup functions obtained experimentally. Since we have already verified that our first pass rendition of the reduced neuronal-like model is consistent with both behavior and our new ARP model, the next logical step is to try to unify all three of these. We will conduct basic parameter searches to determine the relationship between the four parameters that describe buildup behavior and alternation statistics and the free parameters of the competition models. The expected result is that we will be able to match mechanistic parameters that reliably reproduce behavioral results, suggesting potential neurobiological mechanisms for the processes underlying stream segregation.

SA 2.2: Define inputs to each population in the competition model by computations performed on stimulus histogram. One thing which we would like is to know how alternation dynamics depend on the stimulus characteristics, in addition to internal processes of competition dynamics. To evaluate how the stimulus drives each population, we intend to add an input layer to the model. This input layer will take in a spectrogram of the stimulus over time and calculate the strength of the cues for integration and the strength of the cues for segregation. These calculated values will be used for the input current for each separate population.

SA 2.3: Enhance models based on results of behavioral experiments: We expect that our first pass mechanistic models may not be able to reproduce all effects we see behaviorally, such as maintenance of perceptual state during silence (**Aim 3**). Thus, we will update our model with appropriate mechanisms, such as recurrent excitation (like in short term memory models), to synergistically relate to the empirical results we find.

Specific Aim 3: The effects of previous exposure and context will lead to significant changes in both buildup and alternation statistics. The models will be applied and enhanced in order to account for context effects.

Materials and methods: We will use the same subjects as in Aim 1. These experiments will be conducted using the same kind of ABA_ stimuli. Dynamic stimuli will vary DF continuously throughout a trial.

Experiment 1: Dynamic stimuli will be 120 second sequences of repeating ABA_ with DF slowly varying over the range from 3 to 7 st, the same as those used in previous experiments. These stimuli will be arranged so that DF is either ascending to descending, or descending to ascending. There will be 30 trials for each sequence.

Analysis: We will generate predictions for likelihood of segregation as a function of time in sequence, and evolving dF values, using the gamma parameters we obtain in Experiment 1. We will use Monte Carlo simulations based on random samples from these and interpolated distributions (for DF values between those previously tested), using the ARP model to generate percept duration samples composing simulated timecourses. These simulated timecourses will be averaged and compared to the averaged experimental timecourses to determine whether probability of stream segregation in a dynamic scene can be predicted by the steady state statistics of fixed scenes.

Experiment 2: The DF will be chosen based on the results of experiment 1, such that both integrated and segregated percepts are possible and buildup is not too fast or slow, but likelihood of segregation at the end of the trial is high, eg 7 semitones. When a trial ends, one of five silent inter-trial intervals (ITI) will intervene-- 1.2, 2.4, 3.6, 4.8, and 6 seconds. We expect that the “reset” of buildup will strongly depend on the length of the silent interval between trials.

Experimental timecourses will be averaged to construct buildup functions for each preceding ITI. We will then calculate the change in probability of segregation during the first 1 s as a function of ITI, and use that function to fit parameters for mechanistic model simulations.

Potential Pitfalls: We need to ensure that we vary the stimulus at an appropriate timescale-- if the stimulus varies faster than the intrinsic dynamics of perceptual alternations, we will likely lose predictive power by simple Monte Carlo simulation. However, we may be able to propose a rule for switching out of a perceptual epoch when the underlying parameters change.

