PROGRAM CONTACT:

Release Date: 03/01/2019
Revised Date:

Application Number: 2 R01 DC013591-06A1

Principal Investigator

MCCREERY, RYAN W.

Applicant Organization:

Review Group: **AUD**
Auditory System Study Section

Meeting Date:	02/07/2019	*RFA/PA:*	PA18-484
Council:	MAY 2019	*PCC:*	HR05
Requested Start:	07/01/2019		
		Dual IC(s):	HD

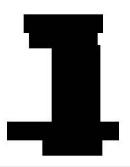*Project Title:* **COMPLEX LISTENING SKILLS IN SCHOOL-AGE HARD OF HEARING CHILDREN**

SRG Action: Impact Score:19   Percentile:2
Next Steps: Visit https://grants.nih.gov/grants/next_steps.htm
Human Subjects: 30-Human subjects involved - Certified, no SRG concerns
Animal Subjects: 10-No live vertebrate animals involved for competing appl.
Gender: 1A-Both genders, scientifically acceptable
Minority: 1A-Minorities and non-minorities, scientifically acceptable
Children: 1A-Both Children and Adults, scientifically acceptable

Project
Year
6
7
8
9
10

ADMINISTRATIVE BUDGET NOTE: The budget shown is the requested budget and has not been adjusted to reflect any recommendations made by reviewers. If an award is planned, the costs will be calculated by Institute grants management staff based on the recommendations outlined below in the **COMMITTEE BUDGET RECOMMENDATIONS** section.

2R01DC013591-06A1 McCreery, Ryan

RESUME AND SUMMARY OF DISCUSSION: This resubmission of an R01 renewal from an established investigator addresses the cognitive underpinnings of persistent deficits in understanding speech-in-noise among children with hearing loss, despite clinically improved audibility from the hearing aids they are wearing. Specifically, the investigator will assess the influence of selective attention and working memory on spectral resolution, as well as speech recognition in noise, and address whether frequency band weighting might be a strategy used by children with better selective attention for speech, providing a possible avenue for optimal customizing of individual hearing aid prescriptions by amplification of particular frequencies. The panel members found the investigator was very responsive to the comments from the initial review and that this is a strong team, including a statistician, to conduct these innovative proposed studies. In the discussion, a few minor weaknesses were noted. Some reviewers sought clarification on the justification for University of Iowa as a performance site. Other reviewers expressed concerns over the sensitivity of the metrics used, particularly with reference to data shown in Figures 3 and 6 of the application. Finally, there were some concerns noted on the lack of an explicit hypothesis for the longitudinal study proposed, as well as the correlational nature of the cognitive data to be collected, rather than the elucidation of a causal mechanism for these speech-in-noise recognition deficits. These minor concerns did not significantly diminish the study section's enthusiasm for this well-crafted high impact application which may lead to improved prosthetic hearing devices.

DESCRIPTION (provided by principal investigator): Many children with hearing loss (CHL) now receive early intervention within the first few months of life. Even with early intervention, however, some CHL with hearing aids do not reach their full developmental potential. Challenges are compounded in learning and social environments because most listening environments are characterized by background noise. CHL experience significantly greater difficulty than children with normal hearing (CNH) with understanding speech in noisy situations. CHL who wear hearing aids are an under- studied population, leading to substantial gaps in our knowledge regarding the underlying mechanisms for their speech in noise deficits. A limited understanding of the mechanisms for speech recognition in noise hinders the development of targeted intervention strategies to reduce these deficits. The current application will identify factors that underlie variability in speech recognition in noise in school-age CHL who use hearing aids. This application is based on the premise that selective attention, working memory, and language support processes that are crucial for speech recognition in noise. The current application seeks to test the hypothesis that CHL with better selective attention, working memory, and language abilities will have stronger spectral resolution, perceptual weighting for speech, and less susceptibility to informational masking. Advantages in these skills will be associated with better speech understanding in noise. Three specific aims are proposed: Aim 1. Examine the effects of selective attention, working memory, and spectral resolution on speech recognition in noise. Aim 2. Characterize the effects of selective attention and language on perceptual weighting for speech in noise. Aim 3. Evaluate selective attention as a predictor of speech recognition in speech maskers. In Aim 1, we will examine measures of selective attention, working memory, and spectral resolution on speech recognition in noise for CNH and CHL. We predict that selective attention and working memory support spectral resolution in children, which in turn support speech recognition in noise. In Aim 2, perceptual weighting functions will be measured for speech stimuli that vary in linguistic complexity. We predict that CNH and CHL with stronger selective attention, working memory, and language skills will have perceptual weights concentrated in mid-frequency bands, reflecting mature and selective listening that is less susceptible to noise. In Aim 3, we will assess the effects of selective attention on speech recognition with speech maskers that produce informational masking. We predict that CNH and CHL who have stronger selective attention skills will have less susceptibility to informational masking than peers with poorer skills, but that this effect is mediated by the child's language and working memory abilities. The data generated from this application will inform theoretical models regarding speech recognition in CNH and CHL. The proposed studies will also provide empirical evidence for the

development of individualized strategies for prescribing hearing aids for children that are based on the child's individual cognitive and linguistic skills.

