Examining the first-person perspective as appropriate prelaboratory preparation

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Submitted 17 December 2018; accepted in final form 6 May 2019

Nederveen JP, Thomas ACQ, Parise G. Examining the first-person perspective as appropriate prelaboratory preparation. Adv Physiol Educ 43: 317–323, 2019; doi:10.1152/advan.00213.2018.—Prelaboratory tasks are used to facilitate learning and introduce and provide context for laboratory work. The application of first-person perspective (FPP) technology may provide interesting new approaches to providing prelaboratory preparation. However, there is limited knowledge as to whether this perspective is useful or enjoyable for students preparing for laboratory tasks. The purpose of this study was to examine whether prelaboratory preparation, utilizing the FPP technique, was enjoyable and led to improvements in laboratory task-specific self-efficacy in comparison to the traditional text-only (TO) style. We observed that the FPP group found the style to be generally more enjoyable, entertaining, and generally fun compared with the TO group (5.3 ± 0.2 and 2.7 ± 0.3, respectively, P < 0.05). Furthermore, we found that the FPP group had a greater laboratory task-specific self-efficacy than their counterparts in the TO group, following the prelaboratory preparation (93.6 ± 1.6 and 83.5 ± 3.2, respectively, P < 0.05). We did not find any differences in scenario-based self-efficacy between the FPP and the TO group. Taken together, our data support the use of FPP videos as a novel, refreshing approach to prelaboratory preparation that builds self-efficacy in students performing laboratory tasks.

Nederveen JP, Thomas ACQ, Parise G. Examining the first-person perspective as appropriate prelaboratory preparation. Adv Physiol Educ 43: 317–323, 2019; doi:10.1152/advan.00213.2018.—Prelaboratory tasks are used to facilitate learning and introduce and provide context for laboratory work. The application of first-person perspective (FPP) technology may provide interesting new approaches to providing prelaboratory preparation. However, there is limited knowledge as to whether this perspective is useful or enjoyable for students preparing for laboratory tasks. The purpose of this study was to examine whether prelaboratory preparation, utilizing the FPP technique, was enjoyable and led to improvements in laboratory task-specific self-efficacy in comparison to the traditional text-only (TO) style. We observed that the FPP group found the style to be generally more enjoyable, entertaining, and generally fun compared with the TO group (5.3 ± 0.2 and 2.7 ± 0.3, respectively, P < 0.05). Furthermore, we found that the FPP group had a greater laboratory task-specific self-efficacy than their counterparts in the TO group, following the prelaboratory preparation (93.6 ± 1.6 and 83.5 ± 3.2, respectively, P < 0.05). We did not find any differences in scenario-based self-efficacy between the FPP and the TO group. Taken together, our data support the use of FPP videos as a novel, refreshing approach to prelaboratory preparation that builds self-efficacy in students performing laboratory tasks.

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INTRODUCTION

The practical component to undergraduate education in the field of science usually involves a laboratory component as part of a traditional classroom course. There is considerable evidence to suggest that an undergraduate curriculum involving laboratory components provides a vehicle to deeper learning and offers opportunities for problem solving to the involved student (32), which can be facilitated with proper prelaboratory preparation (10, 27, 34a, 41). When put into the context of an undergraduate level laboratory class, prelaboratory preparation becomes more important, given the restrictive laboratory time periods and the potential stressors of laboratory-related assessments (e.g., laboratory report). In these conditions, students are likely to focus entirely on “getting through the laboratory,” as opposed to more fully understanding the underlying concepts (24); application of the scientific procedure (22) provides

experimental context (30) and ultimately improves course performance (36). Indeed, a student who does not have the prerequisite introduction to these skills will tend to focus on the technical aspect of the laboratory (12, 25). When considering pipette use or other manipulative skills common in undergraduate science laboratory experiments, the application of prelaboratory learning, while varied, has been shown to be effective in life sciences (18, 23). Taken together, students who enter the laboratory with the appropriate theoretical framework are not only more likely to derive a greater benefit from the practical application (i.e., pipetting skills, laboratory equipment usage), but also will be able to remain relaxed and attentive to the task at hand.

