

SUGGESTIONS FOR FUTURE DIRECTION AND CONCLUDING COMMENTS

This final report for NIA2 contains a rich body of information regarding the NIA2 project, and we have already discussed the extent to which the NIA2 project's three Specific Aims as well as the implicit educational goals were met. In this final section, we the evaluators offer our overall conclusions regarding the major themes that emerged during the evaluation process and make recommendations for future directions.

Suggestions for Future Directions

There are already numerous suggestions embedded within the evaluation narrative above. The recommendations below were created as a result of being themes that we have repeatedly run into through multiple sources of data. The first two suggestions deal directly with the future of NIA2. The last two focus on creating and sustaining a larger community of users.

- ***Continue working on the tutorials in progress and refer back to the “wish-lists” in this report for future tutorial ideas.*** First and foremost, we applaud you for being so responsive to your audience, really listening to NIA1 users and making changes to the NIA2 interface that have definitely improved the usability and value of the product. It was definitely the right move at the right time. We understand that this “project detour” made it almost impossible to complete all of the plans you outlined in the NSF proposal. We want to strongly encourage you to keep moving forward with the specialized tutorials. When you finish with those, you will find that NIA2 instructors around the country are more than willing to share with you their ideas for new tutorials. For a start, refer back to the “wish-list” sections of this report. Already there are some interesting suggestions from current users. Frankly, you have terribly spoiled many students and instructors. Once they have experienced learning in this dynamic way, they want to be able to explore all of their course content in that manner.
- ***Consider a more “guided discovery” approach to “Why do you think this happens?” types of questions.*** As we have heard from many students and instructors, the greatest strength of NIA2 lies in its dynamic environment, which allows students to bring to life cellular-level processes via mathematical models that once were just equations on a page for many students (if that). By interacting with these models through parameter changes, students can now “see” what is happening and ask, “What if I...?” Neuroscience concepts are discovered and curiosity is ignited. Yet, the NIA2 authors and classroom teachers want even more. Observing what happens is not enough. Instructors want students to connect what they see to the biology and explain behavior within the context of underlying physiological mechanisms that drive the observed processes to arrive at the answer to the overarching question: “Why did that happen?” During our site visits, we noted that the majority of the students struggled with making these connections, even with the help of knowledgeable faculty and teaching assistants. These students are at some of the best colleges and universities in the country. From our explorations of the various links within NIA2 and discussions with instructors and the PIs, we have come to realize that the level of thinking required to answer these “why” questions (and sometimes *just to understand someone else’s explanation*) is at a much deeper level than many students have experienced before. They need to be led more incrementally

to that deeper understanding of why. This is not an easy task. If the “guiding questions” are broken up into too many tiny pieces, they focus on the minutiae and never see the big picture. If they are told too much, then they have not discovered it for themselves. Without enough guidance, students get frustrated and never realize there are steps they can take themselves to get to that deeper understanding. We feel there are two things that could be added to some of the newer tutorials to help students gain access to these more mature levels of thinking:

