

PSYD62: The Neuroscience of Pleasure and Reward

Fall 2024

Professor Ravi Thiruchselvam
Course Email: thiruchselvam.psyd62@gmail.com
Seminar Time: Tuesdays 11am – 1pm
Location: AC 332

This course will focus on the affective neuroscience of pleasure and reward. The ability to feel pleasure and reward is one of the most fundamental capacities we humans have, and we share it to a large extent with many other species. What are the brain processes that underlie this capacity? How do these processes contribute to our social life, including humour, altruism, and attachment? How do they become dysfunctional in specific forms of psychopathology, such as psychopathy, addiction, and depression? We will explore current scientific debates and emerging findings about the brain bases of pleasure and reward and their role in human psychology.

Course Objectives

It is my hope that, by the end of this course, students would be able to:

- 1) Understand current scientific debates in the affective neuroscience of pleasure/reward and their connection to foundational theories and findings in the field.
- 2) Learn how to read and carefully decipher primary scientific articles in affective neuroscience, discerning the meaning and significance of both the core elements and finer details of the articles.
- 3) Develop critical thinking skills by identifying important strengths and limitations in current affective neuroscience research (e.g., in conceptual foundations, methodology, and data analysis or interpretation) and reflecting on potential ways to improve the state of the field.
- 4) Strengthen oral communication skills by actively engaging with peers and the instructor in thoughtful class dialogue and presentations.
- 5) Learn to write more effectively by completing reflection papers on assigned readings and a two-stage APA-style research proposal.
- 6) Identify the broader relevance of the content covered in the class to other academic disciplines (e.g., the arts, political science).

Course Email

All course-related emails must be sent to the following address:
thiruchselvam.psyd62@gmail.com

Messages sent to other addresses (e.g., to Quercus or the instructor's individual email account) may not be answered. Please ensure that the correct email address is used in all your course-related communications.

Course Webpage/Quercus

The website associated with this course is accessible on Quercus via <http://q.utoronto.ca>. The syllabus, relevant course documents, and announcements will be posted there. I strongly recommend that you check Quercus regularly.

Office Hours

Office hours will be held over Zoom on Mondays 6-8pm. You can join by using this link: <https://utoronto.zoom.us/j/89903064105>

If you cannot attend office hours but have questions about course content, performance in the class, or neuroscience and psychology more broadly, feel free to schedule a meeting. To do so, please email me at: thiruchselvam.psyd62@gmail.com

Course Evaluation/Marking Scheme

Seminar participation: 20%
Discussion questions: 8%
Article Analysis: 20% (two phases)
Student-led seminar discussion: 15%
Research proposal: 37% (12% outline and 25% final paper)

Below, I offer a high-level summary of each of the evaluation components in the course. A more detailed rubric, including the grading scheme, for each of these assessments will be shared separately as the course progresses.

Seminar Participation (20%)

Seminar classes offer an invaluable space to interact directly with your peers and instructor – to openly ask questions, share thoughts, and to ultimately learn from each other. For seminars to be most meaningful, it is important that students actively participate by contributing to class discussions. I invite you to view seminar discussions as an ongoing opportunity to develop and refine your oral communication skills – to learn how to ask better questions, express ideas more clearly, challenge arguments and offer alternative views. In addition to bringing us towards the ideas of *other people*, seminars can also be a helpful vehicle with which to investigate *our own* thinking carefully by inviting real-time feedback from peers and the instructor. To this end, we will aim to cultivate an atmosphere where respectful, non-judgmental dialogue is promoted and self-inquiry is valued. I understand that students may sometimes find it difficult to actively participate for different reasons (e.g., technical issues, shyness). If that is the case, please feel free to schedule office hours meetings with me to discuss potential solutions. Seminar participation will be graded based on regularity of attendance (you are expected to attend all

classes on time) and the thoughtfulness of questions and comments raised during the class discussion.