While the application of laboratory preparation has been varied in scope and in methodology, the “flipped-learning” or “blended-learning” platforms have been shown to provide a promising approach, adding appropriate prelaboratory knowledge. These approaches can facilitate learning by integrating both face-to-face and online instruction (19) and in this capacity can support an enhanced laboratory experience (22, 27, 39) through the use of digital resources. These approaches have been generally well received in the laboratory environment (42) and have utilized a plethora of learning techniques, including online modules, video clips reviewing laboratory procedures and data analysis, or other prerecorded media (11, 14, 27, 44).

While this blended learning approach, utilizing videos and pictures (typically from a second-person or third-person viewpoint), is likely efficacious for improving learning, new evidence suggests that learning skills can also drastically improve following first-person (FP) experiences. Interestingly, when presented with a FP view of a complex virtual environment, individuals demonstrate improved performance in video game scenarios (6, 20, 21), as well as changes in neural plasticity (46). In terms of using FP perspective (FPP) in the classroom, the aspect of using commercially available devices (i.e., GoPro, Google Glass) has been explored during the teaching of surgical techniques (5) and the use of nuclear magnetic resonance machines (15, 16) and in visual social sciences (7, 8). Taken together, these studies suggest that there is a growing interest in the FP viewpoint as it pertains to education. Work from Fung (15) outlines some of the pitfalls and technical aspects of capturing FP videos, but there is a marked paucity in the literature regarding whether students who are exposed to these videos find them to be enjoyable and/or useful in preparing for laboratory tasks. Importantly, the implementation of...
improved prelaboratory education may subsequently lead to improved self-perceptions of preparedness in undergraduate students during laboratory experiments. Therefore, the purpose of this study was to examine whether prelaboratory videos, utilizing the FPP technique, are 1) enjoyable to undergraduate students; and 2) lead to task self-efficacy before the completion of a given laboratory task.

**METHODS**

**Participants.** Participants were undergraduate students who had no previous experience performing laboratory techniques in a wet laboratory environment (n = 30; 10 women, 20 men; 20.7 ± 0.7 yr of age). Participants were screened for previous laboratory experience, and participants with previous wet laboratory experiences were excluded from the study. Following screening, participants provided informed consent. The study was reviewed and approved by an institutional research ethics board before any recruitment or data collection.

**Educational context.** The Exercise Metabolism Research Group (EMRG) at McMaster University is a collective of the Vascular Dynamics Laboratory, Molecular Exercise Physiology and Muscle Aging Laboratory, Protein Metabolism Research Laboratory, Integrative Neuromuscular Biology Laboratory, and the Human Performance Research Laboratory. These laboratory environments attract undergraduate students from the Faculty of Science and the Faculty of Health Science at McMaster University, completing various research practicums, projects, and/or theses. Typically, these students are upper level undergraduates (i.e., level III or IV), but their previous exposures to the wet laboratory and/or laboratory skills (e.g., pipetting, scale balancing) are widely variable. These students have also formally completed their laboratory safety training, including, but not limited to, Workplace Hazardous Materials Information System Biohazard, Chemical Fume hood, and Fire Safety training, as well as having been informed on the appropriate use of personal protective equipment (PPE). During the academic term, incoming students into the EMRG have not begun any experiments, but instead go through a training period for various tasks in the laboratory, like those found in undergraduate biochemistry laboratories (e.g., calibrating pH meters, creating saline solutions).

**Experimental overview.** Before the prelaboratory task intervention, participants completed a general self-efficacy questionnaire relating to the participants’ perceived laboratory technical ability. The participants were then randomized into a “text-only” (TO, n = 15) group and a FPP (n = 15) group. Following this, prelaboratory preparation was delivered via both laboratory task background (in text only) and step-by-step instructions relating to the performance of the laboratory task. The TO group received these instructions via text only, the FPP group received these instructions through FPP. Subsequently, participants in both TO and FPP groups were asked to complete a task enjoyment questionnaire, as well as a questionnaire comparing their prelaboratory preparation (i.e., TO and FPP, respectively) to their previous experience of prelaboratory preparations. Participants were asked to complete a laboratory task-specific self-efficacy questionnaire. Following the prelaboratory task, task enjoyment, and task-specific self-efficacy questionnaires, participants proceeded to the laboratory bench to begin the experiment. The experiment consisted of a trained graduate student observing (i.e., 1:1 student-to-teaching assistant ratio) a pH meter calibration and then the creation of a phosphate-buffered saline solution by the participant. The trained observer was able to provide help if required (as would be the case in a laboratory experiment within an undergraduate level course) but refrained from taking an active role or offering unsolicited advice. As a note, none of the participants (n = 30) required assistance information from the observer. The experiment was performed under a 45-min time limit, as to appropriately mimic an undergraduate laboratory session, and all participants (n = 30) completed the task in the allotted time frame. On completion of the laboratory task, participants were asked to repeat the task-specific self-efficacy questionnaire, to observe if there was a change following completion of the laboratory task. Finally, participants were asked to complete a future scenario-based self-efficacy questionnaire.