Protection of Human Subjects
1. Risks to Human Subjects
a. Human subjects involvement and characteristics.
Behavioral task. The tasks will involve listening to computer-generated sounds through headphones; performing cognitive operations (e.g., responding to or making a decision about a stimulus); and making a response (e.g., a button press) regarding the presented stimuli. Subjects will be screened ahead of time to determine normal auditory function. In addition, we will obtain informed consent before each experimental session. Our subject population will include approximately 50% men and 50% women (age range: 18-65), and minorities at rates representative of the diverse population of NYU and the surrounding community (see Inclusion of Women and Minorities and Inclusion of Children). These subjects will be found by advertising on campus electronic bulletin boards and by posting announcements on bulletin boards placed throughout campus. These subjects will be paid $10/hour for behavioral experiments. Subjects who are unable to attend to or respond to stimuli as required by the experimental protocol will be excluded. There will be no cost to the subjects for participation in this study. No private or personal data will be retained by our lab. Any data that may be published in scientific journals will not reveal the identity of the subjects.
b. Sources of materials. N/A. We will collect no physical materials from subjects.
c. Potential risks. The risks to subjects from these studies will be minimal. Subjects will be informed that they should contact the PIs if they have experienced a research related injury. Because of the extended period of focused attention required for psychophysics, some subjects can find the experience unpleasant. It is also conceivable that subjects might experience claustrophobia or other anxiety in the soundproof booth. Neither of these scenarios poses a major threat to subjects' physical health, but efforts will be made to make the experience as comfortable as possible to encourage retention of the subject pool. Participants will be informed that they may withdraw from the experiment at any time with no penalty if they so desire.
2. Adequacy of Protection Against Risks
a. Recruitment and informed consent. Prior to participating in the study, subjects will be informed of the risks and benefits of the study, and will fill out and sign the informed consent. Experimenters will verbally question the subjects to make sure that the informed consent has been understood. Subjects will be able to withdraw from the study at any time with no penalty. The human subject protocols will be reviewed annually by the University Committee on Activities Involving Human Subjects (UCAIHS). Confidentiality of research records will be strictly maintained. All data will be stored on the PIs' computer file servers, under password protection. Only the PIs and their designated research associates will have access to the data. The results of these studies may be published in a book or journal or used for teaching purposes. However, subjects' names or other identifiers will not be used in any publication or teaching material without specific permission. Data will be backed up on to CD, DVD, or computer tape. These backup media will be stored in a locked cabinet in the laboratory. Subject identity will be coded on all documents so as not to breech confidentiality. After publication, the data will be removed from the PIs' computer file servers. The backup media (CDs, DVDs, computer tapes) and other documents will be kept indefinitely.
b. Protections against risk. Anyone involved in data collection must have successfully completed the UCAIHS training course at NYU. Only certified investigators may be involved in subject recruitment and administration of informed consent.
3. Potential Benefits of the Proposed Research to the Human Subjects and Others. There will be no direct benefits to subjects for their participation in the proposed experiments. The psychophysical and psychological knowledge to be gained from these studies, as well as potential impact on health treatments, justifies the use of human subjects.
4. Importance of the Knowledge to be Gained.
The proposed research has the potential to challenge the traditional account of auditory processes underlying behavior, and is a platform for major advancements in basic research through computational modeling of neurobiological mechanisms. In addition, the methods and measurements used in our analysis may have clinical application for tracking higher level auditory abilities in patient populations. These advancements come with minimal risk to the subjects involved in psychophysics.

Inclusion of Women and Minorities

Inclusion of Women.

Our subject population will include approximately 50% men and 50% women, reflecting the population as a whole. We will ensure very nearly 50% women and men by drawing actively from the undergraduate students, graduate students, and postdoctoral researchers at NYU, as well as the surrounding community.

Inclusion of Minorities.

Our subject population will mainly reflect the demographics at New York University (see http://www.nyu.edu/ir/pdf/demographics/2007/Enrollment.pdf):

Hispanic: 6%
Asian/Pacific Islander: 15%
American Indian/Alaskan Native: 0%
Black (non-Hispanic): 5%
White (non-Hispanic): 43%
International: 13%
Unknown/other: 18%

The NYU population is sufficiently diverse that it should be possible to achieve this target. However, we actively and substantially recruit from the extraordinarily diverse population of New York City, via postings at city universities and public gathering locations throughout the boroughs. These steps are taken to ensure a population with maximal demographic relevance to the public health questions being addressed by our proposed studies, both regarding ethnic and gender diversity as well as, crucially, age across the lifespan.

Targeted/Planned Enrollment Table

Study Title: Dynamical systems theory for a dynamic auditory world

Total Planned Enrollment: 20

TARGETED/PLANNED ENROLLMENT: Number of Subjects			
	Sex/Gender		
Ethnic Category	**Females**	**Males**	**Total**
Hispanic or Latino	2	2	4
Not Hispanic or Latino	8	8	16
Ethnic Category: Total of All Subjects *	10	10	20
Racial Categories			
American Indian/Alaska Native	0	0	
Asian	4	4	8
Native Hawaiian or Other Pacific Islander	0	0	
Black or African American	2	2	4
White	4	4	8
Racial Categories: Total of All Subjects *	10	10	20

* The “Ethnic Category: Total of All Subjects” must be equal to the “Racial Categories: Total of All Subjects.”

Inclusion of Children:

NYU undergraduates under the age of 21 will represent children in our sample of subjects. We believe that it is necessary to exclude children under the age of 18 for the following reasons. 1) The behavioral task can be conceptually subtle and requires long periods of sustained attention. 2) The fact that we use relatively small sample sizes increases the importance of having subjects that are extremely reliable and capable of performing the behavioral tasks at a high level of aptitude. 3) While stream segregation mechanisms are thought to function similarly in children and adults we cannot be certain that higher order mechanisms contributing to the effects of context, such as working memory, will be matched across adults and juveniles.

Respective Contributions:

The proposed experiments were conceived of and developed by the applicant, in collaboration with the sponsors, John Rinzel and Elyse Sussman. The proposal was written by the applicant with help provided in the form of feedback, training, and intellectual support from both John Rinzel and Elyse Sussman.

The proposed research will be carried out by the applicant. Data analysis will be conducted by the applicant with input from the sponsors. The sponsors will help to ensure that appropriate analyses are conducted, and relevant theoretical and clinical questions addressed to the extent the data permits. Preparation of manuscripts will be done by the applicant in collaboration with the sponsors in the form of conceptual discussions and feedback on the writing.