Discussion Questions (8%)

Prior to every seminar meeting, students will submit two discussion questions for each of the two assigned articles each week, for a total of 4 discussion questions per week. In each case, you are asked to clearly describe the question and add a brief (i.e., 3-5 sentence) explanation about why you believe this specific question is interesting or important. Student discussion questions for each week's assigned readings should be submitted sometime before our seminar meeting, by Mondays at 10pm at the latest on Quercus. Where possible, I will try to integrate students' questions into the seminar discussion for that meeting.

In addition, I will be posting my own set of discussion questions for the assigned readings each week on Quercus prior to every seminar meeting. You are encouraged to reflect on these questions as you read the assigned articles, as they will help orient your attention to aspects of the readings that will become the focus of our seminar discussions.

Article Analysis (20%)

You will select an empirical article from our set of assigned readings to summarize, analyze, and critique. This will be completed in two phases to promote self-reflection about your analysis. For your first submission, you will receive feedback from me alongside a set of novel questions about your report. Your second submission is expected to respond to my questions and incorporate my feedback where relevant, and it will be partly graded in how effectively it accomplishes that. The first and second report submissions will be due on October 16th at 11:59pm and November 22nd at 11:59pm, respectively. Additional details will be provided in class.

Student-led Seminar Discussions (15%)

Working in small groups, you will lead a class discussion for one seminar session to be held in Weeks 8-13 in the course. Your task will be to first summarize and present to the class the assigned readings for that week, and then to elicit and facilitate thoughtful seminar discussion about these readings. Group composition and topic selection will be based on a student preference survey completed within the first two weeks of the course, and it is expected that each group will consist of 3-4 students (although this may vary based on final course enrollment).

Following some introductory remarks from me about the topic, each group of students will first make a 30-minute presentation to the class summarizing each of the two assigned readings. For empirical articles, the presentation should cover the theoretical background and research strategy (e.g., the rationale for the research question, experimental methods, core findings, and broader implications). If the article being covered is theoretical, the presentation should strive to summarize the core features of the authors' arguments and reasoning clearly and succinctly. During the presentation, the content should be divided up such that each group member speaks

for approximately the same amount of time. Groups should practice together to ensure that the necessary information will fit into the allotted time.

The group will then devote the next 45 minutes in the session to generate class discussion about the presented articles. Specifically, the group's goal will be to ask the class questions and elicit their thoughts and insights about important features of the articles. You are encouraged to meet as a group with me prior to the presentation date to clarify outstanding questions and to solicit feedback about strategies to promote thoughtful class discussion about your assigned readings.

Research Proposal (37% total: 12% proposal outline and 25% final paper)

One goal of the course is to generate new hypotheses for research in the affective neuroscience of pleasure and reward. Since the field is relatively young, the possibilities for novel research questions are vast, and you are asked to think creatively to identify new questions and predictions. You will choose a specific topic within affective neuroscience that we cover in the course, review the relevant literature on it, construct novel predictions, design a study to test these predictions, and outline expected findings. This will culminate in an APA-style research proposal.

The research proposal will have two components: a proposal outline (due October 23rd at 11:59pm) and a final paper (due December 3rd at 11:59pm). The purpose of the initial proposal outline is to offer you feedback that can then be integrated into the final paper. For the proposal outline, you are asked to submit a brief (i.e., 2-3 page, double-spaced) summary of your planned proposal. This will include a justification of your research question based on a review of the literature and an overview of the research methods, including the study design and key measures. The final research proposal (expected to be 10-12 pages in length, double-spaced) should strive to elaborate on the core elements in your outline and integrate my feedback where possible. More details will be provided in class.

Class Format

We will meet in-person on Tuesdays 11–1pm in AC 332. Class will begin promptly at 11:10am. In general, I will begin most sessions with a brief lecture, offering context for our discussion of the assigned readings for that week. We will then open the session for class discussion, focusing on the discussion questions that I had posted online for that week. I will also aim to weave together into our discussion the questions that students have submitted prior to the seminar meeting.

Course Outline

I have tried to make the schedule as comprehensive as possible. However, I reserve the right to make minor adjustments as necessary. I will inform you of these changes as soon as possible.

