

LINGUISTICS

370 Temple Street, Rm. 204, 203.432.2450
<http://ling.yale.edu>
 M.A., Ph.D.

Chair

Raffaella Zanuttini

Director of Graduate Studies

Jim Wood

Professors Claire Bovern, Veneeta Dayal, Robert Frank, Laurence Horn (*Emeritus*), Frank Keil,* Maria Piñango, Fernando Rubio (*Center for Language Study*), Zoltán Szabó,* Raffaella Zanuttini

Associate Professors Simon Charlow, Jason Shaw, Jim Wood

Assistant Professors Tom McCoy, Natalie Weber

* A joint appointment with primary affiliation in another department.

FIELDS OF STUDY

The Department of Linguistics embraces an integrative approach to the study of language, based on the premise that an understanding of the human language faculty arises only through the combination of insights from the development of explicit formal theories with careful descriptive and experimental work. Members of the department offer courses and conduct research in which theoretical inquiry proceeds in partnership with historical and comparative studies, fieldwork, experimental work, cognitive neuroscience, and computational and mathematical modeling. Faculty expertise includes all of the major domains of linguistics (phonetics, phonology, syntax, semantics, pragmatics) and spans a wide range of languages.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

Coursework

The conception of linguistics embraced by the Yale Ph.D. program requires that students receive training that is both deep in its coverage of areas of linguistic inquiry and broad in the range of methodological approaches. The course work requirements are designed to accomplish these complementary goals. This course work includes a set of courses designed to expose students to core ideas, together with courses equipping students with a range of methodologies in linguistic research.

During their first two terms, students must take LING 519, Perspectives on Grammar. This course is taken SAT/UNSAT. A minimum of thirteen other courses are required: four foundational courses, three methodology courses, three advanced seminars, and three linguistics elective classes. No single course can simultaneously satisfy a requirement in two distinct areas. During the initial two years of course work, students must receive at least three grades of H (= Honors). Two or more grades below HP (= High Pass) during the initial two-year period constitute grounds for dismissal from

the Ph.D. program. As per graduate school general regulations, grades of F cannot be counted toward degree requirements.

Foundational Courses This requirement ensures that students achieve breadth in several linguistic subfields. Students take at least one sufficiently advanced course in four or more subfields of linguistics. The following courses satisfy this requirement:

LING 612	Linguistic Change	1
LING 631	Neurolinguistics	1
LING 635	Phonology II	1
LING 639	Phonetics II: Speech Production and Perception	1
LING 654	Syntax II	1
LING 664	Semantics II	1
LING 680	Morphology	1

Students decide on their courses, in consultation with the director of graduate studies (DGS) and other faculty, when they arrive on campus. Other sufficiently advanced courses may also satisfy the requirement, subject to DGS approval.

Methodology Courses For the methodology requirement, students must take three relevant courses. The following courses, which are offered regularly by the department, qualify, but other courses may as well, to be determined in consultation with the adviser and DGS:

LING 600	Experimentation in Linguistics	1
LING 619	The Evolution of Language and Culture	1
LING 624	Mathematics of Language	1
LING 627	Language and Computation I	1
LING 631	Neurolinguistics	1
LING 634	Quantitative Linguistics	1
LING 636	Articulatory Phonology	1
LING 641	Field Methods	1
LING 796	Semantic Investigations in an Unfamiliar Language	1
An advanced course in statistics such as the following may qualify:		
PSYC 518	Multivariate Statistics	1
S&DS 538	Probability and Statistics	1
S&DS 563	Multivariate Statistical Methods for the Social Sciences	1
S&DS 661	Data Analysis	1

One of the methodology courses must be taken during the first year of the program, and two must be completed by the end of the second year. Courses cannot simultaneously satisfy the foundational and methodology requirements.

Seminar Courses Graduate students are active participants in department reading groups and seminars. Students should participate in three advanced seminars in which they read the original literature of the field and write a research paper. With permission of their adviser and the DGS, students may enroll in the appropriate 790s-numbered

LING course and count active participation in a department reading group, including the submission of a final research paper, as satisfying this requirement.

Linguistics Electives Students must take three more linguistics courses that are at least 600 level.