Selection of Sponsor & Institution:

I chose to pursue my graduate study at New York University under the mentorship of Drs. John Rinzel and Elyse Sussman because they both have exceptional qualifications and innovative approaches for guiding my training as an investigator of the perceptual dynamics guiding human behavior. Each sponsor offers complementary expertise that will provide a well-rounded training program in support of my goals. I will receive sophisticated training in modern techniques of computational and theoretical modeling as well as experimental design that will enable me to pursue a career in innovative, holistic research in perception. Dr. Rinzel is a renowned theorist who has collaborative relationships with researchers around the world. He has pioneered neuronal modeling on a microscopic level in decades past, but has a keen insight for applying general principles of dynamics to describing processes on both systems level and behavioral neuroscience. His work with Dr. Nava Rubin produced novel insights into the perceptual dynamics which underlie visual bistability, which has provided some of the groundwork for this proposal. His mentorship of students with interests in perceptual and cognitive processes has been fruitful – both in producing impressive, creative new computational models for everything from timing perception to categorization network models, and also in producing successful, independent new researchers who have remained productive long after leaving his lab. He is something of a Renaissance mathematician, and his enthusiasm for engaging in collaborations with researchers with a wide range of experimental methods makes him unusually capable of expressing complex theoretical concepts in straightforward, appealing ways. I consider myself extremely fortunate for entering the doctoral program at CNS at the same time as he began to pursue research in auditory streaming-- I benefit from of both his position as an established researcher with excellent professional relationships and experience, in addition to his excitement and enthusiasm as a scientist beginning a new research program.

The mentorship of Dr. Sussman provides an experimental counterpoint to Dr. Rinzel's talent for theory. With over a decade of experience in empirical investigation into the problem of auditory grouping, she will be an invaluable resource in my development of psychoacoustic paradigms. Her experience in experimental design, as well as her experience working with different patient populations and subject groups, will provide the critical grounding and insight into real-world problems we need for making a meaningful contribution to the field. Her previous mentoring relationship with Dr. Rinzel provides reason to expect a productive dialogue, and I am confident that our interactions will foster synergy between theoretical and empirical avenues of investigation. She has been successful at developing novel experimental designs to capture the role of context and previous experience in stream segregation, an aspect of auditory processing I strongly wish to incorporate into a quantitative framework for perception.

In general, the environment I find myself in is exactly what I had hoped for in pursuing doctoral training. The Center for Neural Science is, so far as I can tell, one of the best places in the world to pursue systems-level computational methods in understanding perception. There are a number of prominent investigators studying perception and related processes with a strong quantitative or computational focus, with theorists like Dr. Rinzel (Simoncelli, Wang), physiologists (Reyes, Movshon, Viventi), and psychophysicists (Heeger, Landy, Poeppel). The department itself fosters a culture that prioritizes computation as a level-bridging tool, with required coursework for first year students in linear algebra and statistics. Our close affiliation with the Psychology department, in particular the Cognition and Perception program, as well as with the Courant Institute and Polytechnic institute, fosters productive dialogue between investigators from a variety of backgrounds. My research will be carried out at the Center for Neural Science.

Responsible Conduct of Research:

During the Spring of 2011, I attended a series of highly informative and well-designed seminars on responsible conduct of research. This lecture series was developed by Prof. Lynne Kiorpes, Center for Neural Science (CNS) who worked in collaboration with Marti L. Dunne, Associate Vice Provost for Research Compliance and Administration, Dr. Keith Micoli, NYU School of Medicine Ethics Program Coordinator, and Prof. Malcolm Semple, CNS and Acting Dean of the Graduate School of Arts and Science, as well as a faculty committee consisting of senior researchers from the affected schools and departments.

This series was open to all professional levels of the NYU scientific community including the following affiliated schools: the Courant Institute of Mathematical Sciences, the College of Dentistry, and the Steinhardt School of Culture. Compliance is monitored via online registration by participants and actual attendance records; the monitoring is done by the Office of the Senior Vice Provost for Research. Materials used may include such elements as case studies, on-line and print materials available from NAS and ORI, and the textbook Scientific Integrity, 3rd Ed. by F.L. Macrina (ASM press, 2005). Those who miss any regularly scheduled face to face instruction are offered make-up sessions with DVD or podcast viewing of the missed session.

This course series was designed to meet the NIH requirements for instruction on the responsible conduct of research, as updated in NOT-OD-10-019 Nov. 24, 2009. Specifically, the topics that were addressed are summarized as the following: conflict of interest; policies regarding human subjects; live vertebrate animal subjects in research, and safe laboratory practices; mentor/mentee responsibilities and relationships; collaborative research including collaborations with industry discussions and lecture; the peer review process; data acquisition and laboratory tools; management, sharing and ownership; research misconduct and policies for handling misconduct; responsible authorship and publication practices; the scientist as a responsible member of society, contemporary ethical issues in biomedical research, and the environmental and societal impacts of scientific research. I completed this course in May 2011.

