



Epistemic positioning and knowledge-building in postgraduate neuroscience classroom interaction

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ABSTRACT

This article explores the dynamics of epistemic positioning and knowledge-building in classroom interaction in two postgraduate neuroscience classrooms. Using an interdisciplinary approach combining multimodal Conversation Analysis and Legitimation Code Theory (LCT), it examines how lecturers and students negotiate epistemic stance and status through interactional practices, and how these practices legitimise certain stances or “gazes” in relation to doing neuroscience. Drawing on six hours of video-recorded classroom interaction, the study uses detailed transcripts to uncover the epistemic positioning practices of two lecturers teaching modules on neurobiological bases of psychiatric disorders and addiction. The interactional data are reanalysed from the knowledge-building perspective of LCT, revealing that the two lecturers were operating different *specialization codes* and activating different *gazes* in terms of the social relations of both themselves and their students as knowers. The analyses demonstrate how slight shifts in interactional practices around epistemic positioning can have significant consequences for legitimating different knower positions in postgraduate neuroscience education. By combining micro-analysis with the sociological framework of LCT, the study offers insights into the complex dynamics of knowledge-building in advanced academic settings and offers tools for reflection on and enhancement of teaching practices in postgraduate science education contexts.

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1. Introduction

Classroom interaction in advanced academic settings such as postgraduate science education is a highly complex arena where participants co-construct, negotiate and legitimise knowledge through their communicative practices. A key feature of these practices is epistemic positioning - how participants display, negotiate, and hold each other accountable for access to different knowledge domains (Heritage, 2012). In postgraduate science education settings, where students are at the frontier of the novice/expert divide, the dynamics of epistemic positioning can be consequential for how they make this transition.

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In constructing and negotiating knowledge in classroom interaction, participants orient to epistemic status - socially recognized rights to ownership of specific knowledge - and epistemic stance, the shifting moment-by-moment expression of epistemic positions in talk (Heritage, 2012; Sert, 2013). While the interplay between epistemic status and stance is important for all types of classroom interaction, it is particularly salient in postgraduate science education as students are not only acquiring complex conceptual knowledge but are building identities as emerging experts in their disciplines.

One such science education context which provides an ideal context for the exploration of epistemic positioning is that of postgraduate neuroscience. Neuroscience is a rapidly evolving multidisciplinary field which encompasses multiple domains of knowledge (Carandini, 2019), ranging from molecular biology to cognitive psychology. In learning neuroscience, students may have particular struggles with neuroscientific “threshold concepts” which act as gateways to developing deeper knowledge and becoming recognised as experts in the discipline (Correia et al., 2014; Sandrone and Alavian, 2021).

Despite the importance of epistemic positioning in knowledge-building and identity formation in postgraduate science education, there is a lack of research examining how these processes unfold in moment-by-moment classroom interaction, particularly in less-examined disciplines such as neuroscience. Thus, this study aims to address this gap by investigating epistemic positioning and knowledge-building practices in the context of postgraduate neuroscience classroom interaction.

To capture the complexity of these practices, we argue for the necessity of an interdisciplinary approach, which combines a focus on epistemic positioning at the micro-level of unfolding interaction with a framework which allows us to investigate the consequentiality of these practices for disciplinary knowledge-building. To accomplish this, we combine the microanalytic tools of multimodal Conversation Analysis (CA) with the sociological framework of Legitimation Code Theory (LCT). CA allows us to unpack the sequential organization and multimodal resources through which epistemic positions are enacted (Mondada, 2018), while LCT provides conceptual tools for revealing the underlying organizing principles that shape knowledge practices (Maton, 2014). By combining these approaches, we aim to provide a comprehensive account of how epistemic positioning is interactionally and sequentially accomplished, and of its consequences for the construction of “knower” identities in one postgraduate neuroscience education context.

This study aims to enhance understanding of epistemic practices in academic discourse, providing insights which may go beyond the context of postgraduate neuroscience and thus be applicable across a range of disciplinary contexts in higher education. Moreover, by throwing light on the complex ways in which knowledge is constructed and legitimized in interaction, and participants positioned as different kinds of knowers, the study has implications for enhancing teaching and learning practices in postgraduate education.

In the following section, we introduce key concepts and review the literature on epistemics in classroom interaction. We then go on to introduce the sociological framework of Legitimation Code Theory, focusing on the dimension of the theory, Specialization, which we use in the study, particularly the notion of “gaze”. This is followed by the methods section in which we describe the study’s setting, participants, data, and analytic procedures. In the Findings and Analysis section, we present the analysis of three extracts each from two lecturers who taught postgraduate neuroscience modules at a university in Spain, focusing on their epistemic positioning practices and underlying principles based on the relationship between knowledge and knower. In the discussion section, we pull together the different threads of the interdisciplinary analysis to offer insights into knowledge construction in postgraduate science interaction.

2. Epistemics in classroom interaction

Knowledge construction is a dynamic and context-sensitive procedure, which has been investigated from the interactional perspective as the sub-field of epistemics (Heritage, 2012, 2013). During interaction, participants demonstrate their access to different domains of knowledge, and thus co-construct shared understandings. This process can be understood in light of two important concepts: *epistemic status* and *epistemic stance*. While *epistemic status* refers to ‘a relational concept concerning the relative access to some domain of two (or more) persons at some point in time’, *epistemic stance* depends on how this access to knowledge is deployed through minute-by-minute interaction (Heritage, 2012, p. 4). By demonstrating their epistemic status using diverse interactional practices, and shaping one another’s epistemic stance, participants position themselves and one another as more (K+) and/or less (K-) knowledgeable on an epistemic gradient (e.g., Balaman and Sert, 2017b; Heritage and Raymond, 2005). They strive to find a balance between their epistemic status using multimodal resources including verbal (e.g., declarative sentences, references to past learning) and embodied actions (e.g., nodding, gaze) as well as the use of materials (e.g., handouts) (e.g., Balaman and Sert, 2017a; Can Daşkın and Hatipoğlu, 2019; Bozbiyik et al., 2024; Jakonen and Morton, 2015; Koole, 2010).

In the last two decades, studies have explored dynamic epistemic progression in different participation frameworks (i.e., teacher-initiated interaction, learner initiatives, peer interaction) in face-to-face and online pedagogical settings (e.g., Balaman and Sert, 2017a; Gardner, 2007). In teacher-fronted classrooms, teachers/lecturers adopt a more knowledgeable position as the source of epistemic authority (e.g., Heritage, 2013; Keevallik, 2011), and attempt to shift the epistemic status of the students from (K-) to (K+). In doing so, they display their epistemic stance through various interactional and pedagogical

resources such as asking questions, acknowledgment, and nodding (Filipi, 2018; Koole, 2010). They also check their students' epistemic status using 'epistemic status checks' (ESCs), and gaze (Sert, 2013), and identify interactional troubles signalled by students' smiles, laughter, or long silences (Sert and Jacknick, 2015). Thus, teachers/lecturers attempt to fill knowledge gaps, and reduce epistemic asymmetry through 'doing demonstrating knowledge' in ongoing classroom interactions (Kääntä, 2014).