Research

The primary focus of a Ph.D. program is independent research. In the course of our Ph.D. program, students carry out cutting-edge linguistic research, culminating in the completion of a dissertation. To help students in the transition from “consuming” to also “producing” linguistic research, there are a number of structures and requirements in place.

Research Adviser and First-Year Directed Readings By the end of the first term of the program, students find a department faculty member who acts as their research adviser. This choice should be made on the basis of compatibility of research interests and discussions between the student, faculty member, and DGS. Starting from the spring term of the first year, students will, with the help of their adviser, define a topic of research interest, meeting regularly (minimally once every three weeks) and carrying out a series of readings on this topic. Students should keep a research journal, describing their readings and how they fit in with work in the area, and chronicling the development of their thinking about the research topic. It is the faculty’s expectation that this exploration will form the foundation for the research reported in the student’s first qualifying paper (on which see below). Note however that the initial choice of research adviser is not binding: students who want to change their choice of topic or adviser for whatever reason may do so. It is the student’s responsibility to find a suitable adviser, and students are expected to have a faculty adviser at all times during their enrollment in the program. Some students have two faculty co-advisers.

Portfolio At the conclusion of the first year of the program, students submit to the faculty a portfolio of two research papers, in two distinct subfields (such as Phonetics, Phonology, Morphology, Syntax, Semantics, Pragmatics, Historical Linguistics, Neurolinguistics, Computational Linguistics). These papers should demonstrate a student’s mastery of the material in these fields to the level covered in the foundational courses in the area, as well as the ability to identify a significant research question and argue for a possible solution. In short, such papers should be at the level of an excellent term paper, representative of a student’s best work during the first year of course work. The faculty do not expect students to write papers expressly for the portfolio. Rather, the portfolio will typically consist of term papers from courses taken during the first year in the program. The deadline for the submission of these papers is May 10 each year.

Annotated Bibliography/Research Plan On the basis of the research journal begun during the first year in the program, students will prepare an annotated bibliography and research plan (ABRP) for their first qualifying paper. The ABRP, which should be approximately twenty pages in length, should lay out the question that the student wants to explore, motivating its importance through a presentation and synthesis of relevant past literature on the topic. The deadline for submission of the ABRP is September 10.

Qualifying Papers Once the ABRP has been completed, the student will proceed to work on the qualifying papers (QPs). The goal of the QPs is to develop a student's ability to conduct independent research in linguistics at the level of current scholarship in two different areas of linguistics. The faculty expect a QP to report on the results of a substantial project, which are written up in a manner consistent with the standards of the field, and to be eventually published in an academic journal, working papers, or conference proceedings. Students are strongly encouraged to identify a target journal early in the project.

The process of writing the first QP is broken into a number of smaller steps with specific deadlines for each (all during the second year of the program).

1. Students discuss their preliminary results in an appropriate venue (lab meeting, reading group, seminar, etc.) by no later than the end of the fall term.
2. Also by the end of the fall term, the student will send a request for a QP reader to the DGS. This request must include a title and brief summary of the project, and may also request specific faculty members to be involved. On the basis of research area and faculty availability, the DGS will identify a faculty member other than the adviser to serve as a QP reader. This reader will be involved in the ultimate evaluation of the QP once it is completed. Because it is useful to get a range of feedback on one's work, we encourage students to make the best use of their QP reader by meeting with them and keeping them up to date on the progress of the project.
3. Students must submit a first draft of their QP to their adviser and reader no later than February 1.
4. Students present their work to the department at the yearly "QPFest," shortly before spring recess. This takes the form of a twenty-minute conference talk to members of the department.
5. Students must submit the final version of the paper to their adviser and reader by March 31. Toward the end of the spring term of the second year, the student should begin to explore possible areas and advisers for the second QP, and must have identified an area and adviser by September 1 of the third year. Students follow the same steps and deadlines listed above for the second QP, this time during the third year.

The second QP should be in a different area of linguistics, with a different adviser, from the first QP. It is particularly important that students make satisfactory progress toward the first QP and complete all work by the relevant deadlines. Failure to do so may result in being asked to leave the program.