PUBLIC HEALTH RELEVANCE: The purpose of this research application is to investigate the underlying mechanisms that support speech recognition in noise for school-age children with hearing loss. The proposed research is relevant to public health because it will provide important insights into the impact of hearing loss on the ability to listen and learn in background noise. This project is highly related to the NIH's mission because the data will lead to improved and more individualized treatment options for individuals with mild to severe hearing loss and has the potential to improve how children who wear hearing aids function in every day listening environments.

CRITIQUE 1:

Significance: 1
Investigator(s): 1
Innovation: 2
Approach: 2
Environment: 2

Overall Impact: This is a resubmission of a renewal application for five additional years of funding. During the first cycle, significant progress was made to attempt to uncover the role of audibility in the difficulty that hearing-impaired children have understanding speech in noise. The principal investigator now wishes to evaluate the impact of cognitive factors affecting speech recognition in noise, with a possible discovery of an improved customization of hearing aid fitting to maximize the cognitive factors and interact positively with the more sensory based audibility issues. This is an excellent and productive team of researchers; the environment is superb. The significance is high as it promises to find new ways to improve speech understanding in noise for these children. Finally, the new project builds directly on the findings emerging from the previous cycle of funding.

Significance:
Strengths

- This research team has clearly shown, through their previous cycle of funding, that even though audibility for hearing impaired children may be sufficient due to hearing aid usage, there still remain deficits in the communication abilities of these children in noise that are not accounted for.

- This project focuses on two cognitive factors that have been shown to relate to the ability of normal hearing individuals to correctly recognize speech in noise even when the sensory signal is masked. These factors are selective attention and working memory.

- This is a logical place to look for improvements that might be undertaken to maximize these cognitive inputs.

- It is suggested that, based on the findings of this research, it might be possible to maximize these cognitive factors for hearing impaired children by customizing more high-level acoustic patterns through improved hearing aid fitting techniques.

- This study is significant because it promises further understanding of why, even with appropriate hearing aid fitting and use of hearing aids, these children still lag behind their peers with normal hearing, and it holds out hope that in the future some additional intervention based on the findings here may be possible.

Weaknesses

- None noted.

Investigator(s):

Strengths

- Principal investigator has been very productive during the previous cycle.

- Six co-investigators will make specific contributions to the research.

- Presence of a statistician is a plus.

Weaknesses

- None noted.

Innovation:

Strengths

- It is innovative to consider these cognitive functions and the possibility that they have not fully developed in hearing impaired children.

- It is also innovative, and will be of considerable interest, to have these measurements in both hearing impaired and normal hearing children.

Weaknesses

- None noted.

Approach:

Strengths

- Hearing aid function will be monitored at each study visit – this is critical and appropriate.

- The approach is systematic, with three experiments in each of the three aims: one to test speech recognition in noise, one to measure elements of spectral resolution (ripple discrimination and detection) and one to measure these functions at 3 different time points (longitudinal).

- They will, as much as possible, use the same subjects across all the experiments.

- Measuring weighting functions to find patterns of perceptual importance of particular frequency bands can lead to being able to use those weights in hearing aid fitting.

- Each experiment includes the hypotheses underlying the question, and predictions of what the findings might mean.

Weaknesses

- None noted.

Environment:

Strengths

- The experiments will be undertaken at ███████████████ Research Hospital. This is an institution with a considerable reputation for research on communication difficulties in children, and with highly qualified and diversified faculty and environment.

- There could not be a better place to carry out this work.

- They have a large clinical population of children – both normal hearing and hearing impaired, and an easily accessible data base of potential research subjects.

- Some of the experimental work will also be undertaken at the University ██████ also with very good environment and facilities.

Weaknesses

- It was not clear why the University ██████ is included in this project and what the expectations are, and contributions will be, for this second institution.