1. *Provide richer detail in setting up the physiological context(s) of the processes and simulations in some of the newer tutorials.* An example, for the *Coincidence Detection* tutorial, more details could be brought out about the auditory system (see Emory University case study) and explicit connections could be made to the fact that you are dealing with a circuit of neurons as opposed to a single neuron.
 2. *Instead of just asking, “Why do you think this happens?” set up a sequence of a few scaffolding questions that help students build up the knowledge needed (about the graph, about the physiological context, about the neurotoxin used and what it does to a cell, etc) to make the necessary connections.*
- ***In order to see how valuable this tool could be in their classrooms, instructors need to get their hands on NIA2 and play with it.*** In order to see how valuable this tool could be in their classrooms, instructors need to get their hands on NIA2 and play with it. Perhaps the most vivid example of this phenomenon is Williams College professor Steve Zottoli. As we previously noted, most of the faculty with whom we spoke regarding the evaluation had heard about NIA2 (or the prototype NIA1) from Ann Stuart or John Moore, either through one on one conversation or through talks at professional meetings. Steve Zottoli had a copy of NIA2 sitting in a desk drawer for nearly a year, despite being initially excited by Ann's "inspiring presentation" at Woods Hole. Guilt, rather than renewed interest, motivated him to come back to NIA2 before seeing Ann again the following summer. That attitude quickly changed almost as soon as he opened a tutorial and tried a few experiments. He told us that he was quickly absorbed in the program and within an hour was excited about the possibilities for his students. We can say from first-hand experience that we too were intrigued very early on, even though we had little neuroscience experience. Presumably we are not unique. The same playability that captures students' attention appears to hold true for faculty. Talking catches people's interest; action keeps it. We strongly recommend that Ann give more NIA2 workshops on NIA2 (in her abundant spare time). Perhaps they could be structured similarly to her first SPINES introductions to NIA2, where faculty can work through one or more tutorials with Ann's guidance. We were incredibly impressed with how well this went over with the 2008 SPINES participants. We know that one such workshop was held for first-year graduate students at Georgetown in the fall of 2008. As Steve Zottoli noted, faculty who have successfully used NIA2 could also be called upon to share their enthusiasm and experience in some sort of workshop format. Finally, there is also an opportunity to use the latest in technology to further the dissemination of NIA2. If the iTunes model is used to distribute future NIA2 tutorials, it would not be at all difficult for Ann to create some podcasts or instructional minimovies to assist instructors in getting NIA2 into the classroom. Even if the iTunes model is not implemented, the NIA2 web site could host downloadable videos in one or more of the common formats.

Instructors need an active venue to share ideas on how to use NIA2 in their classrooms. Instructors need an active venue to share ideas on how to use NIA2 in their classrooms. One thing that became clear during the evaluation is that NIA2 is being used in a very broad variety of ways, from including minimovies or demos in a lecture class to one or two labs in a larger course to entire courses built around NIA2, either with or without wet labs. Many instructors would like to use it even more than they currently do, but are hampered by external constraints on their course content. Overall, this is phenomenal. Furthermore, many of the instructors we spoke to, especially those who participated in the case studies, are going well beyond what they find in the NIA2 text, creating additional homework sets and projects that allow their students to extend NIA2 concepts and investigate real-world problems. Many faculty noted that it can take a great deal of time for instructors to become familiar with NIA2, especially if they do not have a neurophysiology background. The instructors we spoke to at Emory said that the time it takes to create novel and grade problems is a barrier to offering the NIA2 experience to more students. Currently there are a few instructional materials and suggestions for instructors who wish to use NIA2 in various courses on the NIA2 web site (<http://neuronsinaction.com/instructors/overview>). This web site should be expanded *and widely publicized* at the earliest available opportunity. We feel it is quite likely that many instructors would share their materials, especially if there is a realistic opportunity to obtain other materials in trade. Wikis have also become widely available and make it easy for users to link, post, share, and edit information. As we have learned from prior evaluations of educational innovations, instructors who feel like the “lone violin” often fail to be able to effectively implement new ideas. Peer to peer sharing and community building are essential for creating and supporting change.

Concluding Comments

The evaluation of the NIA2 project has been an amazing adventure that has challenged us as evaluators and as educators. It has been fairly daunting to us step out of our comfort zone into the world of undergraduate neuroscience education. There are probably some sections of this report where our neuro-naivete shines through clearly. However, we have rarely been involved with in a project that has made such a profound impact on education, both in terms of learning and teaching, as the NIA2 project. Spending time talking with the PIs at Woods Hole in 2008 brought home for us the depth of their dedication and the amount of time they have spent considering how to best educate students in the highly complex functions and processes of neurons. While NIA2 has been a long time arriving (since the ideas existed long before the technology to implement them dynamically and effectively), this is only the beginning of what it can ultimately become. Even now, the PIs are hard at work on new tutorials and extensions of the existing ones. To paraphrase a student's comment about NIA2, "there are always more questions out there to answer." The fact that this educational package is "piggybacked" onto a research tool that is itself constantly evolving to meet new challenges will continue to open doors for new tutorials. Furthermore, as the neuroscience research body and demands grow, so will the ideas for pushing the traditional boundaries for undergraduate neuroscience education. Finally, because of NIA2, education at even the most basic levels can better reflect and keep pace with what is being discovered in the research labs.