**Student perception of general self-efficacy.** The New General Self-Efficacy scale (9) was utilized to assess participants’ perceptions of their general abilities relating to laboratory work before the commencement of the prelaboratory task or the laboratory task. The scale consisted of eight questions/items, rated on a 5-point Likert-type scale (29) and was set to range from 1 (“strongly disagree”) to 5 (“strongly agree”). Example items include: “I am confident I can perform effectively on many different tasks,” “I am confident that I can follow safety guidelines in the laboratory,” and “I am confident that I can overcome technical challenges.”

**Prelaboratory preparation task.** Participants in both groups completed an assigned reading (1 page) that provided context to the laboratory experiment, including background information, an overview of the purpose of the experiment, and the applications of the experiment, but, specifically, no step-by-step instructions. Then participants in the FPP group observed a video demonstration (edited for time delay). During the video, the instructor 1) introduced the laboratory equipment via visual inspection; 2) demonstrated the proper and improper usage of the equipment involved; 3) demonstrated safety precautions that must be met; 4) described the step-by-step instructions; and 5) performed the experiment in a time-edited manner. Participants in the TO group read a printed text-only copy of the laboratory task as their prelaboratory preparation, which included the same script as spoken, verbatim, in the video shown to the FPP group, to prevent the potential for different details being provided to the different groups. At this stage, both TO and FPP groups were given the laboratory task list as a reference for the completion of the task.

**FPP video.** The FPP video was captured using a GoPro Hero 4 Session (GoPro), using the 720p (240 frames/s) and wide-view camera settings. This iteration of the GoPro (camera and housing) had the following dimensions: 38 mm height, 38 mm width, 36.4 mm depth; and 74 g weight. The position of the camera was on the demonstrator’s forehead (Fig. 1, A and B), to mimic the perspective of the demonstrator as well as possible (refer to Fig. 1C for the point of view).

**Prelaboratory task preparation enjoyment.** The intrinsic motivation inventory (IMI) (13, 33, 40) is a measurement tool that assesses the participants’ subjective experience, as it relates to a target activity, in this case, the prelaboratory task. The IMI was delivered following the competition of the prelaboratory task. Within this IMI, participants were asked how the prelaboratory task that they completed compared with previous experiences The questionnaire was made up of the following statements: 1) “I enjoyed this prelaboratory more than my previous laboratory experiences”; 2) “I thought this prelaboratory activity was more fun than my previous laboratory experiences”; 3) “I thought this was an interesting way to prepare for a laboratory”; 4) “I felt that this prelaboratory preparation was refreshing”; 5) “I prefer to experience my prelaboratory preparation like this”; 6) “I thought this prelaboratory activity was boring”; 7) “I thought this prelaboratory activity was more boring than my previous prelaboratory experiences”; and 8) “I felt frustrated by this prelaboratory preparation.” The scale consisted of eight items, rated on a 7-point Likert-type scale, and was set to range from 1 (“not true at all”) to 7 (“very true”). This tool has been validated (33). Participants were also encouraged to answer in a free-form answer in additional space provided.

**Student laboratory task-specific confidence.** The laboratory task-specific self-efficacy questionnaire was designed to determine how confident participants were when it came to critical tasks within the greater laboratory task. The questionnaire was made up of the following questions: 1) “I can do appropriate PPE properly”; 2) “I can
handle the pH meter electrode properly; 3) “I can use the auto-calibration setting on a pH meter”; 4) “I can acquire MilliQ water required for experiment”; 5) “I can properly tare the scale”; 6) “I can weigh materials used to create solution”; 7) “I can use the auto-calibration setting on a pH meter”; and 8) “I can properly split NaOH tablets”; and 8) “I can pipette HCl dropwise into 10× PBS solution.” As per the guidelines set out by Bandura (4), participants rated their confidence for each item using an 11-point scale: 0 (not at all confident) to 100 (totally confident). The participants completed this questionnaire at the end of the prelaboratory preparation and then again after the completion of the actual laboratory task.

