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Valuing science: The role of language and body language in a health science lecture

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ABSTRACT

Science is a discipline of academic study that orients us strongly to field; to knowledge of how phenomena are classified and composed, and how activities implicate other activities. A strong focus on knowledge building can obscure the fact that the learning of science is also about understanding the values that associate with that knowledge. To date the teaching and learning of values in science remains relatively under-explored, particularly from a linguistic perspective, and in the context of spoken pedagogic discourse. The research reported here constitutes a case study of a live undergraduate lecture in health science on the topic of urine formation. It draws on systemic functional linguistic (SFL) theory, with the aim to model tools for analysis and an exploratory process for identifying the nature and expression of scientific values in the lecturer's discourse. Importantly we consider expression in relation to the semiotic systems of language and body language, and are able to show how their inter-semiotic relations function to reinforce a recurring set of values in ways that make them more noticeable to students, with greater potential for recognition and affiliation.

1. Introduction

A widespread trend in the research and teaching of academic discourse is to move from a generalist perspective towards a more disciplinary specific one (Bazerman et al., 2005; Hyland, 2000; Hao, 2015). A generalist perspective tends to emphasise ways in which academic language differs from more everyday, commonsense usage. Typically emphasis is given to written text and to how it is composed as periodic flows of information across clauses, paragraphed phases and larger units of discourse (Martin and Rose, 2007: 187ff). Relevant language resources have been discussed with reference to terms such as 'signalling nouns' (Flowerdew and Forest, 2015), and 'nominalisations' (Martin, 2008). From a social semiotic perspective, the resultant distancing of language from material reality constitutes a shift in register as mode (Martin, 1992).

A more disciplinary specific orientation on the other hand needs to take account of more than mode. Disciplinary discourses differ from one another in terms of register as field and as tenor (Halliday, 1994). Broadly speaking, the disciplines of the humanities orient more strongly to tenor, in the enactment of stance and the negotiation of values. Those of the sciences are more strongly field focused, shaped by concerns for how phenomena are described, composed, classified and

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technicalised, and for how activities are causally related (Hao, 2015; Martin, 2017a; Wignell et al., 1993). Nonetheless we recognise that while values may be somewhat backgrounded to knowledge in the sciences they remain an intrinsic feature. Induction into the disciplines of science involves both the building of scientific knowledge and the learning of its values (Hood, 2010; Martin, 2017a; Maton, 2014), each in interaction with the other.

In this paper we take a case study approach to explore means for identifying and making visible how the learning of scientific values is supported in the context of live (face-to-face) lectures. Embedded within this aim are questions of how we identify expressions that value science, what kinds of values emerge with respect to what kind of scientific items and activities, and how these are communicated in ways that support attention from students.

2. Positioning the study

The question of scientific values is of interest to scholars from a range of disciplinary bases and theories. There is of course a discipline devoted to the philosophy of science, where discussions frequently highlight the general values of 'truthfulness' and 'objectivity' in positing scientific findings (Machamer and Wolters, 2004). There are additionally studies that gaze at the sciences from the perspective of the humanities, and critique the values of science on that basis, that is on moral and ethical grounds (e.g. Rodrigues, 2016). The typically negative assessments in such studies reveal more about the values inherent to the humanities than those inherent to the sciences. Discourses of science have also long been of interest to scholars from the broad social scientific fields of linguistics and applied linguistics. From within the field of pragmatics, studies over a number of decades have examined scientific writing as a socially constructed activity (Bazerman, 1988; Myers, 1990; Russell, 1997; Bazerman et al., 2005 provides a valuable review), revealing how it is responsive to its social and historical context. Much research has focused on the ways in which writer stance is manifested in written text, and on the function of rhetorical features such as 'evidentiality', (e.g. Chafe, 1986; Barton, 1993), 'metadiscourse' (e.g. Hyland, 2005), 'hedging', 'stance', 'voice', and 'attitudinal marking' (e.g. Hyland, 2005; Hyland and Sancho Guinda, 2012). The study of communicating science values reported here shares an interest with research in the pragmatic tradition in exploring what, in systemic functional linguistic (SFL) terms, can be interpreted as the enactment of interpersonal meanings in language (Halliday, 1994; Martin, 1992), a concept that is elaborated in the following section.

From an SFL perspective, studies of the language of science trace back to an important set of publications in the 1990s. These include: Lemke's *Talking Science* (1990); Halliday and Martin's *Writing Science* (1993), and Martin and Veel's *Reading Science* (1998). Each of these works foregrounds science as a domain of knowledge that privileges field and ideational meaning. Nonetheless each also includes discussion of certain interpersonal perspectives on the field. In Halliday and Martin (1993), for example, Halliday, writes of the potential for functional and aesthetic values in scientific text (1993: 111–132). In the same volume, Wignell et al. critique the commonsense perspective on scientific technicality as 'jargon' whose function is "to obscure and restrict access to a field" (1993: 180), and Martin considers the negative social impact of the pedagogic up-take of the anti-rationalist perspective of post-structuralism on the learning of science in schools (1993: 291–292). Lemke (1990), in exploring scientific discourse in classrooms, discusses both science and the teaching of science as social processes in context and therefore always additionally about values and social interests (1990: 87–128).

More recent studies in the SFL tradition have foregrounded evaluative meaning in explorations of science texts. These include Hood's (2010) exploration of evaluation in introductions to academic research papers. The study notes the ways in which evaluative resources in the system of APPRAISAL are deployed differently in relation to the two most general fields construed in the texts: the field of the object of study associates with more overt expressions of attitude and the field of research with more implicit or covert means for encoding evaluation. This pattern was evident across diverse disciplines including the sciences. Research by Hao and Humphrey (2012) into values in written experimental reports in biology, finds that as a field is more finely specified so too are the attitudinal values that associate with its parts. O'Hallaron and Schleppegrell (2016) also take an interpersonal perspective on children's science writing focusing on mood and modality choices deployed in the enactment of voice and stance.

Renewed interest in discourses of science, especially in pedagogic contexts, has also been sparked by interdisciplinary dialogue between the linguistics of SFL and the sociology of Legitimation Code Theory (LCT) (Maton, 2014). Interdisciplinary collaborations of SFL and LCT include a study of knowledge building in biology in secondary classrooms documented in Martin and Maton (2013). The study has contributed to ways of 'seeing' cumulative knowledge building in science from both a linguistic and sociological perspective (see e.g. Hood, 2017; Hao, 2015; Martin, 2017a; Maton and Doran, 2017).

One important contribution of LCT is to theorise disciplines as characterised by differing 'specialisation codes of legitimation'. These codes are shaped by the relative strength or weakness of underlying principles of epistemic relations and social relations to knowledge (Maton, 2014: 29–33). Social relations or relations 'between practices and their subject, author or actor' are relatively stronger in the knower code disciplines of the humanities, and epistemic relations or relations 'between practices and their object or focus' are relatively stronger in the knowledge code disciplines of the sciences. However,

these are relative differences and in Maton's terms, "there are always knowledges and there are always knowers" (Maton, 2014: 96).

While studies of science discourse in pedagogic and professional contexts may privilege either scientific knowledge or scientific values, both are always implicated in the discourse. If taking a knowledge focus, for example, questions necessarily arise as to how particular features of the field – particular scientific items, activities, functions and relations – are identified as legitimate or significant. From an alternate orientation, we recognise that values are necessarily about something. In this sense the aims of building knowledge and teaching values are intrinsically related.

The aim in presenting this case study is to model an exploratory process for identifying the nature and expression of scientific values in the less explored context of spoken pedagogic academic discourse. Importantly we consider expression in relation to the semiotic systems of spoken language and body language, and their inter-semiotic relations.

The case study design responds to the considerable diversity in personal and/or institutional preferences in modes of lecturing, variations in the specific fields within the sciences that constitute the content of lectures, and differences in where lecture content sits on trajectories of learning in a curriculum. On this basis we do not suggest that the specific values identified in these data, or their specific expressions in language or in body language necessarily generalise across lectures. Rather what we aim to do, as noted earlier, is to model a process of analysis that can be applied across a diversity of instances. Having said that, our interest in the teaching and learning of values does lead us to explore how instances of kinds of values and means for their expression accumulate over the lecture, offering students greater potential for recognition of, and affiliation with these values.

The paper reports specifically on a study of an hour-length live (face-to-face) lecture in health science on the topic of urine formation, presented to approximately 150 first year undergraduate students at an Australian university. The lecture was audio and video recorded with two cameras focused on the lecturer who was positioned at the front of the lecture theatre. The lecturer's spoken language was transcribed, as were any audible comments from students. The analysis of the spoken discourse of the lecture is informed by systemic functional linguistic (SFL) theory. As a social semiotic theory of meaning, SFL also informs a theorisation of body language. It provides a framework for the analytical description of embodied meanings, and the ways corresponding meanings are co-expressed in each semiotic mode. First, some key dimensions and concepts in the theorisation of language are elaborated in Section 3. This precedes the reported findings in Section 4 with respect to the valuing of science in the spoken language of the lecture. The focus then shifts in Section 5 to an SFL perspective on body language at which point we also explain the rationale for the sequencing of the analyses from language to body language. In Section 6 we explore the cooperation of spoken and embodied expressions of science values in the lecture data.

3. Theoretical foundations: language and meaning

Some concepts drawn from the informing theory of SFL, particularly those related to register as field, tenor and mode, have been briefly introduced. However, a slightly more elaborated introduction to other relevant dimensions of the theory is offered in this section. The aim is to make clear the legitimating theoretical foundations for the approach to analyses and interpretation of data to follow. In that sense, the discussions constitute a dimension of the modelling provided in the case study.

A fundamental tenet of SFL is the theorisation of meaning as metafunctional, as simultaneously realising ideational, interpersonal and textual meaning. As ideational meaning language construes a material or symbolic 'reality', and it is this realm of meaning that relates to register as field. As interpersonal meaning, language enacts social relations and relates to register as tenor. As textual meaning, language composes ideational and interpersonal meaning into kinds of message structures, realising register as mode (Halliday and Matthiessen, 2014; Martin, 1992). These metafunctions of language intersect with a modelling of language across three strata which function at progressively abstracted levels of meaning. From the most concrete plane of phonology/graphology meanings are abstracted to systems at the plane of lexicogrammar, and further abstracted to systems in discourse semantics. Context is understood as realms of meaning abstracted beyond language, as register variables of field, tenor and mode, and at a yet more abstracted plane as genre (Martin, 1992; Martin and Rose, 2007, 2008). In all these systems a relational theory of meaning applies. After Saussure (1974) and Hjelmslev (1961), SFL proposes systems of choices with selections being meaningful in relation to what could have been selected but was not.

In this study the orientation to meanings is from the perspective of discourse semantics. At this relatively abstracted stratum of language, system choices can be realised in a range of lexicogrammatical resources. An appreciation of the social worth of some entity, for example, might be expressed lexicogrammatically as an Epithet in a nominal group (e.g. *this has an important function*), as the Thing itself (e.g. *I want to stress the importance of this function*), or perhaps implied metaphorically in a process (e.g. *take note of how this works*). From discourse semantics we can also look 'up' to context as register and consider the implications for tenor in terms of how the kinds of evaluative meanings we make impact on interpersonal relations.

Key to the analyses that underpin this study is the discourse system of APPRAISAL, which theorises options for the expression of evaluation. APPRAISAL has three semantic dimensions or sub-systems: ATTITUDE, GRADUATION and ENGAGEMENT (see

Fig. 1). All three play a role in the identification of how disciplinary knowledge is valued in the enactment of a live lecture in health science.

Beginning with APPRAISAL as ATTITUDE, resources are categorised into three kinds: APPRECIATION, JUDGEMENT and AFFECT. The category of APPRECIATION concerns the evaluation of 'things', AFFECT expresses human emotions, and JUDGEMENT evaluates people or their behaviour. Each category of ATTITUDE opens to more delicate choices (Martin and White, 2005: 42). Relevant finer distinctions are discussed in the findings in Section 4.1. For further elaboration of categories of ATTITUDE readers are referred to Martin and White (2005).

The example provided above in 'this has an *important* function' illustrates explicit or inscribed ATTITUDE. Such instances are identified on the basis that they carry an intrinsic positive or negative value that can be graded up or down (e.g. *important – very important – vital*). The resources deployed in up-scaling or down-scaling instances of ATTITUDE implicate a second subsystem in APPRAISAL, that of GRADUATION. The basic options in GRADUATION are grading as FORCE (analogous to turning up the volume on a sound system) and FOCUS (analogous to the focusing function on a camera). FORCE functions to intensify values in expressions such as *very important* or to quantify them in expressions such as *much importance*. FOCUS resources function to sharpen or soften categorical boundaries around meanings. Boundaries around the item *reason* are sharpened in *the specific reason*, and those around *plasma* are softened in *it's not pure plasma*. Boundaries around the activity *works* are softened in *it sort of works* (Hood, 2010).

While resources of GRADUATION can couple with instances of inscribed ATTITUDE to adjust FORCE or FOCUS by degree, they can also couple with non-attitudinal (ideational) meanings. In that case they function to give a subjective orientation to an 'objective' meaning. This is a key means by which writers and speakers imply or invoke an attitudinal meaning (Hood, 2010). A final point to note is that any analysis of ATTITUDE is incomplete without attending to what the trigger or target of the evaluation is. In a study of the values of science, critical triggers or targets for evaluation are the entities and figures that realise items and activities of science (Hao, in press; Maton et al., forthcoming).

The third system of APPRAISAL is ENGAGEMENT. This presents options for negotiating inter-subjective stance in discourse. A first cut distinguishes 'single-voiced' from 'multi-voiced' text, more technically referred to as **monogloss** or **heterogloss** (after Bakhtin, 1981). In heteroglossic text, space can be expanded or contracted around alternative positions (Martin and White, 2005). These options are elaborated and exemplified in Section 4.3. In monoglossic text, propositional claims offer no space for negotiation or alternate positions. Martin and White (2005) refer to "bald assertions" but note that such "categorical assertions within a framework concerned with the resources for dialogic positioning" should not be interpreted as "inter-subjectively neutral, objective or even factual" (2005: 98–99).

All three systems of APPRAISAL are implicated in the analysis of values in the lecturer's spoken language. Additionally, the semantic spaces they map offer a framework for interpreting cooperating expressions of body language, as is explained in Section 5.

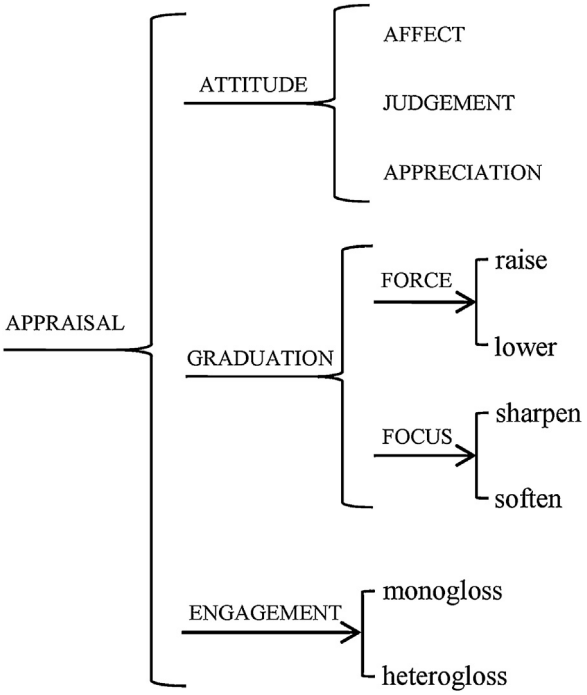


Fig. 1. An outline of the system of APPRAISAL in systemic functional linguistics (from Martin and White, 2005: 38).

4. Spoken expressions of scientific values in the pedagogic discourse

The analysis of the lecturer's spoken language shows that resources in all sub-systems of APPRAISAL, that is, in ATTITUDE, GRADUATION and ENGAGEMENT, are implicated in enacting scientific values. We find that there are distinctive patterns of use in appraising disciplinary knowledge, and that each pattern suggests the enactment of a particular kind of scientific value. The findings are reported on the basis of the patterns of interpersonal meanings identified in the data.

4.1. ATTITUDE: inscribing a value

In a first step of analysis the data reveal a strong preference for evaluative resources of APPRECIATION (valuing phenomena). This is expected in the context of academic discourse that orients generally to objectifying reality (Hood, 2010; Hao and Humphrey, 2012). This general finding suggests a need to explore expressions of APPRECIATION at a finer level of delicacy where further distinctions include **valuation** concerning 'how worthwhile' something is; **composition** to do with 'how complex' or 'balanced' something is; and **reaction** to do with 'how good' a thing is (Martin and White, 2005). In the live lecture data of this study preferences were for APPRECIATION as valuation and as reaction.

Instances of valuation are exemplified in [a], [b], [c] and [d] below in bold font. Each instance enacts positive ATTITUDE with respect to the significance of a scientific phenomenon (underlined).

[a] So what does the urinary system do? The first one is the one which I've already talked about – it's the **principal** means of removing foreign compounds from the body.
[b] last week I talked about the fact – you listened – that the last and **most important** stage of vitamin D activation occurs in the kidneys.
[c] But here's the first thing, which is **unique** about this capillary bed. It doesn't drain into a little vein – a venule. It drains into another arteriole.
[d] The blood supply of the kidneys and the arrangement of the vessels of the kidneys is **quite interesting**, and has some **fairly unique** aspects.

These examples show that what is appreciated in expressions of valuation can be either scientific activities, as in [a] (*the means of removing foreign compounds from the body)*, [b] (*the last stage of vitamin D activation*), and [d] (*the blood supply of the kidneys*), or scientific items, as in [c] (*capillary bed*) and [d] (*the arrangement of the vessels of the kidneys*). The targets of appreciation all construe aspects of the biochemical knowledge that constitute the content of the lecture. A recurring pattern in the spoken discourse of the lecture is the coupling of positive valuation with biochemical activity, as is illustrated in Table 1.

As reflected in Table 1 expression of significance in the lecturer's spoken language is mostly up-scaled with resources of GRADUATION as FORCE, either with pre-modification (as in *most important*) or infused in the attitude (as in *principal, unique*).

This recurring pattern of coupling kinds of biochemical activity with APPRECIATION as valuation points to a generalised type of scientific value, one we label **significance**.

A second choice in APPRECIATION revealed in the data is that of reaction, which we gloss as 'how good a thing?'. This is illustrated in [e].

[e] Big proteins and cells never leave the bloodstream. They leave the glomerulus and stay in circulation. If they're in your blood, and in your urine, **something's wrong**.

In [e], the expression in bold, *something's wrong*, encodes inscribed negative reaction in response to a speculative biochemical phenomenon – i.e. *if big proteins and cells are in your blood, and in your urine*.

In other instances negative reaction is expressed in more implicit terms that invoke an attitudinal interpretation. In example [f], the lecturer's exaggerated description of consequences (in bold) affords an interpretation as negative reaction. Once again the target is a speculative biochemical phenomenon – *having all that plasma peed out.*

[f] So clearly something is going to have to happen to that filtrate before it's turned into urine. You can't just have all that plasma peed out. **You'd be dead in a fraction of a day. You'd turn into dust.**

Like the resources of valuation, instances of reaction in the data are found to be concerned with evaluating scientific phenomena, and in particular resultant conditions. These are dominantly expressed in negative terms, and so generally evaluated as 'disfunctional'. Given the field of health science it is perhaps not surprising that what can go *wrong* is

Table 1
Coupling of ideational meanings with appreciation as valuation.

	Ideational meaning		Interpersonal meaning	
[a]	Biochemical activity	*The means of removing foreign compounds from the body*	+ Appreciation: valuation	*Principal*
[b]	Biochemical activity	*The last stage of vitamin D activation*	+ Appreciation: valuation	*Most important*
[c]	Biochemical item	*Capillary bed*	+ Appreciation: valuation	*Unique*
[d]	*Biochemical activity & item*	*The blood supply of the kidneys and the arrangement of the vessels of the kidneys*	+ Appreciation: valuation	*Quite interesting; fairly unique*

assigned evaluative salience. The pattern of coupling disfunctional biochemical phenomena with negative reaction is shown in Table 2.

The pattern of coupling in Table 2 enacts a distinctive value in health science, which we name **functionality**.

4.2. GRADUATION: adjusting FOCUS

Noted in the earlier theoretical introduction is the use of GRADUATION as FORCE to adjust the intensity of inscribed ATTITUDE. Instances of GRADUATION as FOCUS are also found in the data. FOCUS functions to sharpen or soften categorical boundaries around ideational meanings, and in so doing can invoke an attitudinal interpretation (Martin and White, 2005; Hood, 2010). This is exemplified below in [g], [h], [i] and [j]. In these examples, the resource of FOCUS (in bold) functions to adjust the definitiveness of kinds of ideational meaning (underlined).

[g] And when you magnify it, you can see that inner layer is made of individual cells but they do**n't** join up **exactly**.
[h] In a normal capillary bed, the outlet is the venule. The venules are **fairly** non-contractile.
[i] But you can imagine it's **almost like** a funnel around the papilla.
[j] But it's **not pure** plasma. There's bits missing. So large molecular weight proteins, albumin, is **generally** not there.

These examples demonstrate how categorical boundaries can be weakened in relation to different kinds of scientific ideational meanings. In [g], what is categorically adjusted in definitiveness is the composition of a scientific item – the space between *individual cells*. In [h] it is the quality of a *venule* in terms of its *contractability*. In [i] it is the relative approximation (i.e. *to a funnel*) of the shape *around the papilla*. In [j], the composition of the biochemical item *plasma* is softened (i.e. *not pure*), as is the presence of *large molecular weight proteins, albumin* (i.e. *generally*).

In deploying resources for grading FOCUS, the lecturer expresses values related to degrees of exactness when perceiving biological phenomenon. Dominantly in our data the exactitude is somewhat down-graded, suggesting perhaps space for more nuanced degrees of exactitude in health science than in some other scientific fields. However, this is not an exclusive choice made by the lecturer. An instance of sharpened FOCUS expressing specificity is in bold in [k].

[k] There's a **limit** to how much it will be absorbed, because it requires a transporter.

The expression *there's a limit* constitutes an instance of sharpened specificity as it verbalises the existence of a defined boundary to a scientific property, in this case the capacity to be absorbed. The claim is then supported with an explanation for the limit (*because it requires a transporter*).

We refer to the types of value expressed in [g] to [k] as **specificity**.

4.3. ENGAGEMENT: logical deduction

The third dimension in APPRAISAL is that of ENGAGEMENT. This system also provides significant resources for expressing scientific values in the lecture. ENGAGEMENT systematises resources for managing the dialogic space around a proposition. A dialogic space can be either expanded by opening to other potential voices (e.g. *probably*; *it is believed that…*; *this suggests that…*), or it can be contracted, closing down potential for negotiation. This may be by rejecting or countering a position (e.g. *that's not going to happen*; *but another interpretation is that…*), or strengthening and reinforcing one (e.g. *the facts of the matters are…*; *the study demonstrates that…*) (Martin and White, 2005). Grammatical resources such as projection (*it's thought that…*), modality (*it could be…*), negation (*it's not*) and concessive conjunction (*however…*) are important resources in enacting dialogic expansion or contraction.

In example [l], the relative low modality in *could* and *would* invites students to deduce the potential consequence of a biological condition. The dialogic space is expanded.

[l] So what **could** [expand] that end up being? What **would** [expand] you basically do? You**'d** [expand] lose all your plasma in, what, a fraction of a day.

In example [m], the high modality in *must* negotiates probability in relation to the proposition – *what the hydrostatic pressure is like*. While expressing high probability, the proposition is still heteroglossic and open to alternative voices.

Table 2
Coupling of ideational meanings with appreciation as reaction.

	Ideational meaning		Interpersonal meaning	
[e]	Biochemical activity	*Big proteins and cells are in your blood and in your urine.*	- Appreciation: reaction	*Something's wrong*
[f]	Biochemical activity	*Have all that plasma peed out*	- Appreciation: reaction	*You'd be dead in a fraction of a day. You'd turn into dust.*

[m] Lecturer: So what **must** [expand] the hydrostatic pressure be like in here?
Students: High.
Lecturer: It's high.

Significantly, it is noted that when the lecturer negotiates a proposition with ENGAGEMENT resources, this is frequently initiated with the logical connection *so.*

In [l] and [m], the lecturer uses *so* to establish a logical relationship between what has been previously explained and a deduction to be drawn from that. What is being negotiated in the deployment of resources of ENGAGEMENT (*must*, *could*, etc.) is the validity of the evidence-based deduction. Interestingly, sometimes when a deduction is made with relative high certainty, the ENGAGEMENT resource can be left implicit. This is exemplified in n. Following the logical connection *so*, the resource that contracts the dialogic space, *we conclude*, remains implicit.

[n] **So (we conclude)** that's the first thing which is unusual about this capillary bed.

The recurring pattern of coupling logical deduction (*so*) with ENGAGEMENT choices of heteroglossic expansion enacts the value of logical reasoning in science. We name this type of scientific value **rationality**.

So far we have described the ways in which resources in the interpersonal discourse semantic system of APPRAISAL have been deployed in the lecturer's spoken language in the service of enacting values with respect to the scientific content of the lecture. Four distinctive and recurring patterns emerge. These include positive valuation of scientific phenomena, negative reaction to disfunctional scientific conditions, concerns for degrees of exactitude in scientific meaning, and the negotiation of validity with respect to scientific deduction. Based on these distinctive and recurring discourse semantic patterns, we identify four types of scientific value evident in the discourse of the lecture and name them as: **significance**, **functionality**, **specificity**, and **rationality**.

5. Theoretical foundations: body language and meaning

We turn now to consider a second kind of semiotic potential deployed in the discourse of the live health science lecture, that of body language. Our specific focus is on the ways in which expressions of evaluative meaning in spoken discourse co-instantiate or couple with kinds of embodied expression. This requires a brief account of a social semiotic theorisation of body language and inter-semiotic relations.

As with language, embodied meaning is interpreted metafunctionally. It has the potential to mean ideationally, interpersonally and textually. A systemic functional theorisation of embodied meaning involves the development of networks of choices that establish the grounds for interpretation. Relevant studies include Hood (2011), Martinec (2001), Martin (2011), Martin et al. (2013), Zappavigna and Martin (2018) and Martin and Zappavigna (in press).

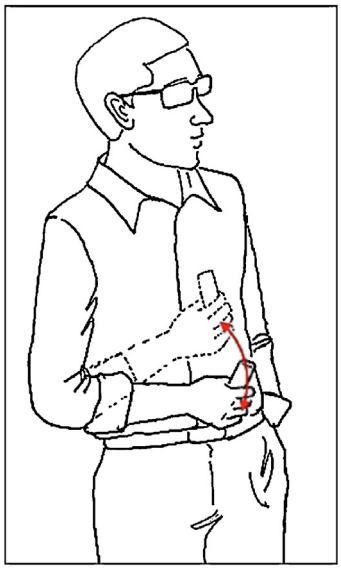
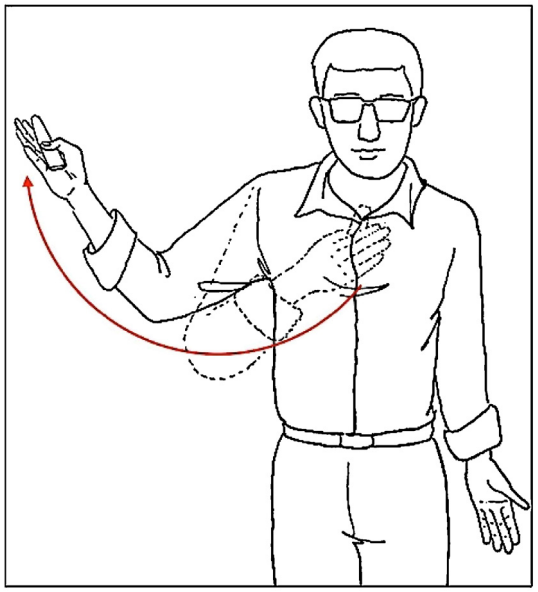


Fig. 2. Example of beats of hand and arm synchronising with phonological salience of underlined syllables.



"You'd pee out everything good in your body."

Fig. 3. Example of GRADUATION fused with gestural expression.

Cléirigh (2011) makes an important distinction between two systems of body language. One is a system in which the body moves in synchrony with the phonological rhythm and stress of spoken language (Halliday and Greaves, 2008), and is therefore dependent on the co-expression of speech. Cléirigh (2011) refers to this as 'linguistic' body language, and more recently it has been termed 'sonovergent', in other words sound-related body language (Zappavigna and Martin, 2018; Martin and Zappavigna, in press). This sonovergent system has the potential to enact both textual meaning and interpersonal meaning, although not ideational. In phonological expression in English, textual meaning is realised in a foot-timed rhythm of syllable stress that marks certain information as relatively more salient across a tone group. One salient syllable within a tone group (the tonic) is additionally marked with pitch movement, signalling that information as New (Halliday and Greaves, 2008; Smith, 2004). Longer wavelengths of phonological rhythm are possible across longer units of meaning. In corresponding rhythmic movements of the body, smaller and therefore faster moving body parts such as hands and head readily synchronise with small phonological wavelengths of salience and tonicity, typically as head-nods or beat gestures (see example in Fig. 2), and may synchronise at even smaller wavelengths of syllable-time. Rhythmic movement of the whole torso can synchronise with longer wavelengths (Martinec, 2000, 2002; Eisenstein, 2008; Hood, 2011). When embodied stress and rhythm are synchronous with phonological expression there is an inter-semiotic coupling that functions to amplify the textual significance of stressed meanings.

From the perspective of interpersonal meaning there are correspondences between phonological expressions of tone (e.g. in a rise-fall expressing surprise), and body movements that trace the intonation profile (e.g. with the fingers, hands, head, eyebrows). Once again, the inter-semiotic coupling enhances the meaning; in this case an interpersonal one.

A second system of body language, referred to by Cléirigh (2011) as 'epilinguistic' and by Martin (2017b) as 'semovergent' or meaning-related, can occur with or without speech, although it is dependent on the potential for speech in that it can only express meanings that are possible to express in language (Zappavigna and Martin, 2018; Kendon, 2004). Semovergent body language allows for expression of meaning in all three metafunctions. Textually, it functions in identification, canonically as a pointing gesture (cf. Kendon, 2004 on deictic gestures). Ideationally, meaning can be realised in a gestural shape or 'drawing' in space. Interpersonally, it can be realised explicitly in facial expression as positive or negative affect (see Painter et al. (2013: 31–32) for an account of facially expressed affect in images). However body language can also invoke evaluative meaning in other ways too. This can involve adjusting an embodied gesture along dimensions of intensity, size, frequency or duration (Hood, 2011), in other words by the deployment of resources of GRADUATION as FORCE. Resources of GRADUATION can couple with gestural expressions of ideational meaning (e.g. in the size of a gestured entity) or textual meaning (e.g. in the size of intensity of a rhythmic beat) to invoke an evaluative interpretation (see for example Fig. 3).

Interpersonally the semiotic potential of the body can also express inter-subjective positioning. This is akin to the more general level of choices available in the ENGAGEMENT system of APPRAISAL realising heteroglossic expansion or contraction (White, 2003). Gesturally a general distinction is made in body language between supine (open) and prone (closed) postural expression (e.g. Kendon, 2004). Openness might be expressed, for example, in an extended forearm with supine hand (palm

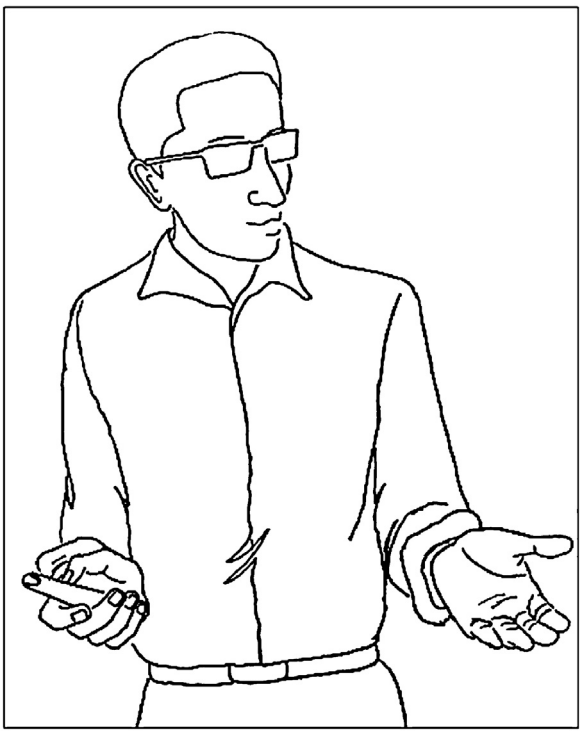


Fig. 4. Supine hand gesture.

up), as in Fig. 4. This constitutes an under-committed expression that may be interpreted as either an offer or elicitation/request, with interpretation likely resolved in co-present speech.

In contrast to offer or elicitation expressed with a supine hand, closure can be expressed with a prone hand (palm down) beat interpretable, for example, as 'laying down the law'. This distinction is semantically related to the ENGAGEMENT system that contrasts heteroglossic expansion with heteroglossic contraction (Hood, 2011; Martin and White, 2005). Heteroglossic contraction as a strong denial or rejection of a proposition may be expressed in the shaking of the head, the extension of an outward facing palm or index finger, and additionally in the shaking from side to side of that hand or finger (see Fig. 5).

De-stabilising or de-centring movements of the body that include oscillating gestures of the hand moving between supine and prone positions, the tipping of the head to the side and/or the shrugging of the shoulders (see Fig. 6) can be interpreted either as expressing a weakened FOCUS, softening the boundaries around entities and qualities (e.g. 'it's not pure plasma') (Hood, 2011), or expanding the heteroglossic space for propositions (e.g. 'I am not sure').

As with the de-stabilising or de-centring gestures noted above, a pinching gesture that closes together the tip of the thumb with the tips of index and middle fingers (see Fig. 7) may also express FOCUS, however in this case as sharpening the boundaries around phenomena (e.g. 'it is exactly like this), it may also express heteroglossic contraction, closing down negotiation of a particular proposition (e.g. 'it is definitely the case'). In other words the specific interpretation is made with respect to the interpersonal meanings that they couple with in spoken language.

In analysing expressions of meaning in body language it is important to note multiple meanings can be expressed simultaneously just as they are in language. More than one meaning may be integrated in a gesture or different meanings may be expressed simultaneously in different parts of the body.

We have approached the data analysis by first analysing the spoken language of the health science lecturer from a discourse semantic perspective that explores couplings of evaluative meanings with the entities and figures that realise items and activities of science. On this basis we have identified a set of patterns in the verbal expression of values. We now move to explore possible cooperating patterns in embodied expression. The sequencing is not an arbitrary decision. As noted above, from a systemic functional perspective, body language, including facial expression, gesture and posture, constitutes a distinct semiotic system but nonetheless one that is para to language, in other words it is "semiosis dependent on language"[1] (Zappavigna and Martin, 2018; Martin and Zappavigna, in press; see also Matthiessen, 2009). This interpretation rests on the noted convergence of different types of body language with the prosodic phonology of spoken language.[2] However, we

[1] This is not to say that body language is part of language (as, for example, in Fricke (2013)) but that it does mean in relation to language.

[2] For a more complete account of this paralinguistic relation (including for body language as mime), readers are referred to the cited sources.

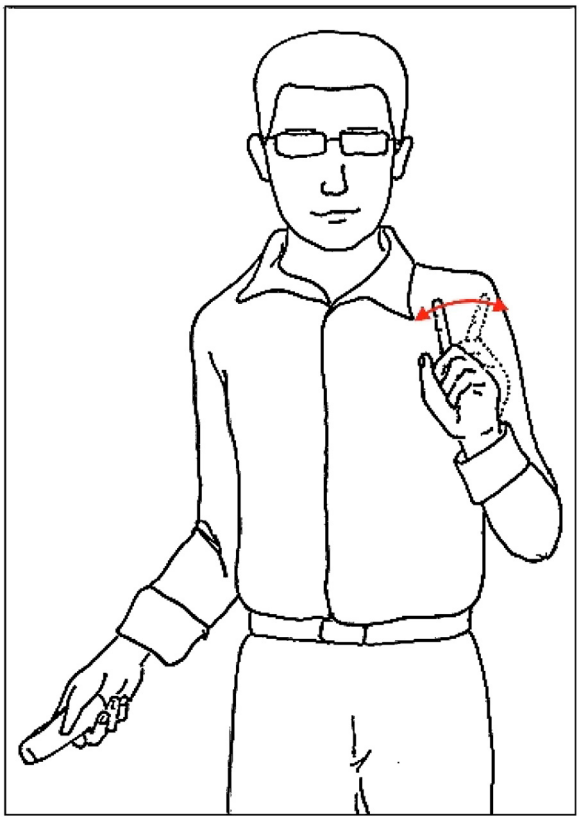


Fig. 5. Denial or rejection gesture.

note that a parallel phonological analysis of the spoken language data is beyond the scope of this paper where concern rests on ways in which expressions of evaluation in language co-instantiate with embodied meanings in the body language of the lecturer.

6. Couplings of spoken expressions of scientific values with embodied expressions in the pedagogic discourse

Our interest here is in where semantically related expressions of meaning in language and body language co-occur in the discourse, that is where we find convergent inter-semiotic **couplings** (as distinct from divergent ones that are also possible) (Zappavigna et al., 2008; Painter et al., 2013). Such points of inter-semiotic convergence function to amplify the meaning that is co-expressed. In our data they function to foreground and give greater interpersonal weight to certain expressions of scientific value. A series of recurring kinds of coupling emerge, as reported below.

6.1. Coupling significance expressed in language with amplified embodied beats

As discussed in Section 5, a social semiotic theorising of body language differentiates one system that must be co-expressive with spoken language and is always synchronous with rhythm and stress in speech; it is sonovergent in that respect (Martin and Zappavigna, in press). The dominant function in this system is to make visual the textual marking of information as more or less salient in the flow of speech. However, in addition to this dependent textual function there is an independent system that can function together with the rhythmic beats of body parts – a system of embodied GRADUATION. This might be expressed, for example, in increased muscle tension in a beat gesture, or in its size or range of movement, or its frequency or duration when held. All constitute dimensions of GRADUATION as FORCE. This additional embodied meaning infuses the textual beat with the potential to function as interpersonal semovergent body language by invoking an attitudinal interpretation.

An analysis of features of body language accompanying expressions of inscribed APPRECIATION in spoken language reveals a recurring pattern. Where expressions of APPRECIATION are graded up in FORCE, they typically couple with amplified embodied beats. These recurring couplings are exemplified and described in [a], [b] and [c] in Table 3. Bold font annotates attitude, and syllables synchronous with beats are underlined.

Fig. 6. Shrug of shoulders.

The generalised value expressed in the amplified beats we name as **prominence.** The couplings configure patterns of spoken significance with embodied (and so visual) prominence.

6.2. Coupling of expressions of disfunctionality in spoken language with embodied rejection

When instances of negative APPRECIATION as reaction in the spoken text are explored for associations with body language, a number of recurring kinds of convergent couplings are found. These feature embodied expressions of rejection or denial. Examples are described in [f-1] and [f-2] in Table 4. See [f-1]illustrated in Fig. 5.

In [f-1] we have an instance in which the expression of disfunctionality in spoken language is implied rather than inscribed. However the negative reaction to the condition (i.e. if nothing happens before the filtrate is turned into urine, in other words, 'having all that plasma peed out') is considerably more committed in the lecturer's body language.

The generalised value expressed in negating or denying gestures we refer to as **rejection**, and the couplings configure patterns of dis/functionality in language with embodied rejection.

6.3. Coupling of weakened specificity expressed in spoken language with a de-centring posture of the body

Analyses show that not all expressions of weakened specificity in the spoken language of the lecture are found to couple convergently with expressions in body language. For example there was no convergent coupling with specificity in *But you can imagine it's* ***almost like*** *a funnel around the papilla.* However a recurring pattern of convergent couplings did emerge. These couplings involve spoken expressions of weakened specificity with respect to scientific phenomena co-instantiating with embodied de-centring gestures or postures that include shrugs of one or both shoulders. These couplings are described in Table 5 and exemplified in Fig. 6. The postural movement expresses a softening of the value of precision.

The generalised value expressed in de-centring gestures and postures we refer to as **precision.** The couplings configure patterns of softened specificity in language and correspondingly in embodied precision.

6.4. Coupling of expressions of sharpened specificity in spoken language with embodied expression of precision

As noted earlier, in our health science data most expressions of the general value of specificity in language, or precision in body language, are softened or weakened, suggesting perhaps that degrees of precision are more commonly expressed when

Fig. 7. Pinching gesture.

referring to biological phenomena. However, we note that the instance of sharpened specificity in language exemplified in [k] (*there's a limit…)* is shown to couple with the gesturing of sharpened precision in body language. Embodied sharpened precision is expressed in a pinching gesture that brings together the tips of thumb, index and/or middle fingers (see Table 6 and Fig. 7 above). While not a recurring coupling in this data set, the embodied expression is recognised in the literature as meaningful with respect to precision (e.g. Kendon, 2004).

The pinch gesture of sharpened precision (illustrated in Fig. 7) contrasts with the de-centring gestures of weakened precision in its enactment of closure. We could argue that in [k] the value of specificity/precision is more committed in the embodied pinch gesture than it is in the spoken language.

6.5. The coupling of rationality in spoken language with embodied proffering

A final step in analysis is to explore associations of body language with expressions of rationality in language. Rationality refers to the negotiation of validity with respect to scientific deduction. Once again we find a set of convergent couplings. In this case the associated features of body language have to do with supine hand gestures directed towards interactants in an expression of offer/invite. This expression corresponds to that of the general realm of heteroglossic ENGAGEMENT, but such embodied expressions do not commit meanings at the levels of delicacy available in language (Martin and White, 2005; White, 2003). The under-committed meaning in embodied expression typically does not allow us to differentiate between embodied offers or invitations.

Examples of coupling body language with expressions of rationality in language are described in Table 7.

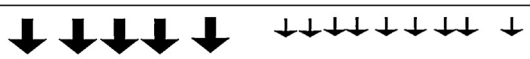
In example [l], the combination of logical connection *so* and heteroglossic expansion, realised by modality *could* and *would*, is coupled with a gesture more likely to invite a response to the question. In example [n] the heteroglossic ENGAGEMENT is implied in the logical connection 'so', but not explicitly articulated. We can interpret it as 'so we know/conclude'. However the ENGAGEMENT choice is implicit in spoken language that is made explicit in body language in an offer/invite gesture.

The general value expressed in the gesture of offer/invite we refer to as **proferring**, and the couplings configure patterns of embodied proferring with spoken expressions of rationality.

It is evident from analysing the discourse of the lecture that expressions of evaluation of scientific phenomena in speech frequently couple convergently with expressions in body language. However, it is important to stress that as independent semiotic systems, this will not always be the case. Each instance of expression will be shaped in its immediate context and co-

Table 3
Coupling of expressions of amplified appreciation in spoken language with amplified embodied beats.

[a]	*It's the **principal** means of removing foreign com-pounds from the body*
	
	An intensified downward beat with the right hand is synchronous with the bolded syllable in the expression of amplified inscribed APPRECIATION in *principal*, giving marked visual prominence to the value. This is followed by a prosody of less prominent rapid beats with the back of the right hand against open palm of the left hand. These are synchronous with underlined syllables in the expression of the scientific activity being evaluated.

[b]	*the last and **most im-por-tant** stage of vit-a-min D act-iv-a-tion occurs in the kidneys*.
	
	A sequence of rapid syllable-time beats amplified with a clenched left fist couples with the amplified APPRECIATION (*most important*). Syllable-timed beats then continue with open (relaxed) left hand, coupling with the scientific activity being appraised (underlined). A last downward beat on *occurs* is held to the end of proposition. The frequency of beats, muscle tension and final hold together constitute a strong visual prosody of prominence to the whole proposition.

[c]	*… the first thing which is **unique** about this capillary bed*
	
	Two strong downward beats with the right hand are synchronous with the first two underlined syllables. Then an exaggerated (larger) beat is synchronous with the underlined syllable in the expression of amplified inscribed APPRECIATION in *unique.* This is held on its completion to the end of the proposition specifying the scientific entity being evaluated.

Table 4
Coupling of expression of negative reaction in spoken language with embodied rejection (as illustrated in Fig. 5).

[f-1]	*So clearly something is going to have to happen to that filtrate before it's turned into urine* The lecturer extends his left index finger facing out from the body and shakes it side to side.
[f-2]	*You can't just have all that plasma peed out.* ***You'd be dead in a fraction of a day. You'd turn into dust.*** The first proposition is coupled with the lecturer shaking his head and holding his left hand palm out and fingers together near shoulder height. This gesture continues to be held across the second and third propositions but with fingers spread.

Table 5
Coupling of expressions of weakened specificity in spoken language with de-centring postures in the body (as illustrated in Fig.6).

[h]	*In a normal capillary bed, the outlet is the venule. The venules are **fairly** non-contractile.* A de-centring shrug of the shoulders couples with the expression of softened specificity in 'fairly non-contractile'
[j]	*So large molecular weight proteins, albumin is **generally** not there.* A de-centring shrug of the shoulders couples with the expression of softened specificity in 'generally'

Table 6
Coupling of expression of sharpened specificity in spoken language with embodied expression of precision (as illustrated in Fig. 7).

[k]	*But, there's a **limit** to how much it will be absorbed, because it requires a transporter.* A pinch gesture is formed with the right hand as the lecturer begins to speak. The gesture is held across the entire clause complex.

Table 7
Coupling of ENGAGEMENT in spoken language with offer/invite gestures in body language (see Fig. 4).

[l]	***So** what **could** that end up being? What **would** you basically do? You'd lose all your plasma in, what, a fraction of a day.* The left arm lowered with palm out, as the lecturer shrugs his shoulders
[n]	***So (we know)** that's the first thing which is unusual about this capillary bed.* The supine left hand is extended from body towards the students.

text. For example, in [o] an embodied expression of rejection does not couple with a spoken expression of dis/functionality, but is simply a response to an answer from a student.

[o] *We're not talking re-absorption yet, that's down at the loop.*
The lecturer extends his left arm and has his palm facing out from the body shakes finger side to side.

Nevertheless, our analyses of spoken language and body language reveal patterns of couplings across expressions of kinds of embodied meanings and kinds of meanings in spoken language. The convergent couplings of the two kinds of semiotic resources function in this way to express meanings 'twice', aurally and visually, and these configurations enable the enactment of values to be amplified. In so doing, the expressions of value are made more noticeable in the flow of the discourse of the lecture.

7. Conclusion

The case study reported here examines the scientific values enacted in a live health science lecture in two social semiotic systems – spoken language and body language. At a general level our findings reinforce an understanding that induction into the disciplines of science, as with all disciplines, has to do with both the building of knowledge and the learning of values (Maton, 2014), and that these may vary more or less across specific fields within a discipline.

More specifically, in drawing on the interpersonal discourse semantic system of APPRAISAL, an analysis of spoken language reveals a recurring set of attitudinal choices related to scientific items and activities that construe the scientific field of the lecture, here the field of urine formation. These recurring choices are generalised as four categories of values we refer to as **significance**, **specificity**, **functionality**, and **rationality**. A further analytic step then considers features of the lecturer's body language that correspond to spoken expressions of value. Recurring patterns of co-occurrence or coupling are identified. In other words a consistency of association is found in the values expressed in language and those expressed in the body. In recognition of the two semiotic systems in play the values expressed in body language are named in related but different terms, as **prominence**, **precision**, **rejection** and **proffering**. Importantly we propose that the convergent couplings of spoken evaluative meaning and corresponding visual embodied evaluative meaning, while perhaps at different levels of commitment, function to amplify the evaluation and enhance their potential to be 'noticed' by students.

As set out in the introduction to the paper, our research does not presume to take on the task of generating a definitive set of findings that would apply across the very divergent modes of interaction that characterise the practice of lecturing. The aim is to present a theoretically informed discourse analytic case study that models the application of analytical tools and processes for exploring the teaching of scientific values. Informed by explanations of theory and descriptions of its application, we demonstrate the identification of recurring values in the language data, and patterns of consistent coupling with recurring sets of embodied expressions in one field of science, in one instance of one mode of lecturing.

The findings in relation to the role of body language in the teaching and learning of values in the face-to-face science lecture raise questions for further research into the significance of modes of pedagogic interaction available to students. The face-to-face mode allows for the collaboration of at least the two semiotic systems of spoken language and body language.

What potential consequences might arise in modes that do not offer this potential as, for example, in some online modes? What other semiotic systems might also play a part in the expression of science values? Can we identify values inherent in scientific images for example?

Finally the identification of general categories of scientific value in this case study of a health science lecture hopefully prompts further research into the teaching of other scientific fields, supporting a more comprehensive picture of its inherent values and how they are expressed.

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