Prospectus No later than the beginning of the sixth term (that is, the spring term of the third year), students choose a dissertation topic and dissertation director. By the beginning of the fourth year, students will present a dissertation prospectus to the entire faculty. The prospectus should lay out clearly the student's proposed dissertation topic. It should motivate the importance of the topic, present the core idea of the proposed work together with its promise and viability, and demonstrate how this work fits into past research in the area. The prospectus should also identify a dissertation committee. The committee must include at least three faculty members (including the adviser), two of whom must be ladder faculty in the Linguistics department. The

prospectus document should be about fifteen pages in length. After it is submitted, the prospectus is defended orally in front of the faculty. Upon successful completion of the prospectus defense, students advance to Ph.D. candidacy.

Dissertation By the end of the seventh term, students must complete a chapter of the dissertation, together with a detailed outline of the dissertation and comprehensive bibliography. When the dissertation committee approves the chapter and dissertation outline, students are eligible for a University Dissertation Fellowship, which will support them in their fifth year of graduate study. Once advanced to candidacy, the student will meet with the entire dissertation committee minimally once each term (but with frequency decided by the committee), to evaluate progress toward the dissertation. During this meeting, the committee will complete the committee meeting form, will provide a copy to the student, and will retain one for the department's records.

Students are expected to complete their dissertations by the end of the sixth year. At least one month prior to the dissertation filing date, the completed dissertation must be orally defended. This defense will typically involve a public presentation of the main results of the dissertation and oral examination by the members of the dissertation committee. Committee members must be given the completed dissertation no less than two weeks prior to the date of the defense.

Language Requirement

Students are expected to exhibit some breadth in their knowledge of the languages of the world beyond those most commonly studied and those most similar in structure to the student's first language. LING 641, Field Methods, fulfills this requirement; alternatively, with the permission of the DGS, the student may instead take an appropriate language structure course, or one or more courses characterized as L3 or higher at Yale or the equivalent elsewhere. This requirement must be completed before the prospectus defense, when the student advances to Ph.D. candidacy.

Teaching Fellow/Research Assistant Requirements

The faculty regard teaching experience as an integral part of the graduate training program in Linguistics. All students serve as teaching fellows for a minimum of two terms, beginning in the first term of the third year. In addition, students must complete two additional terms of teaching assistantship. These may be either as a teaching fellow, or through participation in externally supported, supervised research as a research fellow. Research assistantships may be provided by the Linguistics faculty and by various Yale and Yale-affiliated units. Before accepting a research assistantship in fulfillment of this requirement, students must receive approval from the DGS. To be approved, a research assistantship must meet the following criteria:

1. It must be supervised by a Linguistics department faculty member or a faculty member from an affiliated unit, such as Haskins Laboratories or the Yale School of Medicine.
2. It must provide research experience that complements the student's academic plan of study and is related to the student's dissertation research plans.
3. It must provide at least ten hours of experience per week.

If an approved research assistantship is accepted that does not provide a stipend equal to the standard departmental stipend, a university fellowship will be provided to augment the stipend so as to bring it up to the departmental standard.

MASTER'S DEGREE

M.A. Students who withdraw from the Ph.D. program may be eligible to receive the M.A. degree if they have met the requirements. For the M.A. degree, students must successfully complete the coursework, examinations, and work samples required by the end of the second year of graduate study (see above).

Program materials are available online at <http://ling.yale.edu>.

COURSES

LING 500a / ENGL 500a / MDVL 665a, Old English I Emily Thornbury

The essentials of the language, some prose readings, and close study of several celebrated Old English poems.

LING 510a, Introduction to Linguistics Jim Wood

The goals and methods of linguistics. Basic concepts in phonology, morphology, syntax, and semantics. Techniques of linguistic analysis and construction of linguistic models. Trends in modern linguistics. The relations of linguistics to psychology, logic, and other disciplines.

LING 512b, Historical Linguistics Edwin Ko

Introduction to language change and language history. Types of change that a language undergoes over time: sound change, analogy, syntactic and semantic change, borrowing. Techniques for recovering earlier linguistic stages: philology, internal reconstruction, the comparative method. The role of language contact in language change. Evidence from language in prehistory.

LING 515a / SKRT 510a, Introductory Sanskrit I Aleksandar Uskokov

An introduction to Sanskrit language and grammar. Focus on learning to read and translate basic Sanskrit sentences in the Indian Devanagari script. No prior background in Sanskrit assumed. Credit only on completion of SKRT 520/LING 525.