DATE	TOPIC	ASSIGNED READINGS
Week 1 September 3 rd	Introduction to the course	No Readings
Week 2 September 10 th	An overview of pleasure systems in the brain	Berridge & Kringelbach (2008); Nummenmaa & van Dillen (2021)
Week 3 September 17 th	Pleasure in self-disclosure <i>Group assignments posted for student-led seminars</i>	Tamir & Mitchell (2012); Baek et al. (2017)
Week 4 September 24 th	Pleasure in humour and music	Mobbs et al. (2003); Salimpoor et al. (2015)
Week 5 October 1 st	Pleasure in social influence	Zaki et al. (2011); Campbell-Meiklejohn et al. (2012)
Week 6 October 8 th	Pleasure, effort, and pain: Rivals or cousins?	Harmon Jones et al. (2020); Rozin et al. (2013)
Week 7 October 15 th	Pleasure in altruism	Harbaugh et al. (2007); Karns et al. (2017)
Week 8 October 22 nd	Pleasure in maternal attachment <i>Student-led seminar discussion</i>	Strathearn et al. (2009); Mulligan et al. (2021)
Week 9 October 29 th	Reading Week	No Readings
Week 10 November 5 th	Dysfunction of pleasure in psychopathology: Psychopathy <i>Student-led seminar discussion</i>	Buckholtz et al. (2010); Jones & Neria (2019)
Week 11 November 12 th	Dysfunction of pleasure in psychopathology: Addiction <i>Student-led seminar discussion</i>	Oswald et al. (2014); Berridge and Robinson (2016)

Week 12 November 19 th	Dysfunction of pleasure in psychopathology: Depression <i>Student-led seminar discussion</i>	Schlaepfer et al. (2008); Proudfit (2015)
Week 13 November 26 th	Beyond pleasure: Emerging approaches in affective neuroscience <i>Student-led seminar discussion</i>	Griffiths et al. (2006); Carhart-Harris et al. (2016)

Reading Assigned Articles

A core aim in the course is to delve deeply into the theoretical and empirical literature on the affective neuroscience of pleasure and reward. I have done my best to select articles that are of reasonable length and complexity. However, some of these articles are dense (as they are written with current researchers in mind) and it may be helpful to read them more than once prior to class. To facilitate a deeper understanding of the assigned readings and to prepare for a thoughtful seminar discussion, please read the articles with at least the following four **general** questions in mind:

- 1) What claims are being made exactly? Are the claims supported by strong reasoning and evidence? Do you see any problems or concerns?
- 2) What assumptions are the author(s) making? Are these assumptions reasonable or can they be challenged? In this case, *assumptions* refer to ideas or beliefs that the authors seem to be relying on that are not explicitly stated.
- 3) For empirical papers: What are the specific methods (e.g., experimental design, independent & dependent variables) being used to investigate the research questions? Do these methods have weaknesses, and if so, how might you have conducted the study differently?
- 4) How do the articles' claims fit into broader themes in affective neuroscience? How do they relate to other ideas and findings you have encountered in this course or elsewhere?

In addition to these general questions, as noted above I will also be posting **article-specific** questions for each of our readings every week on Quercus. These article-specific questions are meant to highlight important elements of the readings and orient your attention towards aspects of the papers that we will explore in seminar discussions. Please be sure to reflect on these questions as well as you read the articles. In general, both assigned articles each week should be read prior to the seminar meeting. All readings are available through UofT Libraries or Google Scholar and students are responsible for accessing and downloading them.

Assigned Readings

Week 1: Introduction to the course

No assigned readings

Week 2: An overview of pleasure systems in the brain

Berridge, K. C., & Kringelbach, M. L. (2008). Affective neuroscience of pleasure: reward in humans and animals. *Psychopharmacology*, *199*(3), 457-480.

Nummenmaa, L., & van Dillen, L. (2021). Carnal pleasures. *Current Opinion in Behavioral Sciences*, *39*, 85-92.

Week 3: Pleasure in self-disclosure

Tamir, D. I., & Mitchell, J. P. (2012). Disclosing information about the self is intrinsically rewarding. *Proceedings of the National Academy of Sciences*, *109*(21), 8038-8043.