Student perception of future performance in a scientific scenario-based manner. The self-efficacy for task performance following the laboratory task was assessed using recommendations by Bandura (4). The items were prefaced with the statement, “Compared to how well I did last time, I am confident that I can perform better/worse.” Following this was a gradation of performance, relative to the participant’s perceived performance on the laboratory task just completed. The questionnaire was made up of the following questions: 1) “When I am teaching this to other undergraduate students . . .”; 2) “When I am feeling under pressure in the laboratory . . .”; 3) “When I am tired . . .”; 4) “When an observer from another laboratory is present . . .”; 5) “When I have other tasks that must be performed . . .”; 6) “When I have spent time away from the laboratory (i.e., vacation) . . .”; and 7) “When I am performing this early in the morning . . .”. As per the guidelines set out by Bandura (4), participants rated their confidence for each item using an 11-point scale: 0 (not at all confident) to 100 (totally confident).

Statistics. To determine whether there were any statistical differences between groups, a Student’s t-test was performed (P > 0.05). All results are expressed as means ± SE.

RESULTS

Student perception of general science skill self-efficacy in a laboratory setting before observing the prelaboratory preparation. We report that there was no significant difference between student feelings of general self-efficacy regarding general laboratory skills between the FPP and the TO groups in response to the eight items, as measured by the 5-point Likert scale. The individual responses to eight of the items were then averaged to create a general self-efficacy score for each individual, and there was no statistical difference detected between the TO group (4.4 ± 0.1) and the FPP group (4.5 ± 0.1; P > 0.05, data not shown).

Student enjoyment of prelaboratory preparation. A total of eight questions were posed to the students in both groups, following the completion of either the TO- or FPP-delivered prelaboratory task. A 7-point Likert scale (where an answer of 1 = not true at all, 4 = somewhat true, and 7 = very true) was used. The scale requiring the student to circle the most appropriate answer; free-form comments were also asked for but not required. For each of questions 1–5 (questions related to student enjoyment), the students in the FPP group had a greater level of enjoyment compared with the TO group (P < 0.05). The individual responses to the five questions were averaged to create an “overall” enjoyment score for each individual. We find that the overall enjoyment (i.e., across all 5 questions) was greater in the FPP group compared with the TO group (5.3 ± 0.2 and 2.7 ± 0.3, respectively, P < 0.05, Fig. 2). Student responses were reversed for questions related to the prelaboratory task being “boring, comparatively boring, frustrating” in questions 6–8, with the students in the FPP group reporting a lower “overall frustration” compared with their counterparts in the TO group (2.2 ± 0.2 and 3.8 ± 0.4, respectively, P < 0.05, data not shown).

Student perception of task-specific self-efficacy following prelaboratory task preparation. A total of eight questions that were related to the students’ confidence to complete specific tasks within the laboratory were posed to the students in both groups, following the completion of either the TO- or FPP-delivered prelaboratory task. A 11-point scale (0 registered as “cannot do at all,” 50 registered as “moderately certain can do,” 100 registered as “highly certain can do,” increasing by increments of 10) was used. For two subtasks, question 3, “I can use the auto-calibration setting on a pH meter,” and question 7, “I can properly split NaOH tablets,” the FPP group reported a statistically greater score compared with the TO group (P < 0.05, Fig. 3A). The individual responses to eight of

Fig. 1. Demonstration of the setup used to capture the first-person perspective video. The Go-Pro Hero4 was located low on the forehead (A and B) to accurately capture the point of view of the wearer (C).
the items were averaged to create a specific-task self-efficacy score for each individual. We find that the average scores (i.e., across all subtasks within the laboratory task) were greater in the FPP compared with the TO group (93.6 ± 1.6 and 83.5 ± 3.2, respectively, \( P < 0.05 \), Fig. 3A), following the prelaboratory preparation.