LING 519a or b, Perspectives on Grammar Jim Wood

This biweekly, in-person meeting of all first-year students is led by faculty members and TFs. Students are asked to reflect upon the content introduced in the courses they are taking and share their understanding of how these multiple perspectives connect with each other. The goal is to provide a forum where students can synthesize their views on the grammar of natural language and at the same time create a cohort experience for first-year students. ½ Course cr

LING 538a / SKRT 530a, Intermediate Sanskrit I Aleksandar Uskokov

The first half of a two-term sequence aimed at helping students develop the skills necessary to read texts written in Sanskrit. Readings include selections from the *Hitopadesa*, *Kathasaritsagara*, *Mahabharata*, and *Bhagavadgita*. Prerequisite: SKRT 520/LING 525 or equivalent.

LING 600b, Experimentation in Linguistics Maria Pinango

Principles and techniques of experimental design and research in linguistics. Linguistic theory as the basis for framing experimental questions. The development of

theoretically informed hypotheses, notions of control and confounds, human subject research, statistical analysis, data reporting, and dissemination.

LING 612a, Linguistic Change Edwin Ko

Principles governing linguistic change in phonology and morphology. Status and independence of proposed mechanisms of change. Relations between the principles of historical change and universals of language. Systematic change as the basis of linguistic comparison; assessment of other attempts at establishing linguistic relatedness.

Prerequisites: LING 512, 632, and 653.

LING 617a, Language and Mind Maria Pinango

The course is an introduction to language structure and processing as a capacity of the human mind and brain. Its purpose is to bridge traditional domains in linguistics (phonetics, morphology, syntax) with cognition (developmental psychology, memory systems, inferential reasoning). The main topics covered are morphosyntax and lexical semantics, sentence composition and sentence processing, first- and second-language acquisition, acquisition under unusual circumstances, focal brain lesions, and language breakdown.

LING 619b, The Evolution of Language and Culture Edwin Ko

Introduction to cultural and linguistic evolution. How diversity evolves; how innovations proceed through a community; who within a community drives change; how changes can be “undone” to reconstruct the past. Methods originally developed for studying evolutionary biology are applied to language and culture.

LING 620a, Phonetics I Natalie Weber

Each spoken language composes words using a relatively small number of speech sounds, a subset of the much larger set of possible human speech sounds. This course introduces tools to describe the complete set of speech sounds found in the world's spoken languages. It covers the articulatory organs involved in speech production and the acoustic structure of the resulting sounds. Students learn how to transcribe sounds using the International Phonetic Alphabet, including different varieties of English and languages around the world. The course also introduces sociophonetics, how variation in sound patterns can convey social meaning within a community, speech perception, and sound change.

LING 627a, Language and Computation I Tom McCoy

Design and analysis of computational models of language. Topics include finite state tools, computational morphology and phonology, grammar and parsing, lexical semantics, and the use of linguistic models in applied problems. Prerequisite: prior programming experience or permission of the instructor.

LING 631b, Neurolinguistics Maria Pinango

The study of language as a cognitive neuroscience. The interaction between linguistic theory and neurological evidence from brain damage, degenerative diseases (e.g., Alzheimer's disease), mental illness (e.g., schizophrenia), neuroimaging, and neurophysiology. The connection of language as a neurocognitive system to other systems such as memory and music.

LING 632b, Phonology I Natalie Weber

The structure of sound systems in particular languages. Phonemic and morphophonemic analysis, distinctive-feature theory, formulation of rules, and problems of rule interpretation. Emphasis on data description and problem solving.

LING 635a, Phonology II Natalie Weber

Topics in the architecture of a theory of sound structure. Motivations for replacing a system of ordered rules with a system of ranked constraints. Optimality theory: universals, violability, constraint types, and their interactions. Interaction of phonology and morphology, as well as relationship of phonological theory to language acquisition and learnability. Opacity, lexical phonology, and serial versions of optimality theory. Prerequisite: LING 632 or permission of the instructor.

LING 641b, Field Methods Claire Bowers

Principles of phonetics, phonology, morphology, syntax, and semantics applied to the collection and interpretation of novel linguistic data. Data are collected and analyzed by the class as a group, working directly with a speaker of a relatively undocumented language.

LING 643b, Dynamics of Speech Jason Shaw and Michael Stern

Systems that change over time, from particles to climates to stock markets, are often well described as dynamical systems. Speech, like many aspects of human behavior, involves action and perception components, which are mediated and related by the central nervous system. Each of these components unfolds over time according to laws, which can be formulated using dynamical systems theory. This class provides an introduction to the types of dynamical systems that have been proposed to describe and explain human speech behavior, including (1) articulatory kinematics, i.e., the movements of speech organs such as the tongue, lips, vocal folds, etc.; (2) neural activity governing intention and control; and (3) auditory transduction and perception of speech sound waves. Prerequisites: The course makes use of key concepts from calculus, particularly differential equations. Review of the necessary math is provided in class. Most homework assignments involve light coding in the Matlab environment. No previous experience with Matlab is required; however, we expect students to have some familiarity with basic coding concepts (functions, loops, variables, matrices). Please feel free to reach out to us if you have questions about preparation.

LING 653a, Syntax I Raffaella Zanuttini

An introduction to the syntax (sentence structure) of natural language. Introduction to generative syntactic theory and key theoretical concepts. Syntactic description and argumentation. Topics include phrase structure, transformations, and the role of the lexicon.

LING 654b, Syntax II Jim Wood

Recent developments in syntactic theory: government and binding, principles and parameters, and minimalist frameworks. In-depth examination of the basic modules of grammar (lexicon, X-bar theory, theta-theory, case theory, movement theory). Comparison and critical evaluation of specific syntactic analyses. Prerequisite: LING 653.

LING 663a, Semantics I Simon Charlow

Introduction to truth-conditional compositional semantics. Set theory, first- and higher-order logic, and the lambda calculus as they relate to the study of natural

language meaning. Some attention to analyzing the meanings of tense/aspect markers, adverbs, and modals.

LING 668b / CLSS 829b / HIST 507b / NELC 809b, Historical Sociolinguistics of the Ancient World Kevin van Bladel

Social history and linguistic history can illuminate each other. This seminar confers the methods and models needed to write new and meaningful social history on the basis of linguistic phenomena known through traditional philology. Students learn to diagnose general historical social conditions on the basis of linguistic phenomena occurring in ancient texts. Prerequisite: working knowledge of at least one ancient language.

LING 680a, Morphology Jim Wood

The theory of word structure within a formal grammar. Relation to other areas of grammar (syntax, phonology); basic units of word structure; types of morphology (inflection, derivation, compounding). Prerequisites: LING 632 and 653, or permission of the instructor.

LING 691b, Topics: Events, Distributivity, Durational Modifiers Veneeta Dayal and Simon Charlow

This course bridges introductory courses (LING 263, LING 264) and advanced seminars in semantics. It explores selected topics in some detail, allowing students to appreciate the nuances of semantic argumentation while at the same time emphasizing the foundational issues involved. The goal of this course is to allow students, within a structured format, to become comfortable engaging with open-ended problems and to gain confidence in proposing original solutions to such problems. Topics vary across semesters. Prerequisite: LING 263/LING 663 or permission of instructor.

LING 744b, Topics in Phonology: Prosody, Syntax, Structure Natalie Weber

Introduction to the analysis of prosodic structure, with a focus on the relation of prosodic structure to syntax. Survey of current theories of the correspondence between syntactic and prosodic structure. Particular emphasis on comparing theories and their predictions for language typology. Some empirical analysis of prosodic structure in individual languages. Prerequisites: LING 632 and LING 653, or permission of the instructor. LING 635 is recommended but not required.

LING 752b, Tocharian Claire Bowern

Study of Tocharian B language, an ancient language of what is now Western China, in its historical and material context. Students learn to read the language and the place of Tocharian within the Indo-European family. Tocharian was spoken in the Tarim Basin and is known from texts dating from roughly the fourth to the eighth centuries. We study the writing system, sound system, and grammar (morphology and syntax). After finishing this class, students will have read a number of original works in Tocharian and be familiar with the grammar of the language and how it relates to other languages in the family and region. There are no prerequisites, but some familiarity with an ancient Indo-European language is helpful.

LING 777b, Topics in Syntax: Intensifiers and Degree Phrases Jim Wood

In this course, we take a detailed look at our current understanding of an area of natural language syntax and open questions in that area. This semester, we focus on the syntax of degree expressions and the nebulous category of intensifiers. We examine evaluative readings of intensifiers, cross-linguistic/cross-dialectal variation

in co-occurrence restrictions in the degree phrase, and the syntax of comparative and superlative constructions.

LING 780a, Topics in Computational Linguistics: Neural Network Models of Linguistic Structure Robert Frank

An introduction to the computational methods associated with “deep learning” (neural network architectures, learning algorithms, network analysis). The application of such methods to the learning of linguistic patterns in the domains of syntax, phonology, and semantics. Exploration of hybrid architectures that incorporate linguistic representation into neural network learning. Prerequisites: Python programming, basic calculus and linear algebra, introduction to linguistic theory (LING 106, 110, 116, 217 or equivalent).

LING 784b, Computational Psycholinguistics Tom McCoy

When processing language, the human mind can perform remarkable feats. For instance, we can acquire a language from a small amount of data (thousands of times less data than current systems in artificial intelligence), and we can infer what another person means even when that person’s intended message goes beyond the literal meaning of their words. This course explores how computational modeling can help us characterize our incredible capacity for language learning and processing. We focus on three modeling traditions – symbolic algorithms, Bayesian models, and neural networks – and their application to a range of psycholinguistic phenomena, including parsing, pragmatics, speech perception, word learning, and language acquisition. We also discuss how artificial intelligence can inform theories of human language processing and vice versa.

LING 793a, Topics: Semantic Dynamics Simon Charlow

These seminars provide in-depth exploration of issues in natural language meaning, with topics varying in different semesters. In fall 2024, the seminar focuses on dynamic approaches, originally developed to explain anaphoric processes (most importantly, cross-sentential and donkey anaphora). This kind of anaphora differs in crucial respects from the way variables get bound in systems like predicate logic and λ -calculus. The basic dynamic insight – that sentences express instructions for updating some body of information – was subsequently extended to a wide variety of empirical phenomena: presupposition and the projection problem, ellipsis, (epistemic) modality, conditionals, and vagueness. Dynamic aspects of meaning have recently been reconceptualized in analogy with the “side effects” of programming languages. As these theories gained ground, a robust dissenting literature offered counter-programming. Was dynamic semantics really necessary to treat the phenomena in question, or could they be handled satisfactorily in a more austere, truth-conditional setting? One goal of this course is to become conversant with the literature on dynamics, to learn about different dynamic frameworks. Another goal is to develop an understanding of it means for a semantic theory to be dynamic. Prerequisite: LING 663 or permission of the instructor.

LING 796a, Semantic Investigations in an Unfamiliar Language Veneceta Dayal

This course introduces students to semantic fieldwork. It chooses a language that is likely not known to any student in the class and has no substantive semantic literature. Students are introduced to a phenomenon in the language on which there is some syntactic literature, either in that language or in one or more related languages. This provides a starting point for students to articulate questions to investigate that are primarily semantic in nature. Working with a native speaker consultant, students elicit data that answer these initial questions but very likely lead to further questions

to investigate. To keep the elicitation focused, these investigations are restricted to topics related to the primary phenomenon discussed, while allowing some margin for individual interests. In addition to the syntactic and semantic literature on the chosen topic or topics, students also read material on fieldwork methodologies for linguistics generally as well as those specifically for semantics. Students work in small groups to fulfill part of the requirements. Prerequisites: LING 653 and LING 663 or permission of the instructor.

LING 830a, Directed Research in Neurolinguistics Staff

By arrangement with faculty.

LING 875a, Linguistic Meaning and Conceptual Structure Maria Pinango

The meaning of a word or sentence is something in the human mind that has specific properties: it can be expressed (written/signed/spoken forms); it can be combined with other meanings; its expression is not language dependent; it connects with the world; it serves as a vehicle for inference; and it is hidden from awareness. The course explores these properties in some detail and, in the process, provides students with technical vocabulary and analytical tools to further investigate them. The course is thus intended for students interested in undertaking a research project on the structure of meaning: the nature of lexico-conceptual structure, that is, the structure of concepts, which we refer to as “word meanings,” and how they may be combined through linguistic and nonlinguistic means. The course’s ultimate objective is to bridge models of conceptual structure and models of linguistic semantic composition, identify their respective strengths and weaknesses, and explore some of the fundamental questions that any theory of linguistic meaning composition must answer. Evidence discussed will emerge from naturalistic, introspectional, and experimental methodologies.