Baek, E. C., Scholz, C., O'Donnell, M. B., & Falk, E. B. (2017). The value of sharing information: a neural account of information transmission. *Psychological science*, *28*(7), 851-861.

Week 4: Pleasure in humour and music

Mobbs, D., Greicius, M. D., Abdel-Azim, E., Menon, V., & Reiss, A. L. (2003). Humor modulates the mesolimbic reward centers. *Neuron*, *40*(5), 1041-1048.

Salimpoor, V. N., Zald, D. H., Zatorre, R. J., Dagher, A., & McIntosh, A. R. (2015). Predictions and the brain: how musical sounds become rewarding. *Trends in cognitive sciences*, *19*(2), 86-91.

Week 5: Pleasure in social influence

Zaki, J., Schirmer, J., & Mitchell, J. P. (2011). Social influence modulates the neural computation of value. *Psychological science*, *22*(7), 894-900.

Campbell-Meiklejohn, D. K., Simonsen, A., Jensen, M., Wohlert, V., Gjerløff, T., Scheel-Kruger, J., ... & Roepstorff, A. (2012). Modulation of social influence by methylphenidate. *Neuropsychopharmacology*, *37*(6), 1517-1525.

Week 6: Pleasure, effort, and pain: Rivals or cousins?

Harmon-Jones, E., Willoughby, C., Paul, K., & Harmon-Jones, C. (2020). The effect of perceived effort and perceived control on reward valuation: Using the reward positivity to test a dissonance theory prediction. *Biological Psychology*, *154*, 107910.

Rozin, P., Guillot, L., Fincher, K., Rozin, A., & Tsukayama, E. (2013). Glad to be sad, and other examples of benign masochism. *Judgment and Decision Making*, *8*(4), 439.

Week 7: Pleasure in Altruism

Harbaugh, W. T., Mayr, U., & Burghart, D. R. (2007). Neural responses to taxation and voluntary giving reveal motives for charitable donations. *Science*, *316*(5831), 1622-1625.

Karns, C. M., Moore III, W. E., & Mayr, U. (2017). The cultivation of pure altruism via gratitude: a functional MRI study of change with gratitude practice. *Frontiers in human neuroscience*, *11*, 599.

Week 8: Pleasure in maternal attachment

Strathearn, L., Fonagy, P., Amico, J., & Montague, P. R. (2009). Adult attachment predicts maternal brain and oxytocin response to infant cues. *Neuropsychopharmacology*, *34*(13), 2655-2666.

Mulligan, E. M., Lowe, M., Flynn, H., & Hajcak, G. (2021). The rewards of motherhood: Neural response to reward in pregnancy prospectively predicts maternal bonding with the infant in the postpartum period. *Biological psychology*, *163*, 108148.

Week 9: Reading Week

Week 10: Dysfunction of pleasure in psychopathology – Psychopathy

Buckholtz, J. W., Treadway, M. T., Cowan, R. L., Woodward, N. D., Benning, S. D., Li, R., ... & Zald, D. H. (2010). Mesolimbic dopamine reward system hypersensitivity in individuals with psychopathic traits. *Nature neuroscience*, *13*(4), 419-421.

Jones, D. N., & Neria, A. L. (2019). Incentive salience & psychopathy: A bio-behavioral exploration. *Personality and Individual Differences*, *138*, 167-176.

Week 11: Dysfunction of pleasure in psychopathology – Addiction

Oswald, L. M., Wand, G. S., Kuwabara, H., Wong, D. F., Zhu, S., & Brasic, J. R. (2014). History of childhood adversity is positively associated with ventral striatal dopamine responses to amphetamine. *Psychopharmacology*, *231*, 2417-2433.

Berridge, K. C., & Robinson, T. E. (2016). Liking, wanting, and the incentive-sensitization theory of addiction. *American Psychologist*, 71(8), 670.

Week 12: Dysfunction of pleasure in psychopathology – Depression

Schlaepfer, T. E., Cohen, M. X., Frick, C., Kosel, M., Brodesser, D., Axmacher, N., ... & Sturm, V. (2008). Deep brain stimulation to reward circuitry alleviates anhedonia in refractory major depression. *Neuropsychopharmacology*, 33(2), 368-377.