In addition, all individuals conducting research with Human Subjects at New York University must take a tutorial and pass a test in order to be permitted to do this work. Periodic seminars are conducted by the University Committee on Activities Involving Human Subjects (UCAIHS) at New York University (NYU). These seminars are open to the University community and touch on a range of topics related to responsible conduct of research, highlighting issues such as conflict of interest and scientific integrity in the context of research with human subjects.

Career & Training Goals:

During the fellowship training period I intend to gain skills and insight into devising computational models of auditory perception in conjunction with novel psychophysical paradigms to test these models. In particular, I expect to develop a common framework for quantitatively explaining how the confluence of a variety of factors-- previous exposure, context, attention, motivation-- can impact perceptual experience of sounds. My career as an investigator will likely extend on the models produced under this fellowship. To achieve these goals, I will seek training in the following areas:

<u>Statistics and dynamical systems analysis:</u>
To propose a common framework to unify the dynamical processes underlying stochastic events, I will need rigorous training in formal analysis. Dr. Rinzel teaches a course on nonlinear dynamics, which I will be enrolling in. In addition, I will take courses in statistics and applied math to build upon the foundations of multidimensional calculus, linear algebra and signal processing which I have learned up to this point. Also, I have agreed to teach the first year graduate course in mathematics for my department, which will reinforce the skills I have already acquired as well as providing the opportunity for me to improve my abilities to communicate theoretical principles with individuals from a range of different fields. With a solid theoretical background in analysis, I expect to be able to create models that incorporate both probabilistic and dynamical elements. Furthermore, the analytical skills I will gain through rigorous mathematical training will provide me with a solid foundation and powerful insights throughout my career.

<u>Computer modeling of physiology and behavior:</u>
Studying at NYU affords me exposure to a broad range of computational models of perception. The Center for Neural Science, Courant Institute of Mathematical Science and the NYU Psychology Department are closely aligned, offering interaction between labs studying perceptual processes at a variety of levels. There are theorists (Simoncelli, Rinzel, Wang), physiologists (Reyes, Movshon, Viventi) and psychophysicists (Heeger, Landy, Poeppel) producing observer models from a variety of perspectives-- from linear systems analysis to Bayesian observers to integrate-and-fire network models. I have been invited to many of these labs' meetings, and in general the culture at CNS prioritizes computation and collaboration. This provides an ongoing opportunity to acquire knowledge of a broad range of approaches to the study of neural and cognitive bases for perception. NYU is an excellent community for developing new computational approaches to unify physiological and behavioral modeling. I will be pursuing more coursework from NYU's offerings, including computer science and neural modeling, and I will be applying to summer workshops offering intensive coverage of computational modeling techniques for neural scientists. In addition, I aim to explore computing languages such as XPP and Python for developing software that I can freely disseminate.

<u>Auditory Psychophysics:</u>
While my background is primarily in visual psychophysics, the problem I wish to study is an auditory phenomenon. To this end, I will take advantage of the mentorship of Dr. Sussman, an established auditory researcher at Albert Einstein, as well as Dr. Rinzel. Dr. Sussman's work has produced a number of novel paradigms that implicate the contribution of context and attention in auditory stream segregation. This collaborative training will give me both a practical and theoretical perspective on designing stimuli and experimental protocols. While I have the opportunity to present stimuli, paradigms, and analytical techniques at both institutions, I will be conducting my experiments at NYU in my lab's sound booth. In addition to my mentorship, NYU offers EARS, an auditory journal club, which offers me exposure to novel stimuli as well as psychophysical paradigms. Besides this, our lab group focuses mainly on the auditory system, and lab meetings are held with an auditory physiology lab (Reyes) as well as with visiting speakers. In addition, I have subscribed to the auditory.org daily digest mailing list. This should give me a great deal of experience in learning about and producing auditory stimuli, as well as strategies for collecting responses and analyzing data about human auditory processes.

Activities Planned Under This Award:

As I have reached the second half of my graduate training, I will be primarily engaged in research during the period of this award. However, I will continue to devote a portion of my time to attending workshops and conferences, and engaging directly with other theoretical and experimental groups related to my field. In addition, I will be pursuing coursework in mathematics and computational modeling as well as teaching opportunities. In particular, I intend to work as a teaching assistant for the core graduate first year course, “Math Tools for Neural Scientists,” which will strengthen my quantitative skills as well as improving my ability to express abstract theoretical concepts.

I intend to apply for the Advanced Computational Course in Neuroscience in Poland this summer, a four week intensive workshop in computational modeling of neural systems. Discussion with my sponsor as well as previous attendees has led me to believe that this will be an opportunity to not only gain valuable skills in modeling, but also to interact with senior faculty and other researchers outside of my institution. I expect any further workshop attendance to be similarly targeted at questions directly pertinent to my dissertation research as proposed in this application. In addition to workshops providing instruction in scientific content, I intend to participate in a workshop on scientific communication. This workshop is organized by the NYU Department of Journalism and conducted by Stephen S Hall, a respected author, science journalist, and professor at Columbia University.