On the other hand, a few studies (e.g., Batlle and Deal, 2021) have also shown that teacher epistemic stance and/or displays of teacher knowledge gap can result in interactional trouble in teacher-fronted classrooms, and the students can change the knowledge exchange system (Goodwin and Goodwin, 2004) through different classroom practices such as repair work and the use of external sources of epistemic authority (e.g., mobile phones, dictionaries), collaboratively creating learning opportunities for themselves and teachers (Bozbiyik and Daşkın, 2022). Furthermore, students also coordinate their epistemic roles by positioning themselves and one another as knowledgeable and shaping each other's verbal and embodied contributions for the achievement of knowledge exchange and/or learning inside and outside the classroom student peer/group activities (Balaman and Sert, 2017a; Herder et al., 2022; Jakonen and Morton, 2015). In general, most of the existing literature on epistemics and epistemic positioning (e.g., Sahlström, 2012) has focused on the interactional organization of language and/or content teaching and learning classrooms at primary, secondary, and tertiary levels. However, to our knowledge there are no studies exploring knowledge-building in postgraduate university classrooms with an emphasis on both classroom interaction and the organizing principles underlying knowledge practices. To focus on knowledge itself, and its properties and effects, we use the sociological framework of Legitimation Code Theory, which we introduce in the following section.

3. Legitimation Code Theory for knowledge-building in classroom interaction

Legitimation Code Theory (LCT) is a sociological framework to explore knowledge practices in various fields, and it is particularly concerned with what confers legitimacy in educational practices (Maton, 2014). In other words, it seeks to uncover the 'rules of the game' by which participants can be deemed to be successful in an educational endeavour. In LCT research, there are three main dimensions (i.e., Specialization, Semantics, Autonomy) with different foci on underlying principles of knowledge-building processes. Specialization sees knowledge practices as knowledge-knower structures with varying emphasis on the relation of the practice to what is to be known (epistemic relations) and who the knowers are (social relations). Semantics (Maton, 2013) focuses on how meanings can be more or less embedded in context (semantic gravity) and more or less complex (semantic density). Autonomy investigates how different constituents (e.g., actors, ideas, body movements) can be related to one another during the knowledge-building process (Maton and Howard, 2020).

In recent years, there has been a growing number of interdisciplinary studies using LCT to explore knowledge-building practices in combination with approaches such as Systemic Functional Linguistics (e.g., Hood, 2020; Xie, 2021), Corpus Linguistics (e.g., Argüelles-Álvarez and Morton, 2023), and multimodal Conversation Analysis (e.g., Bozbiyik and Morton, 2023, Bozbiyik and Morton, 2024; Nikula et al., 2024). Using the combined methodology of multimodal CA and the Autonomy dimension of LCT, Bozbiyik and Morton explored how lecturers deployed various knowledge-building practices including using outside knowledge (Bozbiyik and Morton, 2023) and exemplification (Bozbiyik and Morton, 2024) in undergraduate online interaction in English medium university classrooms. In these studies, the authors also demonstrated that the lecturers displayed varying epistemic positioning practices regarding their specific examples, mitigated students' epistemic stance (Jakonen and Morton, 2015), and elicited known information from the students through 'epistemic invitation' (Oliveira and Brown, 2016). In addition, Nikula and her colleagues (2024) closely examined physics and chemistry classrooms in a Finnish content and language integrated learning (CLIL) context using multimodal CA and LCT Semantics. They documented how a teacher shifted between different levels of abstraction by strengthening and weakening semantic gravity and density through verbal and embodied translingual practices during knowledge-building procedures. However, knowledge-building practices in postgraduate face-to-face science education classrooms have not been explored with the combined methodology of multimodal CA and LCT. In this study, we use the Specialization dimension of LCT to explore how two neuroscience lecturers position themselves and their students as knowers in their knowledge-building practices.

In the Specialization dimension, epistemic and social relations can be depicted as intersecting on two axes, thus forming a *specialization plane*, with four quadrants, each of which represents a *specialization code* (Fig. 1). *Knowledge codes* emphasize the possession of knowledge in a specialized domain as the basis of achievement, but downplay attributes of knowers (ER+, SR-). *Knower codes* highlight attributes of knowers, such as belonging to a certain social category, as the basis of achievement, and possession of specialist knowledge is downplayed (ER-, SR+). *Élite codes* underline both the possession of specialist knowledge and being the 'right' kind of person as underpinning claims to success in a practice (ER+, SR+). *Relativist codes* downplay both specialist knowledge and knower attributes as contributing to legitimacy (ER-, SR-).

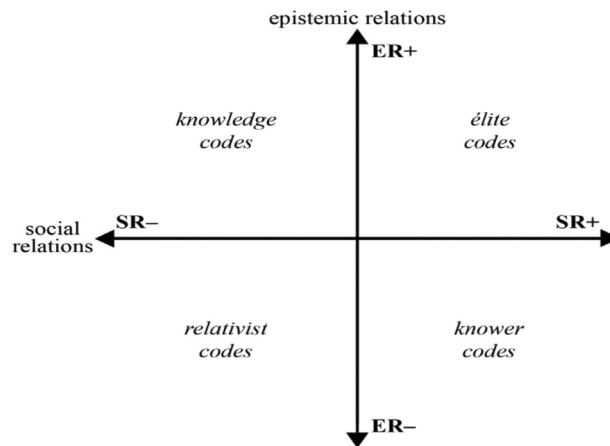


Fig. 1. The specialization plane (Maton, 2014, p. 30).

Social relations can be further broken down into *subjective relations* (SubR) between practices and the kinds of actors involved in them, and *interactional relations* (IR) between practices and different ways of acting (Maton, 2014, p. 184). Again, these two types of relations can be plotted on intersecting axes to produce the *social plane* with four types of gaze (Fig. 2).

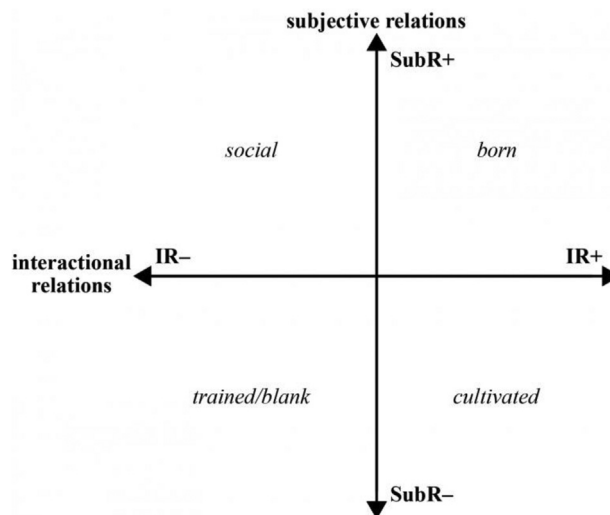


Fig. 2. The social plane (Maton, 2014, p. 186).

Maton (2014, pp. 185–86) outlines the four gazes as follows. A *social gaze* confers legitimacy by emphasizing membership of social categories, but downplaying ways of knowing (SubR+, IR-), so that being a member of this or that social group/category (e.g., gender, ethnic background) is more important than who you have interacted with. This can be seen in different types of standpoint theory, where one's claims to legitimacy are based on belonging to social categories, such as social class, gender or ethnic group. In a *cultivated gaze* categories of knower(s) are downplayed, but importance is given to having participated in legitimate interactions with significant players in the practice (SubR-, IR+). One needs to have been around and interacted with the 'right' people and their works, and thus have developed a 'feel' for the practice. A *born gaze* confers legitimacy by emphasizing both the type of person one is, and ways of knowing (SubR+, IR+), such as standpoint theories which require not just being a member of the relevant social category, but perhaps having one's consciousness raised through interactions with significant others. When both membership of social categories and ways of knowing are downplayed (SubR-, IR-), we have a *trained gaze* that emphasizes having specialist knowledge and skills, or a *blank gaze* which relates to the relativist code (ER-, SR-) on the specialization plane.