Proudfit, G. H. (2015). The reward positivity: From basic research on reward to a biomarker for depression. *Psychophysiology*, 52(4), 449-459.

Week 13: Beyond pleasure -- Emerging approaches in affective neuroscience

Griffiths, R. R., Richards, W. A., McCann, U., & Jesse, R. (2006). Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology*, 187(3), 268-283.

Carhart-Harris, R. L., Bolstridge, M., Rucker, J., Day, C. M., Erritzoe, D., Kaelen, M., ... & Nutt, D. J. (2016). Psilocybin with psychological support for treatment-resistant depression: an open-label feasibility study. *The Lancet Psychiatry*, 3(7), 619-627.

Course Policy on Assessments

Academic Integrity

The University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences.

Potential offences in papers and assignments include using someone else's ideas or words without appropriate acknowledgement, submitting your own work in more than one course without the permission of the instructor, making up sources or facts, obtaining or providing unauthorized assistance on any assignment.

On tests and exams, cheating includes using or possessing unauthorized aids, looking at someone else's answers during an exam or test, misrepresenting your identity, or falsifying or altering any documentation required by the University.

University's Plagiarism Detection Tool

Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site (<https://uoft.me/pdt-faq>).

Use of Generative Artificial Intelligence Tools

Students may not use artificial intelligence tools for taking tests, writing research papers, creating computer code, or completing course assignments. The use of generative artificial intelligence tools, including ChatGPT and other AI writing and coding assistants, for the completion of, or to support the completion of, an examination, term test, assignment, or any other form of academic assessment, may be considered an academic offense in this course.

Late Assignment Submission

To maintain fairness and consistency across the class, assignments submitted late that are not supported with legitimate documentation are subject to a penalty of 10% per day. If there are valid reasons warranting an accommodation (e.g., a medical illness), please follow the Missed Term Work policy outlined below.

Disability-Related Accommodations

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the AccessAbility Services Office as soon as possible.

AccessAbility Services staff (located in Rm AA142, Arts and Administration Building) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations 416-287-7560 or email ability.utsc@utoronto.ca. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.

Religious Accommodations

The University has a commitment concerning accommodation for religious observances. I will make every reasonable effort to avoid scheduling tests, examinations, or other compulsory activities on religious holy days not captured by statutory holidays. According to University Policy, if you anticipate being absent from class or missing a major course activity (like a test, or in-class assignment) due to a religious observance, please let me know as early in the course as possible, and with sufficient notice (at least two to three weeks), so that we can work together to make alternate arrangements.

Equity, Diversity, and Inclusion

The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

The University of Toronto is a richly diverse community and as such is committed to providing an environment free of any form of harassment, misconduct, or discrimination. In this course, I seek to foster a civil, respectful, and open-minded climate in which we can all work together to develop a better understanding of key questions and debates through meaningful dialogue. As such, I expect all involved with this course to refrain from actions or behaviours that intimidate, humiliate, or demean persons or

groups or that undermine their security or self-esteem based on traits related to race, religion, ancestry, place of origin, colour, ethnic origin, citizenship, creed, sex, sexual orientation, gender identity, gender expression, age, marital status, family status, disability, receipt of public assistance or record of offences.

Recording of Classroom Material by Students

Recording or photographing any aspect of a university course - lecture, tutorial, seminar, lab, studio, practice session, field trip etc. – without prior approval of all involved and with written approval from the instructor is not permitted.

Masks in the Classroom

While the mask mandate has been paused as of 1 July 2022, the use of medical masks continues to be strongly encouraged at U of T Scarborough in indoor settings where physical distancing is not possible. We ask everyone to respect each other’s decisions, comfort levels, and health needs. Masks are available at all building entrances at U of T Scarborough and in all classrooms.

Department of Psychology Missed Term Work Policy

For missed term work (assignments and term tests) due to illness, emergency, or other mitigating circumstances, please follow the procedure outlined below.

Procedure:

1. Complete the [Request for Missed Term Work Accommodations Form](#) (“MTW Form”).
2. Email **BOTH** your MTW Form and Supporting Documentation to thiruchselvam.psyd62@gmail.com according to the instructions specified below.