Attending and presenting data at scientific conferences and other research groups is another activity which I have found to be tremendously valuable. As such, I plan to continue to attend and present at meetings of the Society for Neuroscience. In addition, I intend to submit to the Association for Research in Otolaryngology (ARO), and/or the Computational and Systems Neuroscience meeting (CoSyNe), as these are the conferences most relevant to my research. Furthermore, I will be presenting my stimuli, designs, and data to the Sussman research group at Albert Einstein, and I intend to pursue other forums for discussing my research and its implications, both for scientific and lay audiences. As I plan to pursue a career in research with both theoretical and practical applications, I strongly believe that it is important for me to develop the ability to communicate with a wide range of audiences, and to be able to relate my research in a way that is intuitive and appealing. As such, I may seek opportunities for outreach and mentorship, should my advisory committee feel I have the time available.

Year 1:
Research: 85%
Conference preparation and attendance: 5%
Teaching and coursework: 10%

Year 2:
Research: 90%
Conference preparation and attendance: 5%
Coursework and talks: 5%

Year 3:
Research: 90%
Conference preparation and attendance: 5%
Coursework and talks: 5%

Doctoral Dissertation and Other Research Experience

Dissociating visual discrimination performance from awareness using metacontrast masking: Hakwan Lau & Brian Maniscalco

After attending a joint seminar between Columbia and NYU on empirical studies of awareness, I became interested in the phenomenon of blindsight, in which individuals who are subjectively blind display the ability to make forced-choice visual discriminations with performance significantly better than chance. I joined the Perception and Computation lab at Columbia under Dr. Hakwan Lau, where I learned MATLAB programming language while I ran subjects and managed lab records and subject data for all ongoing experiments. The primary method used in this lab was metacontrast masking, in which the visibility of a stimulus presented on screen is reduced by presenting a non-overlapping masking stimulus immediately afterwards. By analyzing subjects' responses to a variant of a two alternative forced choice task (2AFC) using signal detection theory (SDT) we could obtain estimates of their sensitivity and bias under different conditions, such as attention or in the presence of flankers. I assisted in data collection on a number of experiments and introduced a new filing system for organizing confidential subject information.

While learning the practical and computational skills to conduct experiments and analysis for psychophysics, I also gained an understanding of the research problems being tackled by our lab and others like it through lab meetings. I had the idea to explicitly reproduce the response profile of blindsight by pairing a detection task with a discrimination task. I designed new stimuli and tasks, recruited and tested subjects, and tested performance on both task at different masking levels. This resulted in successful dissociation of performance for the two tasks. This work is currently in preparation for publication while the principal investigator is visiting UCLA. In addition, I collaborated with Dr. Lau on a textbook chapter on the function of volitional experience, which has been accepted for publication and is in press.

Visualizing the effect of prior knowledge on probabilistic representations of motion direction: Eero Simoncelli

I approached Eero Simoncelli to do a pre-matriculation summer project on computational vision. I was recruited to get involved with some of the lab's projects on Bayesian representation of orientation and motion direction. Following the work of Alan Stocker, and under the guidance of Ahna Girschick, I developed a Bayesian model for explaining the bias in estimates of motion direction after discriminations. This was based on an alternative explanation to a result originally obtained by Merdhad Jazayeri of Tony Movshon's lab, in which subjects engage in a two phase task during which they must discriminate whether motion of a random dot kinetogram is in a direction clockwise or counterclockwise to a discrimination boundary. In the second phase of a trial, the observer must make an estimate of the direction of motion. Jazayeri found that these subsequent estimates were strongly biased away from the discrimination boundary, and he attributed this bias to the increased weighting for neurons tuned away from the discrimination boundary in fine discrimination decisions. Stocker's explanation of the result uses a Bayesian observer model, in which the discrimination decision functions by producing a prior, that is, the probability that the motion direction was to the other side of the discrimination boundary is taken by assumption to be zero. This explains the self-consistency of the estimates, that is, subjects would always make estimates biased in the direction of their prior discrimination. While this explanation is appealing, it was impossible to distinguish it from the original proposed rationale.

To try to get direct evidence of the change to the internal representation of the stimulus following a decision, I developed a novel psychophysical task for probing subjects' representation of motion direction. In addition, I developed and updated the model proposed by Alan Stocker to reflect the new task. My approach to probing the shape of probabilistic representations of motion direction was to make the stimuli that were probabilistic ensembles, as well, and to ask subjects whether individual tokens presented after an ensemble were consistent with the preceding display. So, ensembles of directions were produced by making random dot kinetograms in which the motion of each dot was drawn from a distribution. After viewing the ensemble, viewers were shown a single dot (a “probe”) moving in one of several fixed single directions, and asked whether it had been present in the previous display. The percent of “yes” answers for each of the probe directions was used to reconstruct the probability distributions subjects were using to represent the stimulus feature of direction. I investigated whether this approach would also work for stimuli with large uncertainty by decreasing motion coherence for monodirectional displays. In addition, I investigated the approach of the probe task for elucidating the probabilistic representation of orientation, both in ensembles (where orientation of each grating is drawn from a distribution) and with noise (e.g. low stimulus contrast). I was able to show that for stimuli with larger uncertainty, whether from wider distribution of features or from increased noise, the subjects would find a wider range of probe directions/orientations consistent with the previous display. While this approach had many problems which were never resolved, it was successful in its basic premise and also served to inspire other research projects.