**Student perception of specific-task self-efficacy following laboratory task.** Following the completion of the laboratory task, we reassessed the students’ confidence to complete the specific tasks in the laboratory task (i.e., do the students feel more confident after completing the laboratory task itself) using the same eight questions. Unsurprisingly, we found that individuals in the TO group scored significantly higher in the specific-task self-efficacy score following the laboratory task (97.0 ± 0.6; Fig. 3B) in comparison to their prelaboratory scores (83.5 ± 3.2; Fig. 3A, \( P < 0.05 \)). Similarly, in the FPP group, the individuals scored significantly higher following the completion of the laboratory task (97.2 ± 1.1, Fig. 3B) in comparison to their prelaboratory scores (93.6 ± 1.6, Fig. 3B, \( P < 0.05 \)). As we reported in the previous section, there was a significant difference in the students’ feeling of task-specific self-efficacy between the FPP and the TO groups following the completion of the prelaboratory task (Fig. 3A, \( P < 0.05 \)). Following the completion of the laboratory task itself, this difference was abolished (Fig. 3B, \( P > 0.05 \)).

**Student perception of scenario-based self-efficacy following the laboratory.** Following the completion of the laboratory task, we assessed the students’ scenario-based self-efficacy. Again, we used the 11-point scale (0 registered as “cannot do at all,” 50 registered as “moderately certain can do,” 100 registered as “highly certain can do”) across seven items to generate a scenario-based self-efficacy score. The items were prefaced with the statement: “Compared to how well I did last time, I am confident that in the future I would perform . . . .” Examples of questions pertaining to scenario-based self-efficacy were: “When I am tired . . .”; “When I am feeling under pressure in the laboratory . . .”; “When there are observers . . .”; and “When I need to teach other undergraduate colleagues . . .”. We found that the students in the FPP group (90.8 ± 2.0) were not significantly different in scenario-based self-efficacy compared with their counterparts in the TO group (86.5 ± 3.1, \( P > 0.05 \), Fig. 4).

**DISCUSSION**

In the present study, we report that prelaboratory videos utilizing the FPP technique appear to be more enjoyable to undergraduate students in the field of life sciences compared with the traditional text-only style of prelaboratory skills. We find that the students who observed the FPP style prelaboratory tasks had a greater task-specific self-efficacy before the completion of a given laboratory task. We report that both TO and FPP groups improved in task-specific self-efficacy following the completion of the laboratory task. We also found that,
while there was no significant difference in scenario-based efficacy between the TO and the FPP, a greater number of students in the FPP group were confident to a greater degree than their counterparts exposed to the text-only style of prelaboratory tasks. Taken together, these findings demonstrate that the utilization of FPP videos, as part of a blended learning approach within a wet laboratory environment, provides an enjoyable and ultimately meaningful method of teaching.

Previous studies have observed that a flipped or blended approach for prelaboratory tasks can improve skills within the laboratory in the basic sciences (42, 43). While many of these studies utilized a third-person video with much success, this viewpoint may be perceived as inauthentic (16). In contrast, the recent rise of wearable technology (e.g., Go-Pro, Google Glass) opens new avenues to teach laboratory skills in an entertaining and engaging way. Work by Fung (15) suggests that undergraduates in chemistry perceive the FP style of videos as engaging, strongly agreeing with the notion that learning laboratory skills through this perspective can enhance their education experience. Our work supports these findings and builds on them, with the undergraduate students who were randomized into the FPP prelaboratory task enjoying the task activity more than their counterparts in the traditional text-only format. By grouping the responses to questions relating to their enjoyment of the prelaboratory task, we determined that the FPP group significantly enjoyed their prelaboratory task compared with the traditional TO group. The FPP group also appeared to prefer this approach for future laboratory preparations, finding that the FPP videos were an interesting way to learn.

The general task enjoyment and the specific notion that the FPP may be an interesting way to provide prelaboratory information is important, considering that studies report that ~20% of chemistry students may not prepare at all (38). While our study was not designed to verify this, it stands to reason that, if prelaboratory preparations are more enjoyable, there may be a greater engagement in the preparation. Consistent with this, students found the FPP technique to be “more fun” than their previous experiences, with various students noting that the point-of-view perspective was “unique,” “helpful,” and “cool.” Importantly, students also commented that this perspective was “refreshing” and made the laboratory seem “quicker and easier to understand.” Ultimately, the generation of students currently enrolled at the undergraduate level are more attuned to this perspective of video, due to the reliance on computer-generated imagery in both movies and in video games alike. In this way, the FPP view can be both natural and also more entertaining. Taken together, these data suggest that the FPP style of videos shot through wearable technology provide for fun, enjoyable, and engaging prelaboratory modules.