In this study, we re-analyse the interactional data using the conceptual tools of the Specialization dimension to identify the different specialization codes and/or gazes in the lecturers' neuroscience knowledge-building practices. LCT studies do not apply the internal language of the theory directly to data, but use 'translation devices' (Maton and Chen, 2016), which allow categories emerging from data analysis to be related to the LCT concepts, such as different specialization codes or gazes. In this study, rather than using a translation device in the way that most LCT studies do, we re-analyse the interactional practices described in the multimodal CA analysis through the lens of the LCT Specialization dimension. Combining the two approaches, the study sought to address the following two research questions:

- (1) How do lecturers display epistemic positioning of the students and themselves through interactional practices in a postgraduate neuroscience module?
- (2) What are the organizing principles of their knowledge-building practices in terms of epistemic and social relations?

4. Participants, data and method

The data for this study consists of video recordings of two different modules of a neuroscience master's program in the Faculty of Medicine at a large public university in Madrid, Spain. 'Neurodevelopmental bases of psychiatric disorder' was offered by Mario (Mar) in the 2021–2022 academic year, and 'Neurobiological bases of drug addiction' was taught by Juan (Jua) in the 2022–2023 academic year. In both courses, there were around 20 master's students with different disciplinary backgrounds such as psychology, chemistry, and neuroscience. Most of the students on the courses were Spanish, but the medium of instruction for both was English. Before the data collection processes, the research purposes and content of this study were explained to both the lecturers and the graduate students by the researchers, and informed consent forms were collected from the participants. For each module, three sessions of approximately 1 h each (6 h in total) were video recorded, using 3 cameras in order to capture the multimodal resources used in the interactions.

As described above, the data were analysed using the combined methodology of multimodal Conversation Analysis (CA) and the Specialization dimension of the Legitimation Code Theory (LCT) (see Bozbiyik and Morton, 2023, Bozbiyik and Morton, 2024; Morton, 2024 for more detailed information about the combined methodology). In using this interdisciplinary approach, we were careful to carry out each analysis separately, with no mixing of conceptual frameworks or terminology, in order to preserve the insights of both (Martin et al., 2020). The analysis starts with the bottom-up and data-driven procedure of multimodal CA (Mondada, 2018; Kääntä and Kasper, 2018). After perusing all the video recordings through "unmotivated looking" (ten Have, 2007), the Jeffersonian (Jefferson, 2004) and Mondada's (Mondada, 2018) CA transcription conventions were used to transcribe and describe all the verbal utterances, and embodied actions as well as the use of diverse classroom materials. Through line-by-line analysis, the fine-grained descriptions of the classroom interaction were closely examined regarding turn-taking, repair, sequence and preference organisation, and multimodality. A candidate phenomenon was identified as the lecturers' epistemic positioning practices, i.e., how the lecturers position themselves and their students in relation to different domains of knowledge in postgraduate classrooms. We built a collection of 40 extracts representing epistemic positioning sequences, 24 from Mario's module, and 16 from Juan's. Three extracts from each module (6 extracts in total) are selected as representative instances of the overall collection, illustrating the epistemic positioning practices in the interaction in each lecturer's sessions. While Extracts 1 and 4 show the lecturers' epistemic positioning in introductory phases of the face-to-face sessions, the other extracts demonstrate the lecturers' recurrent epistemic positioning of themselves and their students following their questioning using different interactional resources.

After completing fine-grained micro-analysis using multimodal CA, the same database was re-analysed through the Specialization Dimension of LCT to investigate the epistemic and social relations, with a particular emphasis on the concept of gaze from the social plane. Thus, the analysis of epistemic positioning is presented first, and this is followed by the LCT Specialization analysis.

5. Findings and analysis

In this section, we present 6 extracts to demonstrate how the two lecturers position themselves and the students as more (K+) and less (K-) knowledgeable using various interactional practices during knowledge-building processes in two different modules of the neuroscience master's program. In the first subsection, we show two cases from two different modules of the neuroscience master's program. In each case, we firstly present one short introductory extract to illustrate the lecturers' epistemic positioning practices when they introduce the module. We then present an analysis of two further extracts from each lecturer, showing how they oriented to knowledge and knowers in their interactional practices. In the second subsection, we complete the findings and analysis section by reinterpreting the interactional data through the lens of the Specialization dimension of LCT, showing the *specialization codes* and *gazes* which were part of the organizing principles of the lecturers' knowledge-building practices.

5.1. Micro-analytic findings

Case 1: Neurodevelopmental bases of psychiatric disorders module

Extract 1 comes right at the beginning of the first session of the ‘Neurodevelopmental bases of psychiatric disorders’ module. The lecturer (Mario-Mar) is introducing the course content, with information on a PowerPoint slide. The extract shows how Mario related knowledge to knowers through epistemic positioning from the first moments of the module.

Extract 1: story of my life_06-09_03.53-04.48

01 Mar: this i:s (.) our course (.) on neurobiology of
 02 developmental disorders(0.8) and now we are going to
 03 talk about: (.) neuro developmental basis of
 04 (.) psychiatric disorders (0.4) this lesson is going to
 05 be: (0.9) the story of my life, o:r at least (.) †a story:
 06 of my li:fe (0.5) because
 07 +(2.9)+
 mar +--1--+ 1: looks at the slide
 08 becau:se
 09 +(3.5)+
 mar +--1--+
 10 +next: (.)i want to tell you (0.4) what i lea:rned (.)
 mar +changing the slide
 11 in this university (0.5) long time ago from nineteen
 12 ninety two: (.) to nineteen ninety four (.) when i was
 13 a medical student, and i was in this university in
 14 this very same department of anatomy, histology (.)
 15 and neuro↑science (.) a:nd they were (.) teaching
 16 me neuroanatomy, anatomy and neuro embryology, embryology
 17 development (.) and i'm sure that +you are familiar
 mar +points at the slide
 18 with these illustrations, right?

From lines 1 to 4, Mario announces the main topic of the module (i.e., neurodevelopmental basis of psychiatric disorders), and he links this with his personal life through mitigation from ‘the story’ to ‘a story of my life’ (lines 4–6). After (2.9) and (3.5) seconds of silence during which he looks at the slide (lines 7 and 9), he provides an account of his experience as a medical student at the same department and university in 1992–4, and mentions the topics he studied (e.g., embryology development). In this way, he positions himself in terms of his personal relationship to the target knowledge through retrospective orientations to his previous experience (Jakonen, 2018) in his undergraduate university life. At the end of this extract, Mario also positions the students as knowledgeable (K+) (Heritage, 2012) about the content of the images including the topics previously referred to (e.g., neuroanatomy) on the slide. This signals an assumption on the lecturer’s part that the students must have studied these topics during their undergraduate years. In doing so, he utters a strong expression (I’m sure you are familiar) that indicates his epistemic stance regarding the students’ epistemic status vis a vis the content knowledge, and the extract closes with a confirmation request (right?). In sum, Extract 1 demonstrates that Mario not only makes a strong connection between the target content knowledge and his personal life through mitigation and references to his prior educational experience, but also positions the students as (K+) using strong epistemic expressions and a pointing gesture to the slide, which turn out to be frequent epistemic positioning practices deployed by Mario.

During these sessions, Mario connects neuroscience knowledge with himself and the students. In doing so, he positions the master’s students as more knowledgeable (K+) about some topics and less knowledgeable (K–) about other domains of neuroscience, and this can mostly be seen in his practice of eliciting definitions of key concepts from the students. Extract 2

shows how Mario elicits a definition of synaptic plasticity, and in his responses shifts the students' epistemic status from (K+) to (K-).

Extract 2: low_07-09-_12.45-14.20

01 Mar: so: (.) let's go: (.) first (.) +to check (.) the relation
 mar +changes the slide
 02 in between cortical type and (.) +synaptic plasticity
 mar +-----1----->
 1: shakes his finger at the students
 03 (0.5) what i:s (0.4) synaptic plasticity?+
 mar -----+
 04 +(1.8)+
 mar +--2--+ 2: looks at the students
 05 i want a definition of synaptic plasticity
 06 +(3.5)+
 mar +--1--+
 07 +not everybody: (.) at the same time+ (.) +please+
 mar +-----3-----+ +--4--+
 3: moves his hand from his right ear in downward motion
 4: moves his hand slowly
 08 Ss: eheh hehe
 09 +(2.3)+
 mar +--2--+
 10 Mar: so: this i:s (0.6) a ↑maste:r's (0.5) cou:rse (0.6)
 11 the second years of a master of neuroscience (0.5)
 12 and you've been listened, you've been hearing (.)
 13 about synaptic plasticity befo:re
 14 (1.2)
 15 so: (0.5) +what do you think+ (.) synaptic plasticity i:s?
 mar +-----5-----+ 5: points at the students
 16 +(2.2)+
 mar +--2--+
 17 S1: °e::r°
 18 Mar: that's a hu:ge problem tha:t (.) we have in the
 19 +twenty first century+
 mar +-----1-----+
 20 because the conceptual abilities of our students are going

21 (.) ↑lo:w, ↑lo:w, low, low, low+ (.)
 mar +-----6-----+
 6: moves his hand downwards

22 (0.5) you: ↑handle concepts without being able to define
 23 them (.) please, +a definition of synaptic plasticity

 mar +points at S1

24 S1: e:r is the: capacity: (0.6) that synapsis ha:s
 25 (inaudible voices) for shaping (inaudible voices)

26 Mar: another definitio:n?
 27 +(2.3)+

 mar +-7---+ 7: looks at S1

28 S1: e:r

29 Mar: this is a capacity: (.) ↓this capacity (.) it's a ↑problem

30 S1: it's an ability:?

31 Mar: it's a property of neural circuits (0.5) to modify their
 32 structure (0.6) in order (.) to:: e:r respond to the (.)
 33 e::rm demands of the ambient so let's say that in order
 34 to (.) ↑lea:rn, you will have to learn something (.) our
 35 circuits will have to be: (.) modified (.) at least
 36 slightly modify (.) ↑this is the concept of synaptic
 37 plasticity:.

At the beginning of Extract 2, Mario initiates a new subtopic by changing the slide and requesting a definition of synaptic plasticity using Wh- questions (lines 3 and 5). He provides interactional spaces for the students to respond as can be seen in the (1.8) and (3.5) seconds of silence in lines 4 and 6 respectively. In line 7, Mario produces a sarcastic statement (*not everybody at the same time*) that refers to the students' unwillingness to participate (UTP) (Sert, 2015). However, he mitigates the possible tension that the sarcastic comment could produce by using 'please' and moving his hand downwards. This is followed by the students' choral laughter and (2.3) seconds of silence, which can signal interactional trouble and the students' UTP. From lines 10 to 13, Mario emphasizes that the module is in the second year of the master's course, and he points out that the students should have learnt and/or heard about what synaptic plasticity is. In this way, Mario positions the students as potentially (K+) due to their previous learning experiences on the programme and the fact that they are now in the second year.

In lines 14 and 15, Mario waits for (1.2) seconds of silence for a student contribution, and reinitiates his previous question through verbal and embodied orientations to the students (i.e., pointing gesture), but this is followed by another long silence (line 16), and S1's elongated hesitation marker. From lines 18–23, Mario raises the epistemic stakes by alluding to the low levels of conceptual understanding of students in the twenty-first century. He does so in quite emphatic terms with the repetition of 'low' accompanied by the multiple beat gestures gradually moving downwards and synchronising the ending of his talk (line 21). Thus, he problematizes the idea of handling concepts without being able to define them, and in so doing may contribute to creating a somewhat challenging classroom atmosphere. He then repeats his request for a definition of synaptic plasticity (line 23). We can see in this extract a shift in Mario's epistemic positioning of the students from more to less knowledgeable in response to the students' UTPs to define synaptic plasticity. In lines 24 and 25, S1 provides a candidate definition of the target concept, but Mario directly asks for another definition rather than providing any explicit feedback on S1's dispreferred response. In line 29, Mario problematizes the choice of the term 'capacity' for the definition of synaptic plasticity, and this is followed by S1 initiating another response (*it's an ability:?*). However, Mario does not provide any evaluation of this response either, indicating that they are dispreferred responses (Schegloff, 2007), presumably because neither of these terms is considered adequate and preferred to describe the neuroscientific phenomenon. Finally, Extract 3 closes with his own

definition of synaptic plasticity in his longer utterances from lines 31 to 37. In brief, Extract 3 illustrates that Mar initially treats the students as (K+), but then shifts to (K–) following long silences indicating the students' UTP with references to their academic knowledge, their current status, and the decreasing level of the students' conceptual abilities. In doing so, he raises the epistemic stakes, emphasizing the steepness of the epistemic gradient between himself (or current neuroscience knowledge) and the students, and creates what may appear to an observer as a rather challenging classroom atmosphere.

During the third session of his module, Mario continues to keep epistemic issues explicitly in play by asking for more definitions. Extract 3 shows how Mario elicits a definition of emotion, which positions the students as (K+) potentially regarding this concept. However, as was seen in Extract 2, he begins to downgrade their epistemic status to less knowledgeable (K–), in his follow-up to their responses.

Extract 3: emotion_08-09_53.41-55.39

```

01  Mar:  e::r so (.) first of all i would like to kno:w
02      (0.5) +what is emotion+
      mar  +-----1-----+ 1: points to 'emotion' on the board
08      ((6 lines omitted.))
09      what is emotio:n? +(1.0)+ a definition of emotion?
      mar  +--2--+ 2: looks at the students
10      i'm sure that those who have psychology background
11      (.) should have a definition fo:r (.) ↑emotio:n +(0.5)+
      mar  +--3--+
      3: points at S1
12  S1:  i think it's very complex and [everyone has different-
13  Mar:  [+not is very complex+
      mar  +-----4-----+
      4: shakes his head
14      but this is not an excu:se
15  S1:  yea:h [bu:t
16  Mar:  [it's very complex (.) no::
17  S1:  +like everyone is here has different (.) °explanations°+
      mar  +-----2-----+
18  Mar:  oka:y then let's try something easier
19      +(0.9) a definition+ for cognition
      mar  +-----5-----+
      5: points at 'cognition' on the slide
20      +(2.4)+
      mar  +--2--+
21      what is cognitio:n?
22      +(6.4)+
      mar  +--2--+
23      hu:h?
24  S1:  but is the final one (.) i mea:n(.) like people defining to
25      produce e:r experiment for example(.) but then every

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26 different autho:r(.)will have a different explanations
 27 Mar: okay so, then then +just e:r i want to know your opinio:n+
 mar +-----5-----+
 28 S1: ↑oka:y
 29 Mar: oka:y [so: please let us know according to your
 30 Ss: [eheh heh
 31 Mar: e:r academic knowle:dge and experience ↑li:fe (.) oka:y?
 32 (0.7) what (0.6) cognition is, what is it?
 33 S1: so: co- cognition, i think is e:rm (0.5) e:rm
 34 (1.5)
 35 it's: (.) differen:t (0.8) processes?
 36 psychological pro°cess°?
 37 Mar: psychological processes
 38 S1: e:r yeah (.) so: it's attentio:n °more°
 39 Mar: oka:y (.) so cognition is a psychological p↑ro:cess
 40 (2.7)
 41 S1: yea:h
 42 Mar: +oka:y+
 mar +nods-+
 43 +(2.0)+
 mar +--2--+
 44 any opinions?
 45 S2: i'm going to follow this e:r debate and I'm going to say
 46 that (.) it's a metaphor
 47 Mar: it's a metapho:r [ok:ay] probably e::r
 48 S1: [eheh]
 49 (1.3)
 50 Mar: any other opinions? so: it's a psychological p↑ro:cess

At the beginning of Extract 3, Mar explicitly asks for a definition of ‘emotion’ with a Wh- question. After a few lines in which Mar comments on the differences in the meaning of “emotion” between English and Spanish, he re-initiates his request for a definition of ‘emotion’ (line 9). Mario positions the students as potentially (K+) by requesting their displays of expertise (Demirören et al., 2024; van Braak and Huiskes, 2022) based on their academic background in psychology, again using a strong epistemic expression (*i'm sure*), and in so doing holds the students to be accountable for the kind of knowledge that would allow them to define ‘emotion’. In lines 12 and 17, S1 refers to the complexity of the concept, and the idea that people will define it differently, in so doing downgrading the epistemic status of the target concept from scientific to everyday knowledge. However, in lines 13, 14, and 16 Mar overlaps and challenges S1's contributions by negating that the concept is complex and stating that this is not an excuse, while shaking his head.

In line 18, Mario downgrades the epistemic demand by switching to something ‘easier’, asking for a definition of ‘cognition’, again asking a direct Wh- question (line 21). The response is long silences during which Mario directs his gaze at the students presumably seeking potential contributions with a pointing gesture to the slide and request for a student contribution (*hu:h?*) (lines 20, 23). S1 continues in a similar vein, by mentioning that different authors (i.e., experts) can have

different explanations of cognition based on experiments. Thus, S1 upgrades the expertise attributions from ‘everyone’ to ‘authors’. Mario continues to downgrade the epistemic expectations by asking only for their opinion with a pointing gesture to the word to be defined (i.e., cognition) on the slide. Following S1’s confirmation token (line 28), Mar elaborates on his preference by referring to the students’ expertise, based on their academic knowledge and life experience, requests their confirmation, and repeats his previous question (lines 29–32). Mar thus positions the students as (K+) but only in terms of their own opinions, not in terms of current neuroscientific knowledge.

From lines 33–36, S1 makes a new attempt at a definition by describing cognition as a psychological process, the turn interspersed with long silences and hesitation markers. In line 37, Mar partially repeats S1’s contribution which is more preferred (*psychological process*). This is followed by S1’s confirmation display and expansion of her response with another term in a mitigated way (*so: it’s attentio:n^omore^o*). In lines 39 and 40, Mar does not orient to S1’s second potential answer but confirms and reformulates S1’s first preferred response and provides a long interactional space (2.7 s of silence) for S1’s potential expanded contribution. After displays of confirmation tokens and a long silence as the indicators of closing the interaction between Mar and S1, Mar requests another student’s answer (*any opinions?*) by framing the knowledge he is eliciting as opinions, and S2 responds with the idea that cognition is a metaphor from lines 44 to 46. The extract closes with Mario’s mitigated confirmation with ‘okay’ and ‘probably’ to S2’s candidate response, another initiation to elicit other student contributions, and a repetition of S1’s preferred response (*so: it’s a psychological p[↑]ro:cess*).

In sum, the analysis of Mario’s orientations to the students’ contributions shows that they were largely treated by him as dispreferred responses. By eliciting definitions of key concepts, Mario initially positions the students as potentially knowledgeable (K+) about these concepts, presumably based on their expertise depending upon previous academic experience, in disciplines such as psychology. However, as the questioning sequences unfold, he downgrades their epistemic status to (K–) following the students’ dispreferred responses, and their unwillingness to participate. In doing so, Mario positions the students as (K+), but in epistemic territory different from current neuroscientific knowledge, for example by alluding to ‘life experience’. He also downgrades the type of knowledge they potentially hold to ‘opinion’, which has a much weaker epistemic foundation as it has less emphasis on academic expertise. By characterising the information sought as ‘something easier’, he also positions the students as (K–) in relation to more conceptually challenging content (i.e., emotion). In sum, Mar orients to students’ contributions through mitigation, reformulation, and confirmation, and enhances student participation through changing epistemic positioning based on the students’ (lack of) expertise.

Overall, the analysis of the three extracts presented here shows how Mario positions himself and the students in relation to different epistemic territories. Mario positions himself in relation to knowledge in terms of his personal biography, and positions the students in terms of different experience and/or expertise they may have gained through previous interactions, including academic study in subjects such as psychology. His use of very direct requests for definitions, requests for expertise demonstrations, lack of feedback or follow-up to some students’ responses, evidence of some dry humour or sarcasm, could be argued to produce a rather challenging epistemic playing field. However, this facilitates students’ contributions following the lecturers’ questions. In addition, this may be something that the students expect or are used to, and it may be that being a neuroscience student in the later stages of a two-year master’s course means being prepared to be challenged and held accountable for knowledge of core or threshold concepts.

Case 2: ‘Neurobiological bases of addiction’ module

In this subsection, three extracts from the module ‘Neurobiological bases of addiction’ taught by Juan are analysed. The extracts provide a picture of Juan’s epistemic positioning practices during the construction of the target neuroscientific knowledge. Extract 4 is from the very beginning of the module, after Juan introduces himself as the lecturer.

Extract 4: mental disorders_10-10_01.58-02.20

```
01 Jua: and toda:y >as we said< (.) we are gonna: (0.3) see
02 +a bit (.) e::rm (0.6)+
    jua +-----looks down-----+
03 how is the relation? we are gonna have a ↑sea:t (.)
04 because is- it's very complicated (.) and (0.3) and
05 since we don't have in the master course no:w
06 (0.7) as subject related to: (.) e:r mental disorders
07 (0.9) i wanted to: introduce a bit (.) this
08 mental disorders (0.3) e::r related to the ↑dru:gs
09 (.) to- to the drug intake (.) .hh ↑so this three
10 classes that we are gonna have toda:y
```

At the beginning, Juan introduces the course content by referring to the relation between drugs and mental disorders (line 3) and shares his stance that the topic is very complicated (line 4). After reminding students that his module covers new content for the master’s program, he briefly introduces the three main topics: mental disorders, drugs, and drug intake (lines 6–9). Unlike Extract 1 from Mario’s teaching session, Extract 4 shows Juan referring to the module content as new knowledge, without explicitly positioning the students or himself as knowledgeable (K+) or personalizing the knowledge during this introductory part.

Extract 5 is from the eighth minute of the first session, during which they focus on the cortical system which is responsible for provoking anxiety in the brain. The following extract illustrates how Juan displays his epistemic stance based on the students' epistemic status through positioning and other interactional practices, and elicits minimal student participation in the knowledge-building sequences.

Extract 5: fight or flight_10-10_08.19-09.54

01 Jua: +↑so: (0.3) what is the syste::m (.) e::r
 jua +-----1-----+
 1: looks at the slide on the smart board

02 +responsible of anxiety:+ (.) of e:rm provoking anxiety
 jua +-----2-----+
 2: turning to the students

03 in the ↑patients (0.8) ↑is the: (.) +e::r
 jua +--1---> line 7

04 (1.8)
 05 the cortica:(l) (0.8) e:r cortico: e::r (.) release
 06 cortico::(.)adrenal release (.) that is affecting the brain
 07 (.) and the >hypothalamus< (.)+
 jua -----+
 08 +↑i don't know if you're familiar with+ thi:s (0.9)
 jua +-----2-----+
 09 have you studied these e:r cortica::l release in the adrena::l
 10 (.) and then activation u::r >the activation of< adrenaline
 11 ((4 lines omitted.))
 15 ↑so: this is >what is happening in< (.) in:: (.)in: the: stress
 16 situation (.) we are having this system that cortisol
 17 +(1.2)+
 jua +--3--++ 3: looks at the students

18 ↑is releasing (.) adrenaline (0.8) that is +overactivating+
 +---draws a
 circle in the air+

19 +the hypothalamus (0.9) is activating the pituitary
 jua +-----turning to the board and pointing----->

20 gland (0.5) and then ba:ck+ (0.4) to: cortisol (0.6) .hh and
 jua -----+
 21 this is the: (.) the mechanism o:f (.) flight (.) or ↑fi:ght
 22 S1: [%°huh huh°%]
 s1 %--nods----%

23 Jua: [you kno:w] (.) when we are facing a situation (0.4)
 24 you are familiar with thi:s? the fight or flight? [%yeah
 s1 %-4--%
 4: nods quickly

25 Jua: when you are facing a situation of stress (0.3) or you
 26 ↑fight (.) or you fly
 27 Sx: °hnm::°

28 Jua: ((nodding)) you kno:w (0.5) ↑but in anxiety, this system i:s
 29 (.) disregulated(0.4) we are having excess of cortisol (0.6)
 30 that is altering (.)the release (.) o:f other hormones etcetera

Between lines 1 and 3, Juan initiates a question about which system provokes anxiety in the brain while introducing the new topic. After a (1.8) second pause, he answers his own question (Bozbiyik and Morton, 2023) by mentioning cortical release and referring to the hypothalamus (lines 6 and 7). He then demonstrates his epistemic stance relative to the students' knowledge by using the mitigated phrase 'i don't know if you're familiar with this' and asking if they have studied cortical release before (lines 9 and 10). Thus, Juan downgrades his displayed epistemic stance using hedged expressions and questioning rather than positioning students as knowledgeable (K+) about academic knowledge and life experience. From

lines 10 to 20, Juan provides extended explanations about how adrenaline and cortisol are activated by looking at the students (1.2 s of silence), referring to the PowerPoint slides, providing an embodied explanation (i.e., drawing a circle in the air), and finally connecting the target knowledge to related psychology concepts and/or daily life (this is the mechanism of flight or fight) (line 21).

By asking students if they know 'fight or flight', he positions them as potentially knowledgeable (K+) about this psychology-related everyday concept as shared knowledge to maintain epistemic progression in talk-in-interaction (Gardner, 2007; Balaman and Sert, 2017a). S1 displays a quiet confirmation token and nodding (line 22), but other students provide no verbal or embodied knowledge demonstrations, which leads Juan to question their knowledge about fight or flight. Although S1 deploys an embodied knowledge demonstration through nodding by overlapping with Juan's go-ahead token (line 24), Juan explains the link between neuroscience and psychology knowledge to the whole class in detail (lines 25–30). In summary, Extract 5 illustrates how Juan creates a less challenging atmosphere through mitigated expressions, reference to everyday knowledge, and open questioning practices while gauging students' knowledge during the content knowledge-building process.

Extract 6 is from the same session, and the topic has moved on to the relationship between drugs and anxiety in line with various anxiety models. The analysis shows how Juan not only positions the students as knowledgeable (K+), but also positions himself and the field as less knowledgeable (K-) using different interactional practices during the knowledge-building sequence.

Extract 6: drugs and anxiety_10-10_15.04-16.33

01 Jua: +so: we are gonna see (.) different models of anxiety
 jua +-----looks at the slide on the board----->
 02 and drug abuse:+ and we are gonna see e::r which models (.)
 jua -----+
 03 we ca:n relate (.) >to the anxiety< and depending on the drug
 04 (.) that we are taking (.) we will see more dru:gs (.) befo:re
 05 (.)before we are already::(.) we focus in tobacco, in canna:- uh
 06 sorry: alcoho:l and cannabi:s >because the most important drugs
 07 that are affecting depression during adole<sce:nce (0.4) but now
 08 with anxiety (.) we are gonna see different drugs (0.6)in which
 09 way (.) you think (.)that dru:gs +can be connected to anxiety?+
 jua +---shakes his left hand-----+
 10 S1: the: (consecutive) withdrawal syndrome
 11 Jua: +oka::y+ (.) +so- (.) so::+
 jua +-nods-+ +-looks at S1-+
 12 S1: so: he (has/have) anxiety: for not taking drug
 13 Jua: +oka::y+ (.) so: is- [you are you are taking the dru:g
 jua +-nods-+
 14 S1: [(inaudible voices) ti:me
 15 Jua: okay you are taking the drug >↑just to calm do:wn<
 16 S1: yeah
 17 Jua: &this is so:me& (.) self medicatio:n
 s1 &----nods----&
 18 S1: &yeah&
 s1 &nods&
 19 Jua: o:kay (.) you can take a dru:g (.) ↑just a self-medication
 20 because you have anxiety (.) so you need to take a dru:g (.)
 21 ↑what else (0.7) >what other relation< you can have with
 22 the drug?
 23 +(1.8)+
 jua +--1--+ 1: looks at the students
 24 and anxiety? (0.6) hu:h it's possible that
 25 +we don't know+ (.) i'm just asking (.) so it's possible tha:t
 jua +-----2-----+ 2: raises his shoulders up

26 you are taking the dru:~g (.) and is provoking anxiety: (.)so in
 27 opposite (.) so it's not that you are taking the drug to kill
 28 the anxiety, but you are addicted to one drug (.) and this is
 29 provoking anxiety (0.7) ↑and the third cause (.) that i:s (.)
 30 that you have common genes of common factors(.) +to::+ (.) e:r
 jua +nodst+
 31 to be (.) to have anxiety (.) and to have addiction

From lines 1 to 4, Juan introduces the topics they will focus on (models of anxiety and drug abuse and relationships between them). He mentions alcohol and cannabis as the most significant factors of depression during adolescence (lines 5–8), referring to the students' previous learning ([Can Daşkın and Hatipoğlu, 2019](#); [You, 2015](#)), and thus provides epistemic hints for his following question. He then moves on to the main topic of the session, and asks the students to think about how drugs can be connected to anxiety (lines 8–9). After S1's response which offers withdrawal symptoms as a candidate explanation, Juan deploys an elongated confirmation token through nodding, and initiates S1's expansion through a repetitive, elongated incomplete utterance (so:), which is followed by S1's elaboration (line 12).

Juan continues by building on the students' contributions, and links them to self-medication (line 17) while S1 is producing verbal and embodied confirmations (lines 16, 17, 18). At lines 19–20, he engages in multilogue ([Schwab, 2011](#)) by reformulating S1's previous contribution to make it accessible to the whole group. He then goes on to initiate another question, eliciting more relationships between drug taking and anxiety (line 21). He waits for (1.8) seconds of silence during which he directs his gaze at the students, none of whom offers a response to his question (line 23). At lines 24–25, he positions the academic field as possibly (K-) about other connections between drugs and anxiety, and lowers the epistemic accountability by stating that he is 'just asking' (line 25). In this way, Juan not only positions himself and the field as (K-) about this relationship, but in so doing he also highlights the legitimacy of each contribution provided by the students, given that there is a lack of consensus in the field. From lines 25–31, Juan lists possible explanations of links between drugs and anxiety.

In summary, Extract 6 shows Juan guiding students to respond to his questions by referencing their past learning experiences ([Jakonen, 2018](#)), building on their contributions, connecting them to other related academic knowledge ([Bozbiyik et al., 2024](#)), and providing extended explanations. This extract also demonstrates Juan positioning himself and the field as less knowledgeable (K-) about certain areas of the target domain, thereby orienting to a less steep epistemic gradient ([Heritage, 2013](#)) and possibly defusing the level of challenge in the classroom atmosphere.

Overall, as seen in Extracts 5 and 6, Juan creates a less challenging atmosphere by downgrading his displayed epistemic stance based on the students' knowledge status. He uses mitigated epistemic expressions (e.g., *I don't know if you are familiar*), varied questioning practices, references to students' prior learning, and extended explanatory turns to elicit student responses to his prior questions during the knowledge-building process. Additionally, he positions himself and the field as less knowledgeable (K-) about the neuroscientific knowledge under discussion.

5.2. LCT analysis

Using the evidence from the interactional analysis, we can claim that both lecturers were operating in different *legitimation codes*. Mario placed strong emphasis both on the knowledge of neuroscience that he wanted the students to acquire but he also highlighted the stance that the students needed to have in order to engage in the practices of neuroscience. In other words, he constituted the students as being a certain type of knower in order to successfully engage in the practice of neuroscience. In this sense, we can claim that Mario was operating in an *élite* code in that both epistemic relations and social relations were emphasized. In order to be successful in Mario's module, the students needed to have a high level of conceptual understanding of the neuroscience content as well as an orientation or stance towards being a specific kind of knower.

On the other hand, in Juan's sessions we can claim, based on the interactional evidence, that he was operating a *knowledge code*. For Juan and his students, similarly to Mario, a high level of conceptual understanding of the neuroscience content was expected. However, Juan downplayed social relations in his practices and he did not explicitly refer to experiences related to any specific social category nor did he openly express or require the students to adopt a stance towards neuroscience knowledge or the practices of being a neuroscientist. He approached knowledge often from the perspective of what students might be expected to know as members of society in general, for example their own experiences or other experiences that they may have heard about relating to the topics of drug and alcohol addiction, for example. So, overall, we can claim from the interactional evidence that Mario was operating in an *élite* code and Juan was operating in a *knowledge code* (as depicted in [Fig. 3](#)).

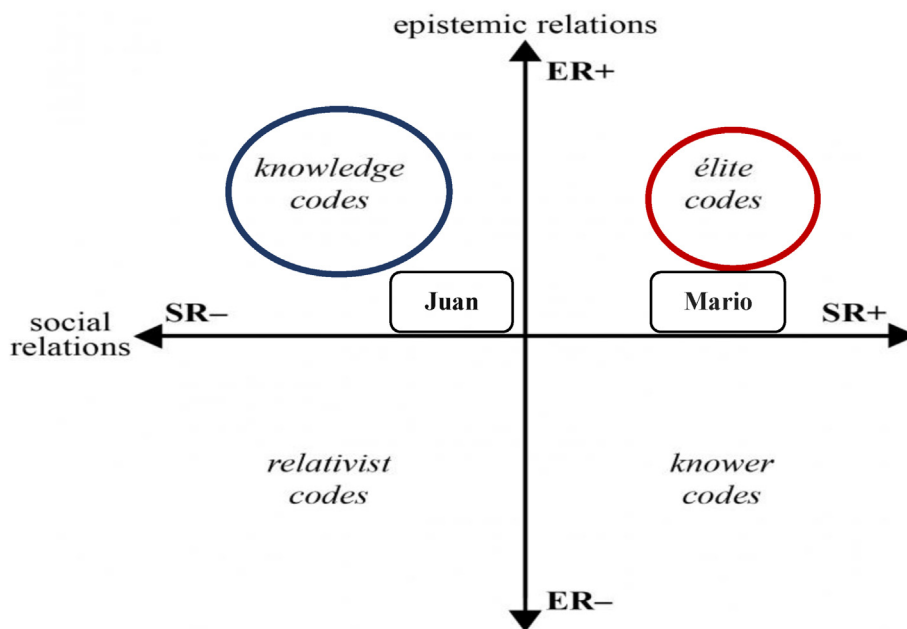


Fig. 3. The two lecturers' positions on the specialization plane.

Moving to an analysis on the social plane, we can draw out the different gazes which were being activated in Mario's and Juan's practices. Mario positioned himself as having a *cultivated gaze* as he referred to his own life story and his own experiences working with leading researchers in the field of neuroscience. For Mario, having been around at a certain time and working and studying under certain professors and researchers was an important component in his own development as a neuroscientist, and played a significant role in his relationship with neuroscience knowledge. As far as the students were concerned, Mario positioned them as being accountable for knowledge because of certain experiences or interactions they had had in the past, such as having previously studied psychology, or having come into contact with concepts such as synaptic plasticity. In this sense, he was not highlighting their belonging to any specific social category (SubR-), but he did show that he expected them to have had certain significant interactions (IR+). In doing so, he was highlighting a *cultivated gaze* as a basis for legitimation in studying and becoming an expert in neuroscience. However, it was gaze that he oriented to as having been attained for himself, while for the students it was an aspiration or expectation, not yet realised. It could be suggested that Mario was projecting the type of gaze that the students may be expected to acquire in the future, if they see Mario as being a model for them. Thus, they will eventually become neuroscientists who have both a high level of conceptual understanding and also an appropriate stance and attitude towards neuroscience and science in general as a practice, perhaps acquired through immersion in specific contexts and working with specific researchers such as Mario.

In Juan's sessions, he did not position himself explicitly in relation to the neuroscience knowledge that he was imparting. It was not a 'story of his life' in the way it was for Mario. Neither did he strongly position the students as belonging to any specific social categories or as having had any specific significant interactions. What they could be expected to know about topics such as drug addiction could be gained from their general experience as members of society. In this sense, they were being positioned as having a *trained gaze*, that is, the social categories they may or may not belong to, or any specific interactions in the practice, did not legitimise any claims to knowledge they might have, and did not interact with their acquisition of neuroscientific knowledge in ways which legitimise their practice. Overall, then, by using the findings from the interactional analysis as a kind of translation device for a posterior LCT analysis, we can show how two lecturers working in the same discipline in the same programme, albeit in different domains of neuroscience, were operating different underlying legitimation codes, and positioning themselves, and their students, in different ways by ascribing different gazes within subjective and interactional relations.

6. Discussion

The analyses of the six extracts show that knowledge-building in advanced postgraduate neuroscience classrooms is far from being a unidirectional flow of disciplinary knowledge from those expected to have a higher epistemic status in this domain (the lecturers) to those with an assumed lower epistemic status (the students). Rather, there is a constantly shifting dynamic epistemic progression (Balaman and Sert, 2017a; Gardner, 2007) of displaying and negotiating epistemic status and

stance (Heritage, 2012) as both lecturers adjust their epistemic positioning of students in moment-by-moment interaction based on the students' responses and displays of knowledge.

The epistemic positioning practices revealed in the two lecturers' classrooms revolve around a set of distinct parameters: the type of knowledge to which one can have access (broadly, disciplinary neuroscientific or "everyday") (e.g., Bozbiyik and Morton, 2023); who has access to which types of knowledge; where that access came from (everyday life experience or previous academic study); the extent to which knowledge is attached to one's personal biography or identity ("a story of my life" or being a postgraduate student); hierarchies of epistemic access (knowledge or "opinion"), and the different levels of conceptual difficulty ("easier" concepts). Apart from these more static parameters, the analyses revealed a set of interactional practices and resources through which (mostly) lecturers oriented to more or less steep epistemic gradients, thus increasing or decreasing epistemic asymmetry (Balaman and Sert, 2017b; Heritage and Raymond, 2005; Käätä, 2014). These included different questioning techniques, references to past learning, displays of expertise, mitigation of epistemic stance, and the use of a range of multimodal resources (Can Daşkın and Hatipoğlu, 2019; Demirören et al., 2024; Koole, 2010; Sert and Jacknick, 2015; Sert, 2013).

Disciplinary knowledge of neuroscience and more "commonsense" or "everyday" knowledge were involved in the epistemic positioning practices in both classrooms. Mario invoked concepts such as "emotion" or "cognition" which could be accessed from either one's own personal experience, or from a psychological or neuroscientific perspective. He positioned the students as potentially (K+) in relation to these concepts both from their everyday life experience and from previous academic study (including in related disciplines such as psychology) (Bozbiyik and Morton, 2023). He also invoked specific concepts from the domain of neuroscience, such as "synaptic plasticity", and raised the epistemic stakes by holding the students accountable for a definition of the concept due to their previous academic study. Juan also invoked both everyday and neuroscientific knowledge, but in this case, he tended to link the more familiar phenomena such as "fight or flight" with their neuroscientific counterparts (cortical release). However, he did not assume (K+) status even with the more everyday concepts and/or more familiar terms from psychology, as he checks that "fight or flight" is actually shared knowledge (Gardner, 2007).

In terms of their interactional epistemic practices around these parameters, the two lecturers differed somewhat. Juan worked to reduce epistemic asymmetry and maintain a more level playing field by using students' life experience as a way into the more conceptually difficult neuroscientific knowledge, thus orienting to a less steep epistemic gradient by downplaying the entire neuroscientific community's epistemic status in relation to a specific aspect of knowledge, such as the relationship between taking drugs and anxiety. Mario, in contrast, seemed to orient to a steeper epistemic gradient by directly eliciting definitions of key concepts and holding the students accountable for (not) knowing the material. By emphasizing the relationship between one's biography and identity and access to knowledge territories he raised the challenge for the students. Being a neuroscientist entails having access to certain territories of knowledge, particularly the conceptual domains of the field (Carandini, 2019; Correia et al., 2024; Sandrone and Alavian, 2021). By raising the interactional stakes in this way, there was a sense of interactional trouble which had to be resolved by production of appropriate epistemic displays (Bozbiyik and Daşkın, 2022; Batlle and Deal, 2021). However, it would be hasty to attribute anything negative to such an interactional epistemic climate, as challenge may be just what students studying advanced neuroscientific topics at master's level may expect and be accustomed to.

In terms of hierarchies of epistemic access and levels of complexity, Mario invoked both by downgrading students' epistemic access (Balaman and Sert, 2017a) to "opinion" about what cognition is, and this happened after he had shifted from eliciting a definition of "emotion" to the "easier" topic of "cognition". This suggests that epistemic objects themselves can be positioned in terms of hierarchies of more or less "difficulty" and that when (K+) status in a domain is unavailable, access can be downgraded to the weaker epistemic position of having an opinion about something. In contrast, in Juan's practices, having an opinion about an aspect of neuroscience can be seen as legitimate when there is uncertainty in the field (as in the example of drugs and anxiety). In this sense, an opinion would not be an epistemic downgrade, but a possibly legitimate contribution to a candidate explanation. Interestingly, in Mario's class, it is a student who refers to the concept of emotion being "very complex" and everyone having "different explanations". Mario himself does not position the field as (K-) in relation to any aspect of knowledge, and in so doing orients to a steeper epistemic gradient with references to displays of expertise in the field (Demirören et al., 2024; van Braak and Huiskes, 2022).

In terms of specific interactional practices and resources, the analyses suggest a range of possibilities for epistemic positioning, in this case in relation to neuroscientific concepts. One possibility is to probe the students' epistemic status by issuing direct requests for definitions of key concepts, thus raising the epistemic stakes if the students are unable to display a (K+) stance on the topic. Asking directly for definitions using question forms such as "What is synaptic plasticity?" creates a space for interactional trouble, including long silences, minimal student responses and eventually the lecturer providing their own definition (e.g., Koshik, 2003). Another possibility is to orient to a less steep epistemic gradient by focusing on epistemic domains that students are more likely to have access to, or by formulating questions so that there can be a range of possible responses, as when Juan asks about the ways in which drugs can be related to anxiety. Such a question leaves room for informed speculation, even guessing, and thus lowers epistemic demand. Again, the range of options available, and used in any specific interactional sequence, does not imply a criticism of choices made. It shows that at any time in the unfolding interaction, epistemic positioning in terms of the different parameters and specific interactional practices is a shifting dynamic process, with real consequences for the production of epistemic (a)symmetry and orientation to different knower positions.

The Conversation Analytic (CA) perspective on knowledge and knowing focuses on how participants in interaction orient to each other's states of knowledge, adjusting their assessments moment-by-moment in unfolding interaction. In this sense, knowledge is "real" to participants, in spite of it not being understood as a cognitive phenomenon (Drew, 2018). The LCT perspective as used in the reanalysis of the data in this study, also does not see knowledge as an individual cognitive phenomenon, but sees it as "real" from another perspective. It claims that knowledge has real effects in the world in shaping social practices, and that the organising principles of these practices can be the subject of empirical inquiry, thus revealing the "rules of the game" (Maton, 2014). In this sense, we can look at how the interactional epistemic practices described through multimodal micro-analysis may be consequential for the legitimation of the knowledge and knowers in this postgraduate neuroscience context. The LCT analysis shows that the basis of legitimation in the two lecturers' practice is different, in terms of the types of *gaze* their practices make relevant on the social plane. One lecturer (Mario) emphasises attributes of knowers as having had (or being expected to have) certain experiences and interactions, while the other (Juan) downplays both subjective and interactional relations.

In combining multimodal Conversation Analysis of epistemic practices with the empirical tools of LCT to reveal some of the organizing principles of the lecturers' knowledge-building practices, we can achieve a deeper understanding of classroom practices in this advanced science education setting. The multimodal micro-analysis is able to elucidate the interactional resources through which neuroscience teaching "gets done", while the LCT analysis explores the consequentiality of these practices for knowledge-building. Neither approach on its own would provide such a comprehensive picture. Learning neuroscience is about the acquisition of core and threshold concepts, and especially the latter are seen as key to obtaining recognition as an expert in the field (Correia et al., 2024; Sandrone and Alavian, 2021). Postgraduate neuroscience classrooms are key arenas for both the acquisition of concepts across a wide range of domains (Carandini, 2019) and for engaging in the kinds of interactions which will contribute to gaining an appropriate "gaze" as a neuroscientist. How lecturers position students as knowers in relation to the conceptually challenging content they have to acquire can be consequential both for their acquisition of the relevant concepts and their later recognition as experts in the field. This is particularly important in the latter stages of postgraduate taught courses (as was the case in the data examined here), as students are at the cusp of being potential contributors to knowledge in the field (for example through doctoral research). Slight shifts in interactional practices in terms of epistemic positioning, as seen in the practices of the two lecturers in this study, can potentially have profound consequences for what is taken to be legitimate in the knowledge practice.

7. Conclusion

In this study we have adopted an interdisciplinary perspective, combining LCT and Multimodal CA to generate new insights about classroom interaction and the knowledge-building process in one area of science education, postgraduate neuroscience. The study has its limitations, as it focuses only on the practices of two lecturers in one postgraduate programme. Further studies could broaden the database by including more video recordings of classroom interaction and supplementing them with interviews with participants. For example, it would be illuminating to collect lecturers' perspectives on their knowledge-building practices, both before and after viewing recordings, and to enable them to reflect on how they might modify them in the light of the video evidence and acquaintance with the conceptual tools of LCT. Other studies could link 'similar' practices with different specialization codes to students' learning outcomes - both from the perspective of knowledge and skills acquisition and more affective concerns such as how the practice influenced their engagement, participation, and motivation.

The theoretical and methodological approach used in the current study goes beyond the specific disciplinary area of neuroscience, and could be expanded to a wide range of topics in science education more generally. It is particularly appropriate near the end of taught postgraduate science programmes, where students are expected to acquire not just disciplinary knowledge and skills, but to achieve recognition as having expertise in the discipline. If all educational practices are knowledge-knower structures, then lecturers must find ways to navigate the delicate linguistic, interactional, and pragmatic demands to build appropriate messages, not just about the core and threshold concepts they want students to acquire, but also about the kinds of professionals they want their students to be.

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CRedit authorship contribution statement

Merve Bozbiyik: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Tom Morton:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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