Dissertation: statistical and mechanistic models of stream segregation in dynamically changing auditory scenes:
John Rinzel

When I learned that John Rinzel was developing new projects to study the dynamics of stream segregation, I joined his lab and we began developing models and collecting data.
When presented with ABA tone sequences with an intermediate frequency difference between the tones, subjects report alternating between two distinct percepts of the sound (Pressnitzer & Hupe, 2006). In some epochs, the tones sound coherently grouped in a galloping rhythm, whereas in the other epochs, the tones sound like two unrelated monotonic beep trains at different frequencies and rhythms. The progression from the first of these perceptual states to the second is thought to recruit intrinsic mechanisms that the auditory system relies on for stream segregation, i.e., the ability to distinguish different sound sources in a mixture (van Noorden, 1975). We developed a statistical model to describe the buildup of the segregated percept from coherent epochs. The buildup function is the probability as a function of time that a subject will perceive an unchanging stimulus as two distinct sound sources, given that the percept started as coherent. Rather than treating buildup as a process of accumulation over time of sensory evidence or of some intrinsic neuronal process, such as adaptation, our model explains the evolving probability of segregation over time as a simple consequence of alternations between random durations drawn independently from distributions for the two percepts. In our model, segregation dynamics can be predicted by these distributions of percept durations alone. To evaluate these predictions, we collected data from human subjects as well as from neural competition model simulations. The behavioral experiments used long (>4 min) presentations of ABA tone triplets with different frequency differences between the tones. We constructed buildup functions by estimating the probability over time that a fixed stimulus was perceived as two streams based on an event-triggered average aligned to each switch into the coherent percept. Preliminary experimental data is consistent with the predictions of our statistical model-- by fitting a gamma distribution to the percept durations for each percept (one stream vs two streams) we can simulate buildup functions that matched those found experimentally. Moreover, we found that scrambling the order of the experimentally observed percept durations does not significantly change our computed buildup function. Simulations using noisy competition models give similar results, even though there are some correlations between durations from percept to percept. Finally, we have solved analytically our statistical model for the buildup dynamics. Our buildup functions, which treat percept durations as statistically independent, provide good approximations for the buildup functions obtained from both behavioral data and simulations from competition models.

SECTION II – SPONSOR INFORMATION

a. Research Support Available

I have no funding support currently available for a PhD student for the proposed training experience.

b. Sponsor's Previous Fellows/Trainees

Predoctoral: 9; Postdoctoral: 32

B Ermentrout (1979-82)	Univ Pittsburgh (Dept Math, Full Prof)
S Shamma (1983-84)	Univ MD, College Park (EE Dept, Full Prof)
G Svirskis (1998-05)	Kaunas Medical Univ, Lithuania (Group leader)
P Jercog (2004-08)	Columbia Univ (postdoc w/ E Kandel, neurosci)
E Shea-Brown (2004-07)	Univ Washington (Applied Math Dept, Asst Prof)

Co-sponsor Elyse Sussman:

Total trainees: 28

J Rimmelle (2008-11)	Postdoc, Hamburg University
A Panasse (2010-11)	Research Scholar, Columbia University
E Dinces (2004-pres)	Associate Prof., Montefiore Medical Center, Dept. Otorhinolaryngology HNS
S Chen (2009-pres)	Postdoctoral
J Sussman-Fort (2010-pres)	Predoctoral
C Max (09-pres)	Predoctoral

c. Training Plan, Environment, Research Facilities

Classes, seminars:
Trainees in my group frequently take graduate-level applied math courses and experimental and computational neuroscience courses at NYU (the latter in either the Courant Institute of Mathematical Sciences or the Center for Neural Science, CNS). Steele has already had the foundational neuroscience courses in CNS. I will encourage her take as electives some of the following computationally oriented courses: Math aspects of neurophysiology; Modeling of neuronal systems; Neuronal networks; and importantly, a graduate level statistics course from our Psychology Department. There are numerous seminars and journal clubs, including the topics mathematical biology, nonlinear dynamics, computational neuroscience and auditory processing. In addition, in CNS there is a Student-Postdoc Forum (SPF) for graduate students and postdocs, in which participants meet weekly to discuss and critique recent journal articles in the field. Trainees also present at our Auditory Journal Club. I will also encourage Steele to submit applications to the intensive 2-4 week summer courses in computational neuroscience (MBI-Woods Hole, ACCN –currently in Poland, China course – primarily cognitive focus…). These courses recruit top-notch faculty over a broad range of topics; the students are welcomed into the international community.