Protections for Human Subjects:

Acceptable Risks and/or Adequate Protections

- Processes are in place to safeguard both the safety and confidentiality of subjects

Data and Safety Monitoring Plan (Applicable for Clinical Trials Only):

   Not Applicable (No Clinical Trials)

Inclusion of Women, Minorities and Children:

- Sex/Gender: Distribution justified scientifically
- Race/Ethnicity: Distribution justified scientifically
- For NIH-Defined Phase III trials, Plans for valid design and analysis:
- Inclusion/Exclusion of Children under 18: Including ages <18; justified scientifically
- Both boys and girls will be included in the recruitment. Ages will be from 6 to 12 years for most of the experiments. A small group of adults with normal hearing will also be recruited for one of the experiments. The institution has made significant improvements in recruiting minorities and continues to emphasize those goals

Vertebrate Animals:

Not Applicable (No Vertebrate Animals)

Biohazards:

Not Applicable (No Biohazards)

Resubmission:

- Very good responses to the previous review, with appropriate changes made to the research plan.

Renewal:

- The progress report was excellent, with nearly 30 publications during the previous cycle, and multiple scientific presentations. Obviously, a very productive team.

Budget and Period of Support:

Recommend as Requested

CRITIQUE 2:

Significance: 2
Investigator(s): 1
Innovation: 2
Approach: 3
Environment: 1

Overall Impact: This is an excellent application from an established principal investigator and strong research team that addresses an important topic: the ability of children with hearing loss to understand speech in noise. The experimental approach is designed to assess the importance of selective attention and working memory on the ability to understand one talker among competing talkers or other sources of sounds and addresses the extent to which successful hearing aid fittings depend on these abilities. The application of the proposed methods to this population is innovative and rigorous and the underlying scientific premise is very strong. The principal investigator has the background and track record to assure that the plan of study will be implemented as proposed and the research team adds considerable expertise to the project. Enthusiasm is high for this application which promises to generate important new findings that will have a significant impact on the field with the potential for high translational value.

Sex as a biological variable is explicitly addressed both in subject recruitment and in the design of the statistical analyses of the results.

Significance:

Strengths

- The problem of hearing in noise for children with hearing loss is important with advances in our knowledge of this problem, and how it can best be treated, likely to have a significant impact on the field.

- The underlying scientific premise that selective attention supports language development and working memory is sound and approaching the problem of hearing in noise from a selective-attention based perspective is likely to yield important new findings.

- The proposed work has both scientific merit and translational value.

- The focus on the benefit of hearing aids for children listening to speech in complex, multiple-source environments has high face validity and is a very important line of work.

Weaknesses

- None noted.

Investigator(s):

Strengths

- Established principal investigator leads strong research group with appropriate background and expertise to conduct research plan as proposed.

Weaknesses

- None noted.

Innovation:

Strengths

- Although many of the individual tests are established and are not unique to this application, the comprehensive nature of the approach is novel.

- Consideration of audiologic, perceptual and cognitive factors as predictors of speech in noise/speech performance and the potential benefit/detriment of broadband amplification is highly innovative.

Weaknesses

- None noted.

Approach:

Strengths

- Specific hypotheses concerning the relationship between selective attention and working memory, spectral resolution, distribution of weights across frequency and ability to overcome informational masking provide a strong basis for empirical tests and relate directly to the underlying scientific premise.

- The emphasis on relating selective attention to speech in noise/speech performance is a major strength as applied to this problem in the pediatric population.

- Focusing on determining the factors underlying the variation across individuals in speech in noise performance is a strength of the approach and likely to have high translational value.

- Explicit consideration of the possible negative consequences of amplification for children who have not developed sufficient selective attention abilities enhances the significance of the approach.

- The proposed methods and analyses are rigorous and, in some cases, quite innovative.

Weaknesses

- The mix of factors influencing performance makes integration of findings across experiments challenging. The way that this will be addressed is unclear in places, slightly diminishing rigor.

Environment:

Strengths

- The environment is outstanding and comprises a major strength of the application.

Weaknesses

- None noted.

Protections for Human Subjects:

Acceptable Risks and/or Adequate Protections

- Extensive experience testing this age group (children) demonstrates facility with conducting the research plan safely and with appropriate protections of human subjects.

Data and Safety Monitoring Plan (Applicable for Clinical Trials Only): Not Applicable (No Clinical Trials)

Inclusion of Women, Minorities and Children:

- Sex/Gender: Distribution justified scientifically
- Race/Ethnicity: Distribution justified scientifically
- For NIH-Defined Phase III trials, Plans for valid design and analysis: Not Applicable
- Inclusion/Exclusion of Children under 18: Including ages <18; justified scientifically

- Primary subject group ages 6-12. Sex as a biological variable explicitly incorporated into statistical design.

