Final Progress Report for Research Projects Funded by Health Research Grants

Instructions: Please complete all of the items as instructed. Do not delete instructions. Do not leave any items blank; responses must be provided for all items. If your response to an item is "None", please specify "None" as your response. "Not applicable" is not an acceptable response for any of the items. There is no limit to the length of your response to any question. Responses should be single-spaced, no smaller than 12-point type. The report **must be completed using MS Word**. Submitted reports must be Word documents; they should not be converted to pdf format.

1. **Grantee Institution:** Drexel University

2. **Reporting Period (start and end date of grant award period):** 1/1/2010-12/31/2013

3. **Grant Contact Person (First Name, M.I., Last Name, Degrees):** Anne Martella

4. **Grant Contact Person's Telephone Number:** (215) 895-6471

5. **Grant SAP Number:** 4100050893

6. **Project Number and Title of Research Project**: 8 - *Neuronal Substrates of Cognitive Flexibility*

7. **Start and End Date of Research Project:** 1/1/2010 - 6/30/2013

8. **Name of Principal Investigator for the Research Project:** Jeffrey Oristaglio, PhD

9. **Research Project Expenses**.

   9(A) Please provide the total amount of health research grant funds spent on this project for the entire duration of the grant, including indirect costs and any interest earned that was spent:

   $ 152,452

   9(B) Provide the last names (include first initial if multiple individuals with the same last name are listed) of **all** persons who worked on this research project and were supported with health research funds. Include position titles (Principal Investigator, Graduate Assistant, Post-doctoral Fellow, etc.), percent of effort on project and total health research funds expended for the position. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name, First Name	Position Title	% of Effort on Project	Cost
Oristaglio, Jeffrey	Assistant Professor	60%	$46,387.55

9(C) Provide the names of **all** persons who worked on this research project, but who *were not* supported with health research funds. Include position titles (Research Assistant, Administrative Assistant, etc.) and percent of effort on project. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name, First Name	Position Title	% of Effort on Project
None		

9(D) Provide a list of **all** scientific equipment purchased as part of this research grant, a short description of the value (benefit) derived by the institution from this equipment, and the cost of the equipment.

Type of Scientific Equipment	Value Derived	Cost
None		

10. Co-funding of Research Project during Health Research Grant Award Period. Did this research project receive funding from any other source during the project period when it was supported by the health research grant?

Yes_____ No____x_____

If yes, please indicate the source and amount of other funds:

11. Leveraging of Additional Funds

11(A) As a result of the health research funds provided for this research project, were you able to apply for and/or obtain funding from other sources to continue or expand the research?

Yes_____ No_____x_____

If yes, please list the applications submitted (column A), the funding agency (National Institutes of Health—NIH, or other source in column B), the month and year when the application was submitted (column C), and the amount of funds requested (column D). If you have received a notice that the grant will be funded, please indicate the amount of funds to be awarded (column E). If the grant was not funded, insert "not funded" in column E.

Do not include funding from your own institution or from CURE (tobacco settlement funds). Do not include grants submitted prior to the start date of the grant as shown in Question 2. If you list grants submitted within 1-6 months of the start date of this grant, add a statement below the table indicating how the data/results from this project were used to secure that grant.

A. Title of research project on grant application	B. Funding agency (check those that apply)	C. Month and Year Submitted	D. Amount of funds requested:	E. Amount of funds to be awarded:
Methylphenidate effects on noradrenergic transmission and sensory signal detection	☒NIH ☐ Other federal (specify:_____) ☐ Nonfederal source (specify:_)		$ 424,875	not funded
Eyeblink conditioning as a test of cerebellar function in children with autism	☒NIH ☐ Other federal (specify:_____) ☐ Nonfederal source (specify:_)		$ 424,875	not funded

11(B) Are you planning to apply for additional funding in the future to continue or expand the research?

Yes____x_____ No_____

If yes, please describe your plans:

Resubmit grants for federal and foundation funding.