Interaction with other groups and scientists:
My working group (3 postdocs and 2-4 predocs) has a bi-weekly multi-lab meeting at which considerable interaction occurs. The meeting includes members of other working groups, those of Xiao-Jing Wang (CNS), Daniel Tranchina (Courant Institute) and Alex Reyes (CNS). Both mathematical and experimental issues and results are discussed. There is a rotation sequence for presentations of ongoing research by each group member. I encourage and facilitate interactions with other groups and scientists. I have established a working relationship for research and training in the area of auditory scene analysis with Dr. Elyse Sussman at the Albert Einstein College of Medicine. Her work involves behavioral experiments with human subjects, including EEG analysis, and her interests overlap with Steele's. Dr. Sussman has agreed to serve as co-sponsor for Steele, offering guidance in training and in the research being proposed here. Since Sussman's lab is a straightforward commute from NYU, we expect that Steele will make frequent visits. Over many years with training students and postdocs, in collaborative cross-disciplinary projects, I hold planning, assessment,

working meetings regularly and jointly with co-mentors; I expect to have joint meetings with Steele and Sussman at Einstein and at NYU. Sussman has already invited Steele to present her preliminary results at her lab meeting. I urge my trainees to attend and present their results at one or two conferences per year including primarily experimental audiences (e.g., Society for Neuroscience meeting, and ARO Mid-winter meeting) as well as mathematical/computational audiences (e.g., the annual Computational Neuroscience meeting).

Interaction with PI:
I meet with each of my trainees individually on a weekly/bi-weekly basis, and more during times of intense research activity or writing/presentation preparation or when they/I request a get-together; I am frequently available for lunch with them. These direct interactions with my postdocs and students involve problem formulation, experimental protocols, solution methodology, analysis, interpretation and presentation of results; the trainee usually writes the first draft of any paper or poster and I edit the manuscript.

Research environment:
Each of my trainees has office space (in the CNS and/or in the Courant Institute) with a desk and computer workstation, and use of the computing facilities of the Courant Institute and the CNS. My computational "lab" in CNS has 450 square feet that includes a conference area (300 square feet) and with some workspace for postdocs/visitors. My lab will have (delivery expected in the next few weeks) a 4x6 sound proof booth (equipped with monitor, dedicated computer and quality head phones) for auditory psychoacoustic experiments.

Relationship of research training to Steele's career goals:
In joining my working group, Steele (coming from a cognitive science background) is placing herself into a multidisciplinary research environment that is unusually rich in theory. Several labs in the CNS are primarily computational: Rinzel, Simoncelli, Wang, Daw (joint with Psychology Dept). She will on a day-to-day basis be interacting with neuroscientist experimentalists (behavior and wet experiments) and theorists. This will naturally expose her to a broad range of research topics in systems and computational neuroscience that are actively being pursued; such exposure is one of her primary goals. The proposed research, especially the modeling component, will challenge Steele to think in new and general ways, to formulate new models, and to communicate effectively with both theorists and experimentalists. I will work directly with Steele in setting up the behavioral experiments in my lab; Sussman's expertise will confirm and further guide our protocols. The co-mentoring by Sussman and myself will also illustrate for Steele how theory and experiment can synergize. Steele has expressed to me the wish to be challenged in these ways.

Relationship to Steele's career goals of the skills and techniques that she will learn:
Through our guidance Steele will learn to meet the challenges described above. She has already demonstrated during her pilot studies some proficiency with Matlab to generate sound stimuli, to gather and analyze data as well as to program and run the mechanistic competition and statistical (ARP) models. Acquisition of these multidisciplinary skills is important for becoming a practicing neuroscientist that seeks to wear two hats. During the duration of the project she develop more the abilities to formulate new models and to design experiments to test the models, disprove them, enhance them and to design new experiments. She will learn foundations of dynamical systems theory, neuromechanistic and statistical modeling and auditory scene analysis. The project is well-suited for learning these skills and techniques. She will develop empirical experience, intuition, and skills for modeling and performing auditory psychophysical experiments.

d. Number of Fellows/Trainees to be Supervised During the Fellowship

I anticipate 2-3 postdocs (currently 3) in my lab. I anticipate the current group of predocs to continue through Steele's training period: 2 from Math and 2, including Steele, from Neural Science (each will be co-mentored).

e. Applicant's Qualifications and Potential for a Research Career

I have known Steele for about 1 year, first as a student in my introductory neural modeling course then as a rotation student in my lab since Spring, 2012. She did a good class project related to the neural competition models that we had developed for perceptual bistability in vision (over the past 5 years), using dynamic plaids. In conversations that we had about perception and auditory streaming Sara would ask very good questions and raise interesting ideas for experiments to do. I proposed to her as a rotation project the issue of buildup, the time course of the probability for the 2-stream percept of the triplet pattern, ABA_ABA_.., in the ambiguous regime. I was unsure about the level of math that Sara could take on. The project could have been a totally simulation based study of my statistical model idea. But, interestingly, my colleague Dan Tranchina in Math had seen similar phenomena in a completely different context. He with others in Math had formulated the math problem for this statistical model and had solved it analytically, using Fourier transform methods. Sara bit… she jumped in and implemented some of Tranchina's methodology in order to fit the stat model to simulated data. Furthermore, she used our previously developed, neuromechanistic, competition model for perceptual bistability (the dynamics of alternations) as a testbed – it was our perceptual bistable neuronal system in the computer. She could fit the stat model's parameters well to the buildup seen in the competition model.