Vertebrate Animals:

Not Applicable (No Vertebrate Animals)

Biohazards:

Not Applicable (No Biohazards)

Budget and Period of Support:

Recommend as Requested

CRITIQUE 3:

Significance: 2
Investigator(s): 1
Innovation: 2
Approach: 2
Environment: 1

Overall Impact: This application aims to investigate the variability in speech recognition abilities in children with hearing loss (CHL), with a focus on the effect of background noise. This is a pressing issue, given the prominence of background noise, e.g., in school settings. Aim 1 examines the role of attention and working memory processes, Aim 2 aims to characterize the importance of particular acoustic parameters, and Aim 3 investigates the role of selective attention in informational masking paradigms. The application is well structured and provides substantial pilot data and there is great enthusiasm for the approach; however, the interpretation of some of these data as presented in the application is possibly over-stated.

Significance:
Strengths

- Better understanding how background noise (e.g. in school settings) affects speech perception in CHL is an important and critical step to help CHL better function in their daily environments.

Weaknesses

- None noted.

Investigator(s):
Strengths

- The principal investigator and team have an excellent publication record for their previous funding period.

Weaknesses

- None noted.

Innovation:

Strengths

- The inclusion of higher-level cognitive metrics as predictors for speech perception performance is relatively innovative.

Weaknesses

- None noted.

Approach:

Strengths

- The test batteries and equipment used seem appropriate.

Weaknesses

- The slopes of the regressions in Fig. 4 look driven by two points for both Flanker and Switcher tasks: approx. (-0.8,-9.6) and (1.8,-2.2) in the Flanker task, approx.. (-0.8,-9.6) and (1.4,-2.2) in the Switcher task; it is unclear whether these points correspond to the same two participants. The dependence of the regression slopes on these values may indicate that the measures are not appropriately sensitive. A similar question may be raised for Fig. 3, approx. (-13,-5).

- Fig. 5: the authors may be overinterpreting their data with respect to the importance difference between 2 vs. 4 kHz bands as a function of age; for that matter, 1 kHz and 8 kHz also show similar effects.

- Aim 1a: The choice of the two carrier frequencies (500 Hz, 2000 Hz) is not well explained. If anything, an even higher carrier should be included. The application does not discuss whether there exists evidence that spectral ripples have a different impact on different carrier frequencies.

Environment:

Strengths

- The scientific environment, available equipment and access to participants is excellent at ████ ██████████████████ Hospital.

Weaknesses

- None noted.

Protections for Human Subjects:

Acceptable Risks and/or Adequate Protections

Data and Safety Monitoring Plan (Applicable for Clinical Trials Only): Not Applicable

Inclusion of Women, Minorities and Children:

- Sex/Gender: Distribution justified scientifically
- Race/Ethnicity: Distribution justified scientifically
- For NIH-Defined Phase III trials, Plans for valid design and analysis: Not Applicable
- Inclusion/Exclusion of Children under 18: Including ages <18; justified scientifically

Vertebrate Animals:

Not Applicable (No Vertebrate Animals)

Biohazards:

Not Applicable (No Biohazards)

Resource Sharing Plans:

Acceptable

Budget and Period of Support:

Recommend as Requested

THE FOLLOWING SECTIONS WERE PREPARED BY THE SCIENTIFIC REVIEW OFFICER TO SUMMARIZE THE OUTCOME OF DISCUSSIONS OF THE REVIEW COMMITTEE, OR REVIEWERS' WRITTEN CRITIQUES, ON THE FOLLOWING ISSUES:

PROTECTION OF HUMAN SUBJECTS: ACCEPTABLE

INCLUSION OF WOMEN PLAN: ACCEPTABLE

INCLUSION OF MINORITIES PLAN: ACCEPTABLE

INCLUSION OF CHILDREN PLAN: ACCEPTABLE

COMMITTEE BUDGET RECOMMENDATIONS: The budget was recommended as requested.

Footnotes for 2 R01 DC013591-06A1; PI Name: McCreery, Ryan W.

NIH has modified its policy regarding the receipt of resubmissions (amended applications). See Guide Notice NOT-OD-14-074 at http://grants.nih.gov/grants/guide/notice-files/NOT-OD-14-074.html. The impact/priority score is calculated after discussion of an application by averaging the overall scores (1-9) given by all voting reviewers on the committee and multiplying by 10. The criterion scores are submitted prior to the meeting by the individual reviewers assigned to an application, and are not discussed specifically at the review meeting or calculated into the overall impact score. Some applications also receive a percentile ranking. For details on the review process, see http://grants.nih.gov/grants/peer_review_process.htm#scoring.