12. Future of Research Project. What are the future plans for this research project?

Complete manuscript and re-submit grant to NIH

13. New Investigator Training and Development. Did students participate in project supported internships or graduate or post-graduate training for at least one semester or one summer?

Yes_____ No____x_____

If yes, how many students? Please specify in the tables below:

	Undergraduate	Masters	Pre-doc	Post-doc
Male				
Female				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
Hispanic				
Non-Hispanic				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
White				
Black				
Asian				
Other				
Unknown				
Total				

14. Recruitment of Out-of–State Researchers. Did you bring researchers into Pennsylvania to carry out this research project?

Yes_____ No____x_____

If yes, please list the name and degree of each researcher and his/her previous affiliation:

15. Impact on Research Capacity and Quality. Did the health research project enhance the quality and/or capacity of research at your institution?

Yes_____ No_____x_____

If yes, describe how improvements in infrastructure, the addition of new investigators, and other resources have led to more and better research.

16. Collaboration, business and community involvement.

16(A) Did the health research funds lead to collaboration with research partners outside of your institution (e.g., entire university, entire hospital system)?

Yes_____ No_____x_____

If yes, please describe the collaborations:

16(B) Did the research project result in commercial development of any research products?

Yes_____ No_____x_____

If yes, please describe commercial development activities that resulted from the research project:

16(C) Did the research lead to new involvement with the community?

Yes_____ No_____x_____

If yes, please describe involvement with community groups that resulted from the research project:

17. Progress in Achieving Research Goals, Objectives and Aims.

List the project goals, objectives and specific aims (as contained in the grant agreement). Summarize the progress made in achieving these goals, objectives and aims for the period that the project was funded (i.e., from project start date through end date). Indicate whether or not each goal/objective/aim was achieved; if something was not achieved, note the reasons why. Describe the methods used. If changes were made to the research goals/objectives/aims, methods, design or timeline since the original grant application was submitted, please describe the changes. Provide detailed results of the project. Include evidence of the data that was generated and analyzed, and provide tables, graphs, and figures of the data. List published abstracts, poster presentations and scientific meeting presentations at the end of the summary of progress; peer-reviewed publications should be listed under item 20.

This response should be a DETAILED report of the methods and findings. It is not sufficient to state that the work was completed. Insufficient information may result in an unfavorable performance review, which may jeopardize future funding. If research findings are pending publication you must still include enough detail for the expert peer reviewers to evaluate the progress during the course of the project.

Health research grants funded under the Tobacco Settlement Act will be evaluated via a performance review by an expert panel of researchers and clinicians who will assess project work using this Final Progress Report, all project Annual Reports and the project's strategic plan. After the final performance review of each project is complete, approximately 12-16 months after the end of the grant, this Final Progress Report, as well as the Final Performance Review Report containing the comments of the expert review panel, and the grantee's written response to the Final Performance Review Report, will be posted on the CURE Web site.

There is no limit to the length of your response. Responses must be single-spaced below, no smaller than 12-point type. If you cut and paste text from a publication, be sure symbols print properly, e.g., the Greek symbol for alpha (α) and beta (ß) should not print as boxes (□) and include the appropriate citation(s). DO NOT DELETE THESE

INSTRUCTIONS.

Summary of Research Completed

We have been studying the learning and sustained attention performance of the Spontaneously Hypertensive Rat (SHR), an animal model of Attention Deficit Hyperactivity Disorder (ADHD), and the Wistar-Kyoto rat (WKY), the control strain. Because hypertension is associated with cognitive deficits in adults (Zlocovic, 2011) and also learning deficits in children (Lande et al., 2012), we first examined basic rule-guided learning, retention and cognitive flexibility in the SHR. We then tested the sustained attention capacity of these same rats to assess their ability to remain vigilant and detect transient stimulus events. These studies were done to properly document the behavioral performance of a widely-used animal model of ADHD prior to beginning studies of frontal cortical neural activity in this model.

Learning and retention: Water-restricted subjects were first trained on a simple spatial lever press task inside standard operant chambers (Med Associates), a procedure similar to that used in recent studies (Boulougouris et al., 2008; Boulougouris and Robbins, 2010). *The task consisted of three phases: acquisition (ACQ), retention (RET) and reversal (REV) (***Figure 1A***).* During ACQ, subjects were consistently rewarded (with a small drink of water) for pressing one of the two levers. After reaching behavioral criterion (at least 9 out of 10 consecutive trials correct) testing was suspended for 3 days. On the 4th day after finishing the ACQ phase, subjects began RET phase testing where they had to master the same behavioral rule learned during the ACQ phase. Once criterion was met on the RET phase, subjects were tested the following day on a rule reversal (REV phase) where only presses on the opposite lever were rewarded. As no cue or warning was given to subjects to indicate a rule change, subjects were required to learn by trial-and-error to press the opposing lever for reward.

Figure 2 shows the learning performance of the two strains of rats on the three phases of the spatial lever press task (n = 11 per group). *Learning performance during each phase was measured as the number of trials required to reach criterion performance (trials to criterion, or TTC).* SHRs took significantly more trials to reach criterion during ACQ ($p < 0.5$, *t*-test) but performed as well as WKY controls on RET. The WKY group did not show improvement during the RET phase but this may have been due to a floor effect, since learning performance during the ACQ phase was so high for this strain. Performance for the SHRs on REV was slower than WKY controls ($p < 0.5$, t-test).

We also categorized errors committed during each phase of training using a methodology based on previous studies (Floresco et al., 2008; Ragozzino, 1999) and consistent with the PI's recent study examining drug effects on learning, memory and cognitive flexibility in mice (Dougherty and Oristaglio, 2013). Three types of errors were tallied: learning, regressive and perseverative. *Learning errors were defined as incorrect responses occurring before subjects achieved 5 consecutive correct trials, while regressive errors were incorrect responses committed after this point* (a subject has roughly a 3 percent chance of getting 5 trials in a row correct when operating at chance so 5 trials in a row correct is a reasonable cutoff criterion for determining when a subject has acquired some understanding of the task). Perseverative errors were counted only for the REV phase and occurred when subjects continued to press the previously rewarded lever following the rule reversal. Perseverative errors were defined as wrong choices made prior to achieving chance performance (50% correct) over 10 consecutive trials, a point which suggested that subjects were beginning to learn the new rule. Results

showed that while SHRs took longer to learn rule-based behavior, and therefore committed more errors during the ACQ and REV phases (**Figure 3A**), their relative frequency of error types was not significantly different from WKY rats in any of the three phases (**Figure 3B**). Only the mean number of regressive errors during the retention and reversal phases approached significance ($p = 0.14$ and $p = 0.08$, respectively).

These results suggest that SHRs are slower than WKY rats to learn and respond to changes in simple rule-based behaviors. This accords with previous studies demonstrating slower learning and reduced cognitive flexibility in the Spontaneously Hypertensive Rat (SHR) (Cao et al., 2012; Kantak et al., 2008). Furthermore, though SHRs require more time to learn and adapt simple rule-based behaviors, they appear to be unimpaired in their ability to recall previously-learned behaviors after a period of several days. This is significant since hypertension is reported to be related to reduced cognitive performance (Lande et al., 2011) and to neurodegeneration (Zlokovic, 2011).

Prior to testing on the spatial discrimination task, we assessed the intrinsic spatial bias of our subjects. Rats often will preferentially dwell on one side of the operant chamber and/or more consistently press one lever in favor of the other. As a convention, all subjects that exhibited substantial spatial biases were initially trained to press the lever opposite their bias during the acquisition phase of testing. The rationale here was to require the animal to learn a rule during the initial phase rather than simply responding in accord with a preexisting bias (in which case the subject may not actually have learned anything). Still, given this convention, we were concerned that variations in learning performance might be attributable to the need for subjects to overcome their pre-existing spatial biases. This concern was heightened by the discovery that SHRs had, on average, more substantial spatial biases than WKY rats (see below).

To assess spatial bias prior to beginning testing on the spatial discrimination task, subjects underwent lever press training according to the methodology described by Floresco and colleagues (2008). Briefly, during these training sessions, a trial began with both levers being presented. On the initial trial subjects were rewarded for pressing either of the two levers. On the following trial, subjects were rewarded only if they pressed the lever opposite the one initially pressed. If they failed to choose the opposite lever, subsequent trials continued with the rewarded lever held constant (opposite the initial choice). Once a subject selected the opposite lever, a new cycle began with subjects being rewarded for choosing either lever on the following trial. From this training we derived two measures of spatial bias: “first-choice bias” and the “repeat ratio”. First-choice bias is a measure of a subject’s tendency to preferentially select one lever at the beginning of each cycle (after having been rewarded), while the repeat ratio measures the mean number of trials a subject repeatedly presses the same lever before selecting the opposite lever to complete a cycle. In general, SHRs as a group had higher spatial biases. **Figure 4A** shows a comparison of first choice bias by group. SHRs had a stronger bias and this effect fell just short of significance ($p = 0.07$). **Figure 4B** displays a comparison of group repeat ratios. Again, the higher bias in the SHR group fell just short of significance ($p = 0.06$). However, the two near-significant results on these measures strongly suggest that SHRs possess more substantial intrinsic spatial biases than WKY rats.

As discussed above, because we initially trained subjects with substantial side biases to press the lever opposite the side of their bias, we were concerned that the difference in learning rate between SHRs and WKY rats during the acquisition phase might simply be due to the increased difficulty in overcoming an intrinsic side bias. If this were the case, then we might expect to see a correlation between side bias and the TTC required to achieve criterion during

acquisition. **Figures 4C and 4D** show the relationship between first choice bias and repeat ratio, respectively, and trials to criterion during the acquisition phase. In neither case was there a significant correlation between the two variables. This suggests that intrinsic side bias was not a strong determining factor in the learning rate of the initial spatial discrimination. Thus, it is not likely that spatial bias could account for the group differences in rate of learning of a simple spatial rule-based behavior.

Sustained Attention: *We subsequently trained the same subjects from the learning study just described on the sustained attention task (SAT)* using methodologies adapted from the original study by McGaughey and Sarter (1995). On the SAT, subjects must monitor a centrally-located signal light for a variable period (average of 15 ± 3 seconds). On each trial, the signal light either flashes briefly or does not. After this stage, two signal levers, one to each side of the signal light, are presented. Subjects are trained to press one lever (signal lever) if the light flashed and the opposite lever (non-signal lever) if the light never came on. On each trial, there are four possible outcomes illustrated in Figure 1B. Subject performance is measured in terms of the number of "hits" (signal light flashes and signal lever is pressed: upper left in figure) and "correct rejections" (signal light does not flash and subject presses non-signal lever: lower right in figure).

Initially, we used a 1000 ms signal light duration in order to train subjects to understand the task and bring them to criterion performance. Subjects were then trained with three different signal light durations: 500, 50, and 25 ms, pseudorandomly presented. Surprisingly, thus far, the SHRs have outperformed the WKY rats on the SAT. SHRs have *acquired* the task much more quickly that the WKY rats, requiring fewer sessions on average to reach criterion performance (**Figure 5A**) on the first stage of training (with the 1000 ms signal duration). This is precisely the opposite result as was observed on the spatial discrimination task where the WKY rats performed better.

Figure 5B displays the mean vigilance index (VI) for a subset of subjects during the second stage of training where 3 different signal durations were employed (25, 50 and 500 ms) (data from additional subjects is currently being analyzed). Data is also averaged across all 3 signal durations. Vigilance index is a composite measure of performance on signal and non-signal trials (McGaughey and Sarter, 1995). As can be seen, the SHR group has achieved much higher levels of performance than WKY group. Both groups display the expected psychophysical profile of decreased VI with decreasing signal duration. Note that the poor performance of the WKY rat on the SAT is not due to an inability to understand the task or to a simple visual deficit. With a longer signal duration (1000 ms, used in stage 1 training) WKY rats trained to criterion performance as did the SHRs (though they required more time). Furthermore, when poor-performing WKY rats were given remedial training with the longer 1000 ms signal duration, better performance returned immediately.