Supporting Documentation Requirements and Deadlines:

Reason for Missed Work	Documentation required for a first absence in the term	Documentation required for subsequent absences in the term	Deadline for submitting MTW form and supporting documentation
Illness or Injury	ACORN Absence Declaration	UofT Verification of Illness Form	<u>WITHIN 2 BUSINESS DAYS</u> of the missed work
Bereavement	ACORN Absence Declaration	A death certificate or funeral announcement	<u>WITHIN 2 BUSINESS DAYS</u> of the missed work
University-sponsored athletic or artistic obligation at the varsity/provincial/national level	ACORN Absence Declaration	A note from a university staff member (advisor, coach, residence staff, etc.) who can substantiate the obligation, sent directly to the course email	<u>10 BUSINESS DAYS IN ADVANCE</u> of the missed deadline

Disability-related reasons for students registered with AccessAbility Services	<p>For missed TERM TESTS,</p> <ul style="list-style-type: none"> - Contact your AccessAbility consultant and have them write to the course email detailing the accommodations needed. <p>For missed ASSIGNMENTS,</p> <ul style="list-style-type: none"> - If your desired accommodation is within the scope of your Accommodation Letter (e.g. your letter includes “extensions of up to 7 days” and you need 3 days), send your Accommodation Letter to the course email and specify how many days extension you are requesting. - If your desired accommodation is outside the scope of your Accommodation Letter (e.g. your letter includes “extensions of up to 7 days” but you need more time than that), contact your AccessAbility consultant and have them write to the course email detailing the accommodations needed. 	<u>PREFERABLY IN ADVANCE OF THE MISSED WORK, OR AS SOON AS POSSIBLE</u>
Academic Conflict (e.g. two midterms at the same time)	Screenshot from Quercus demonstrating the conflict.	<u>10 BUSINESS DAYS IN ADVANCE</u> of the
Religious Conflict	None required	missed work

Notes:

- The following reasons are not considered sufficient for missed term work: social activities, recreational travel, technological issues, avoidance of assessments or deadlines, work commitments
- [Missed Final Exams](#) are handled by the Registrar’s Office and should be declared on eService.
- For ACORN absence declarations, the date you declare the absence is required to fall within the seven-day declaration period (i.e.) the absence cannot be submitted proactively or retroactively.
- Instructors cannot accept term work any later than five business days after the last day of class. Beyond this date, accommodations are only possible via the Registrar’s Office [petition process](#).
- If you are unable to submit your request within the specified number of business days, you must still email your instructor within that window to explain the nature of the delay. Exceptions to the deadlines are made only under exceptional circumstances.
- Multiple assignments due on the same day are not considered academic conflicts. Students are expected to manage their time effectively to meet assignment deadlines.
- Back-to-back tests/quizzes are not considered academic conflicts. Only overlapping activities are conflicts.
- Students are responsible for keeping their course timetables conflict-free. Students who register in two courses with overlapping lecture/tutorial/lab schedules will not be accommodated.

Next Steps:

After submitting your documentation, you will receive a response from your instructor or TA. The course instructor reserves the right to decide what accommodations will be made. Failure to adhere to any aspect of this policy may result in a denial of your request. **You are responsible for checking your official U of T email and Quercus course announcements daily**, as accommodations may be time-critical.

For missed assignments, **do not wait for the instructor's response to resume work on your assignment**. Extensions may be as short as one business day, depending on the nature of the illness/emergency. Complete your assignment as soon as you're able, and email it to your instructor.

If an accommodation is granted but a continued illness/emergency prevents you from meeting its requirements, you must repeat the missed term work procedure to request additional accommodations.

Please make it clear in your subject line that you are requesting a second accommodation.

Examples: If you were granted an extension for a paper but are still unable to meet the new deadline, or if you miss a make-up term test, you must submit *another* MTW form and supply documentation according to the "subsequent absences" column in the chart above. *Note: In the case of a missed make-up test, an opportunity to write a second make-up test may not necessarily be provided.