While prelaboratory task enjoyment is important for learning, student self-efficacy and confidence to perform the laboratory task at hand is also a crucial outcome when discussing the impact of prelaboratory skills. Seminal work pioneered by Bandura in 1977 (3) outlined that self-efficacy was a major determinant of motivation, and, therefore, a driver of achievement and ultimately learning (2, 35). Ultimately, improved self-efficacy appears to have a positive influence on both the quantity and quality of learning (i.e., deep learning, greater cognition) (37). Here, we report that prelaboratory tasks provided from the FPP appeared to result in positive task-specific self-efficacy before the completion of the laboratory task. These findings mirror research regarding the importance of prelaboratory tasks, assignments, or quizzes (1, 39) for learning and/or academic achievement. Interestingly, the students in the FPP group appeared to have a greater task-specific self-efficacy than their counterparts in the TO group, suggesting that this delivery style may enhance the learning experience. These findings are supported by work by Maldarelli and colleagues (31), who observed that, following virtual laboratory demonstrations, there was a marked increase in undergraduate students’ mastery of biological laboratory techniques, including pipetting accurately and use of laboratory equipment. However, whether the improvement in task-specific and scenario-based efficacy would allow for a greater understanding of the foundation of scientific theory due to a lesser “stress” being placed on technical skill remains unknown. Previous work (44, 45) suggests that students who had watched prelaboratory videos in advance had felt more at ease with the theory of “why” they were performing the laboratory, and future studies should address if that holds true for FPP-style prelaboratory preparation.

Important to note, all student participants (n = 30), regardless of prelaboratory preparation style, were able to successfully calibrate the pH meter as designated by the laboratory assignment following the prelaboratory analysis, with no marked input from the observer. We did not assess actual performance outcomes (i.e., accuracy of the pH meter adjustment) or the positive impact of prelaboratory tasks on actual outcomes, such as student engagement or confidence (1, 26, 31, 42), as well as grades (10, 34, 36), all important indicators of an enhanced understanding. However, future studies should address whether FPP prelaboratory preparation videos are able to similarly improve postlaboratory quiz grades or some other aspect of academic performance. Furthermore, while the present study compares FPP videos to a more classical or traditional “text-only” prelaboratory preparation document, third-person videos, while not new (28), have also been used as a way to enhance student engagement (12, 22, 41) and are “visually stimulating” (18). Future studies should, therefore, address whether students prefer the FP or third-person video perspective, in terms of enjoyment and also subsequent confidence to perform laboratory tasks.
Taken together, our data support the use of FPP videos as a part of a blended and/or flipped approach to prelaboratory tasks. The FPP prelaboratory preparation was well-received by students as refreshing, entertaining, and more fun than previous experiences, all while enhancing task-specific self-efficacy. Future studies should address where these improvements in self-efficacy contribute to long-term knowledge building (e.g., knowledge retention, conceptual knowledge). The FPP, delivered through exciting “wearable technology,” is an entertaining and useful way to engage students in learning fundamental skills in a laboratory setting and will no doubt come to the forefront in teaching and learning.

ACKNOWLEDGMENTS
We thank all of the study participants and undergraduate volunteers for their time and effort. Furthermore, we acknowledge the technical assistance of Todd Prior and Denver Brown.

GRANTS
G. Parise was supported by a Natural Sciences and Engineering Research Council of Canada (NSERC) Grant (1455843). J. P. Nederveen was supported by a NSERC Canadian Graduate Scholarship (CGS-D).

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS
J.P.N., A.C.T., and G.P. conceived and designed research; J.P.N. and A.C.T., and G.P. interpreted results of experiments; J.P.N. prepared figures; J.P.N., A.C.T., and G.P. drafted manuscript; J.P.N., A.C.T., and G.P. edited a revised manuscript; J.P.N., A.C.T., and G.P. edited and approved final version of manuscript.

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