In summary, *our data indicate that adult SHRs and WKY rats can perform the sustained attention task (SAT), but that SHRs outperform WKY control rats*. This latter observation is particularly surprising given the superior performance of the WKY on our spatial learning task. Taken together, these results may be in agreement with the hypothesis of Sagvolden and colleagues (2008) that the WKY rat (from Charles River Laboratories) may be a good model for the primarily inattentive form of Attention Deficit Disorder (ADD-PI) (inattention in the absence of hyperactivity). This is a very important finding for those interested in studying attention, cognitive flexibility and learning in animal models of ADHD.

Figures

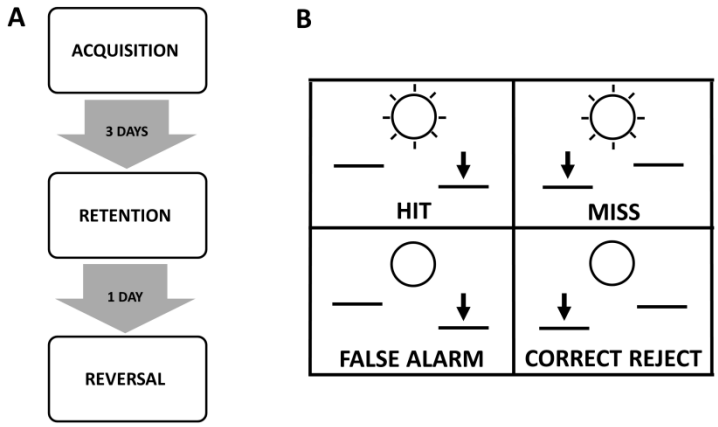


Fig 1

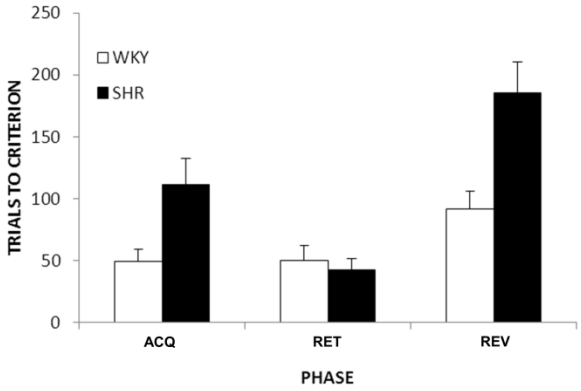


Fig 2

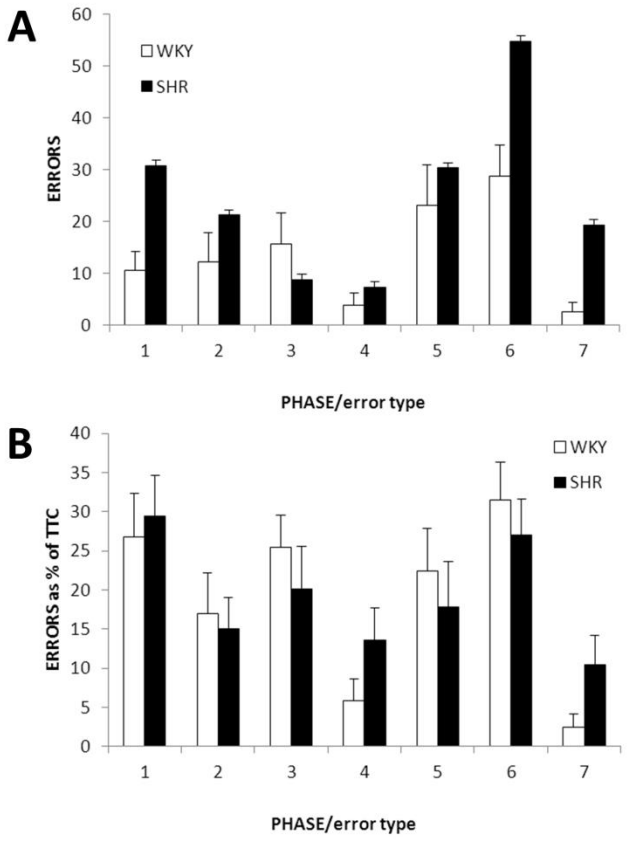
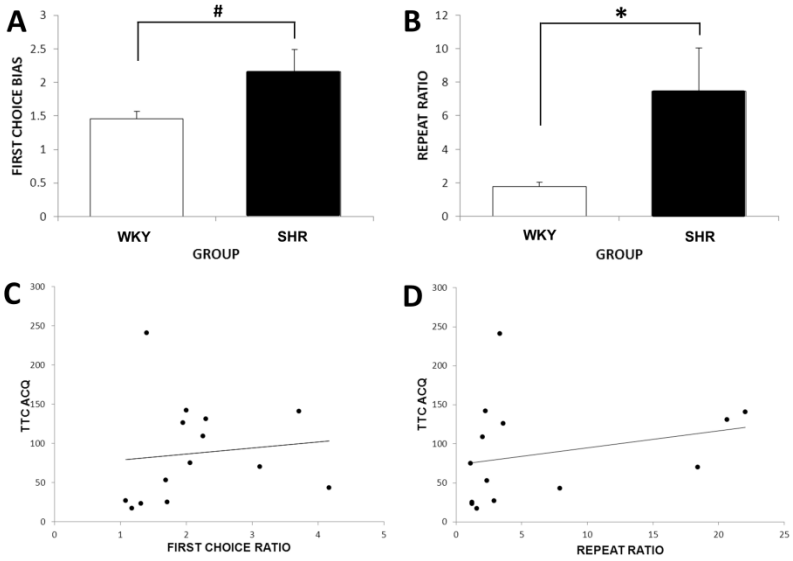

A
WKY
SHR
ERRORS
PHASE/error type
B
WKY
SHR
ERRORS as % of TTC
PHASE/error type

Fig 3


A
#
FIRST CHOICE BIAS
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REPEAT RATIO

Fig 4

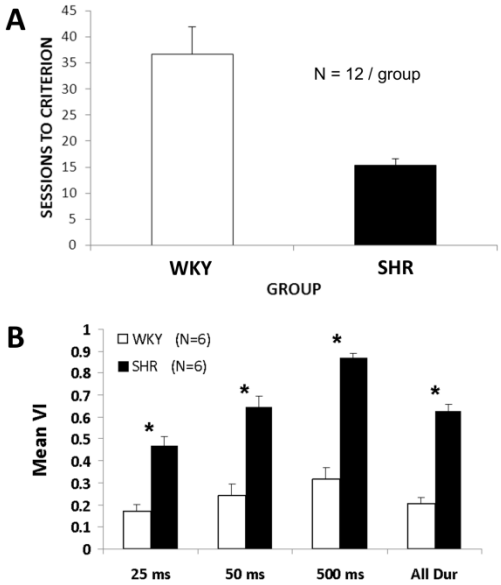

Fig 5

18. Extent of Clinical Activities Initiated and Completed. Items 18(A) and 18(B) should be completed for all research projects. If the project was restricted to secondary analysis of clinical data or data analysis of clinical research, then responses to 18(A) and 18(B) should be "No."

18(A) Did you initiate a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
___x__No

18(B) Did you complete a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
___x__No

If "Yes" to either 18(A) or 18(B), items 18(C) – (F) must also be completed. (Do NOT complete 18(C-F) if 18(A) and 18(B) are both "No.")

18(C) How many hospital and health care professionals were involved in the research project?

_____Number of hospital and health care professionals involved in the research project

18(D) How many subjects were included in the study compared to targeted goals?

_____Number of subjects originally targeted to be included in the study
_____Number of subjects enrolled in the study

Note: Studies that fall dramatically short on recruitment are encouraged to provide the details of their recruitment efforts in Item 17, Progress in Achieving Research Goals, Objectives and Aims. For example, the number of eligible subjects approached, the number that refused to participate and the reasons for refusal. Without this information it is difficult to discern whether eligibility criteria were too restrictive or the study simply did not appeal to subjects.

18(E) How many subjects were enrolled in the study by gender, ethnicity and race?

Gender:
_____Males
_____Females
_____Unknown

Ethnicity:
_____Latinos or Hispanics
_____Not Latinos or Hispanics
_____Unknown

Race:
_____American Indian or Alaska Native
_____Asian
_____Blacks or African American
_____Native Hawaiian or Other Pacific Islander
_____White
_____Other, specify:_____
_____Unknown

18(F) Where was the research study conducted? (List the county where the research study was conducted. If the treatment, prevention and diagnostic tests were offered in more than one county, list all of the counties where the research study was conducted.)

19. Human Embryonic Stem Cell Research. Item 19(A) should be completed for all research projects. If the research project involved human embryonic stem cells, items 19(B) and 19(C) must also be completed.

19(A) Did this project involve, in any capacity, human embryonic stem cells?
_____Yes
___x__ No

19(B) Were these stem cell lines NIH-approved lines that were derived outside of Pennsylvania?

_____Yes

_____ No

19(C) Please describe how this project involved human embryonic stem cells:

20. Articles Submitted to Peer-Reviewed Publications.

20(A) Identify all publications that resulted from the research performed during the funding period and that have been submitted to peer-reviewed publications. Do not list journal abstracts or presentations at professional meetings; abstract and meeting presentations should be listed at the end of item 17. **Include only those publications that acknowledge the Pennsylvania Department of Health as a funding source** (as required in the grant agreement). List the title of the journal article, the authors, the name of the peer-reviewed publication, the month and year when it was submitted, and the status of publication (submitted for publication, accepted for publication or published.). Submit an electronic copy of each publication or paper submitted for publication, listed in the table, in a PDF version 5.0.5 (or greater) format, 1,200 dpi. Filenames for each publication should include the number of the research project, the last name of the PI, and an abbreviated title of the publication. For example, if you submit two publications for Smith (PI for Project 01), one publication for Zhang (PI for Project 03), and one publication for Bates (PI for Project 04), the filenames would be:

Project 01 – Smith – Three cases of isolated
Project 01 – Smith – Investigation of NEB1 deletions
Project 03 – Zhang – Molecular profiling of aromatase
Project 04 – Bates – Neonatal intensive care

If the publication is not available electronically, provide 5 paper copies of the publication.

Note: The grant agreement requires that recipients acknowledge the Pennsylvania Department of Health funding in all publications. Please ensure that all publications listed acknowledge the Department of Health funding. If a publication does not acknowledge the funding from the Commonwealth, do not list the publication.

Title of Journal Article:	Authors:	Name of Peer-reviewed Publication:	Month and Year Submitted:	Publication Status (check appropriate box below):
1. None				☐Submitted ☐Accepted ☐Published

20(B) Based on this project, are you planning to submit articles to peer-reviewed publications in the future?

Yes___x_____ No_____

If yes, please describe your plans:

We are planning to submit a manuscript to Neuroscience.

21. Changes in Outcome, Impact and Effectiveness Attributable to the Research Project. Describe the outcome, impact, and effectiveness of the research project by summarizing its impact on the incidence of disease, death from disease, stage of disease at time of diagnosis, or other relevant measures of outcome, impact or effectiveness of the research project. If there were no changes, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

None

22. Major Discoveries, New Drugs, and New Approaches for Prevention Diagnosis and Treatment. Describe major discoveries, new drugs, and new approaches for prevention, diagnosis and treatment that are attributable to the completed research project. If there were no major discoveries, drugs or approaches, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

This project demonstrated that adult SHRs and WKY rats can perform the sustained attention task (SAT), but that SHRs outperform WKY control rats. This latter observation is particularly surprising given the superior performance of the WKY on our spatial learning task. Taken together, these results may be in agreement with the hypothesis of Sagvolden and colleagues (2008) that the WKY rat (from Charles River Laboratories) may be a good model for the primarily inattentive form of Attention Deficit Disorder (ADD-PI) (inattention in the absence of hyperactivity). This is a very important finding for those interested in studying attention, cognitive flexibility and learning in animal models of ADHD.

23. Inventions, Patents and Commercial Development Opportunities.

23(A) Were any inventions, which may be patentable or otherwise protectable under Title 35 of the United States Code, conceived or first actually reduced to practice in the performance of work under this health research grant? Yes_____ No___x_____

If "Yes" to 23(A), complete items a – g below for each invention. (Do NOT complete items a - g if 23(A) is "No.")

a. Title of Invention:

b. Name of Inventor(s):

c. Technical Description of Invention (describe nature, purpose, operation and physical, chemical, biological or electrical characteristics of the invention):

d. Was a patent filed for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No____

If yes, indicate date patent was filed:

e. Was a patent issued for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No____
If yes, indicate number of patent, title and date issued:
Patent number:
Title of patent:
Date issued:

f. Were any licenses granted for the patent obtained as a result of work performed under this health research grant? Yes_____ No____

If yes, how many licenses were granted?_____

g. Were any commercial development activities taken to develop the invention into a commercial product or service for manufacture or sale? Yes___ No____

If yes, describe the commercial development activities:

23(B) Based on the results of this project, are you planning to file for any licenses or patents, or undertake any commercial development opportunities in the future?

Yes_____ No____x_____

If yes, please describe your plans:

24. Key Investigator Qualifications. Briefly describe the education, research interests and experience and professional commitments of the Principal Investigator and all other key investigators. In place of narrative you may insert the NIH biosketch form here; however, please limit each biosketch to 1-2 pages.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Jeffrey T Oristaglio Ph.D.	Research Assistant Professor
eRA COMMONS USER NAME (credential, e.g., agency login)	

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
Indiana University, Bloomington, IN	B.S.	1989	Sports Science
Bryn Mawr College, Bryn Mawr, PA	Ph.D.	2002	Neurobiology

1994-2001 Teaching Assistant, Dept. of Biology, Bryn Mawr College, Bryn Mawr, PA
2002-2005 Postdoctoral Researcher, Center for Neurobiology and Behavior, Columbia University, New York, NY
2006-2008 Postdoctoral Fellow, Dept. of Pharmacology and Physiology, Drexel University College of Medicine, Philadelphia, PA
2008-present Research Assistant Professor, Dept. of Pharmacology and Physiology, Drexel University College of Medicine, Philadelphia, PA

Awards
1994-2001 Teaching Assistant Fellowship, Bryn Mawr College, Byrn Mawr, PA
1998 Doris Sill-Carland Prize for Excellence in Teaching, Bryn Mawr College, Byrn Mawr, PA

C. Publications
Peer-reviewed journal articles
Oristaglio J., Schneider D.M., Balan P.F., and Gottlieb J. (2006) Integration of visuospatial and effector information during symbolically cued limb movements in monkey lateral intraparietal area. *Journal of Neuroscience* 26:8310-8319.

Balan P.F., Oristaglio J., Schneider D.M., and Gottlieb J. (2008) Neuronal correlates of the set size effect in monkey lateral intraparietal area. *PLoS Biology* 6(7):e158.

Gottlieb J., Balan P.F., Oristaglio J., and Schneider D.M. (2009) Task specific computations in attentional maps. *Vision Research*, 49:1216-1226.

Gottlieb J., Balan P., Oristaglio J., Suzuki M. (2009) Parietal control of attentional guidance: The significance of sensory, motivational and motor factors. *Neurobiology of Learning and Memory* 91:121-128.

Oristaglio J., Anthony G. Romano, and Harvey J.A (2009) Amphetamine influences conditioned response timing and laterality of anterior cingulate cortex activity during rabbit delay eyeblink conditioning. *Neurobiology of Learning and Memory*. 92:1-18.

Selected Abstracts

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