Further, Sara successfully was able to read and analyze some data that I had gathered during my sabbatical on the Career Development award, the first behavioral data for me. This confirmed for me her strong determination and skills with data. Sara values the techniques and concepts from dynamical systems theory and stochastic dynamics that we apply to understand the dynamics of neuronal systems and she wants to learn more. This will be part of her training program.

Throughout our working together, Sara has shown an intense curiosity, ability to generalize concepts and ideas, capability to develop Matlab tools for modeling and data analysis, and productivity. She presented some of her early results at the 2012 SFN meeting and received enthusiastic feedback. I see that Sara has the motivation for research, the creativity to pose good questions and attack them from different angles, the confidence to learn and apply tools and concepts from math, stats, psychophysics and neuroscience to seek understanding of the issues at hand. She has strong potential for a successful career in research.

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PHS 398 Cover Letter

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Attachments

CoverLetterFilename_attDataGroup0

File Name	Mime Type
Cover_Letter1011214366.pdf	application/pdf

Proposal Summary

Proposal Number: 13-0358 **Proposal Status:**
Sponsor Deadline: 12/13/2012 **Submission Method:**
Submission Type: Application

INVESTIGATOR DATA

PROJECT DIRECTOR / PRINCIPAL INVESTIGATOR CONTACT INFORMATION

Prefix:	First Name:	Middle Name:	Last Name:	Suffix:
	Sara		Steele	

Position/Title:		**Organization:**	New York University
Department:	Center for Neural Science	**Division:**	FAS
Street1:	4 Washington Place	**Street2:**	Room 1023
City:	New York	**County:**	New York
State:	NY	**Zip Code:**	10003-6603
Country:	USA	**Employee ID:**	
Phone:	2129983920	**Fax:**	
Email:	sas756@nyu.edu		

First Budget Period Effort: **Calendar:** **Academic:** **Summer:**

Status of PI:
Status Waiver Required?
Signed Intellectual Property Waiver Attached?
Signed Conflict of Interest Disclosure Attached?
Agency Certification Documentation Attached?
Cost Sharing Authorization Form Attached?

SPONSOR DATA

Agency: National Institutes of Health
Proposal Type
Sponsor Mechanism: Ruth L. Kirschstein National Research Service Awards for Individual Predoctoral Fellowships to Promote Diversity in Health-Related Research (Parent F31 - Diversity)
Sponsor Type:
Sponsor Code:
Sponsor Name:
SubDivision 1:
SubDivision 2:

PROJECT DATA

Title of Project: A novel stochastic-dynamical account of buildup and perceptual bistability of auditory grouping
Is This a Subcontract?
If Yes, who is prime?
Type of Proposal:
Type of Agency:
Kind of Application: New
Previous Grant # or Federal Identifier:
Change in grantee institution?
Type of Project:

PROJECT ADMINISTRATION

Who is responsible for this research?
Departmental Identification Number: **Primary:** **Secondary:**
Departmental Name: **Primary:** **Secondary:**
Primary Dept. Contact Info:
Account Classification: **Primary:** **Secondary:**
Other Institutional Code:
NAICS Code:

Proposal Summary (cont'd)

COMPLIANCE DATA

Are animal subjects used? No
Is IACUC review pending?
IACUC Protocol #
IACUC Approval Date:
Are human subjects used? Yes
Is IRB review pending? No
IRB Protocol #
IRB Approval Date: 02/02/2012
Does this project involve use of any of the following? Radioactive Material(s), Radiation Producing Devices(s), Recombinant DNA, Biohazardous Chemical(s), Class IIIb or IV Lasers, Other certifications of health, safety and/or environmental compliance.

BUDGET DATA

Performance Dates	Begin Date	End Date
First Budget Period:		
Cumulative Budget Period:		

Cost Sharing Information	Mandatory	Voluntary
Committed:		
Amount:		
Source:		

Budget Period	Direct Cost	Indirect Cost	Total Cost
Total:			

AWARD DATA

Award #: **Contract #:** **Date:**

Budget Period	Direct Cost	Indirect Cost	Total Cost
Total:			

EXPORT CONTROL

1. Will the project involve participation, collaboration or access to information by foreign nationals, defined as: individuals with foreign citizenship, foreign governments, foreign associations and corporations, or foreign political parties? Note: Foreign nationals granted US citizenship, or permanent residence "green card" or granted status as a "protected individual", e.g., political refugees and political asylum holders are "EXEMPT" from deemed export rule.
2. Will the project involve the shipment of equipment, technology, software, materials data or other information?
3. Will the project involve a foreign subcontract or other foreign contractual agreement?

COMMENTS AND EXPLANATIONS

PLEASE INDICATE ANY SPECIAL INSTRUCTIONS BELOW: