

**Positioning in the Laboratory**

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We gratefully acknowledge support for this research from National Science Foundation  
ROLE grants: REC-0106773 and 0450578.

## Abstract

This paper explores possibilities for using recent formulations of social positioning theory to interpret relationship dynamics in a biomedical engineering laboratory. As a linguistic phenomenon, positioning is most commonly analyzed in person to person or group to group interactions (or person to group). We here extend analysis of positioning to include person to object or person to artifact relations in the laboratory, examining effects of this positioning on the learning trajectory and identity formation of a novice researcher. We construe a dynamic ‘dialogic’ tension between researcher and artifact and view this as necessary for understanding the complex web of cognitive and social practices by which research proceeds. This tension is tied to the recalcitrance of material objects as this serves to constrain and structure research practice. The case material supporting our extended conception of positioning is drawn from a wide-scale, multi-year investigation of cognitive and learning practices in two interdisciplinary learning cultures (biomedical engineering laboratories), for which Nersessian and Newstetter are principal investigators. In the case discussed here, a dynamic shift occurs by which the unexpected death of cells begins to position the researcher, with important implications for his learning and career path. We analyze the rights and duties transformed for the researcher with this shift in position. In addition to the case analysis we describe our understanding of a laboratory as an *evolving distributed cognitive system* and discuss our broader project of using ethnographic and cognitive-historical analysis to articulate numerous dimensions of laboratory practice. Thus a more general aim of our paper is to illustrate how ethnographic observations and interpretive analysis of interviews with practicing scientists might contribute to the developing field of psychology of science.

## Introduction

This paper concerns our ongoing effort to analyze the learning, reasoning and problem solving practices of novice and expert researchers in two biomedical engineering laboratories situated on the campus of a leading research university. The laboratories aim to develop new methods and applications at the frontier of biomedical engineering research. As innovation communities in this sense, the laboratories afford exceptional opportunities to analyze scientific problem solving and creativity in action. As a community or culture, each lab also offers rich opportunities to theorize social interactions and the subtle ways in which these fuse with and facilitate cognitive practices. We use ethnographic and cognitive- historical methods to describe and interpret these complex interactions (Nersessian, Newstetter, Kurtz-Milcke, & Davies, 2003). ADVANCE \d 4

We approach our study of biomedical engineering laboratories with the assumption that cognitive and social processes are inherently inextricable, that they constitute a single system rather than distinct systems intersecting at definable (even indefinable) points of contact. Yet for sake of analysis, it is at times helpful to analyze one side of this partnership more intently than the other. For this paper we focus principally on the social dimensions of the laboratories and consider how social features influence opportunities for learning. Importantly, however, what is meant by “the social” is no settled matter, though it is generally treated as one. That is, the category of “social” typically enters into the discourse of psychology and science studies with very little analysis, as though it is self explanatory, even as its role in producing subjectivity is asserted as primary. Historically, a variety of conceptions of “social” have been made available, and the implications of these divergent senses of sociality are profound. For example, if the very categories of “cognitive” and “social” as construed as conjoined, as in our own framework (similar, for example to the way in which Dewey construed the categories of thought and action to be inseparable), the conception of sociality with which we are working will affect theorizing at every level in our analysis of science.

### **Material as social**

The conception of sociality grounding the present analysis has roots in pragmatism (Mead, 1932, 1938), phenomenology (Merleau-Ponty, 1963) and ecological psychology (e.g. Gibson, 1979), particularly as these are instantiated in recent articulations of “distributed” and “situated” cognition (e.g. Hutchins, 1995, Clark, 1998). In particular we depart from some traditional social psychological studies of laboratory life in our understanding of ‘the social’ as inclusive of not only relationships between persons, or persons and aggregates of persons, but relationships between researchers and the objects and artifacts of their practice. In biomedical engineering, objects and artifacts include the living cells that constitute the tissues developed for an array of applications, such as

artificial blood vessels used as sites of experimentation and cultured dishes of neurons used to study patterns of bursting activity. We regard these objects as not merely components of the laboratory culture but more radically as facets of the social realm that establishes any social psychology of science, as co-participants in the array of practices that comprise laboratory science. As co-participants in practice, relations with these objects might be analyzed with concepts typically reserved for interpersonal dynamics, in ways that invite new views of science practice.

In this paper we explore possibilities for using recent formulations of social positioning theory to interpret relationship dynamics in our two biomedical engineering laboratories, extending the conception of positioning to include person to object or person to artifact relations in the laboratory. Using interview material, we examine some effects of this positioning on the learning trajectory of a novice biomedical researcher, drawing from interview material to illustrate the potential usefulness of the positioning perspective for analysis of science practice.

### **Historical precedent**

Before examining positioning theory and the laboratory project to which we apply it, we might first situate our conception of sociality within the broader traditions of thought that support it. Although the grounding emerges from phenomenological, pragmatist, ecological, and mutualist perspectives as these influence social theory, here we focus on the later writing of George Herbert Mead. His extension of sociality to the natural and artifactual world is clearest in the series of lectures published posthumously as *“The Philosophy of the Present”* (1932) and *“The Philosophy of the Act”* (1938), wherein he explicates various senses or aspects of sociality across different portions of this work. The most basic and underlying feature of sociality he discusses is *“the capacity of being several things at once”*. That is, the nature of a thing, “what it is,” is determined by its relation to a system. As the thing is a part of different systems, it has multiple natures, even if the systems are themselves interlocking or hierarchical: *“The animal traverses the ground in pursuit of its prey, and is at once a part of the system of distribution of energies which makes his locomotion possible and a part of the jungle system which is a part of the life system on the surface of the inanimate globe. . . . There is as genuine a sociality in his relation to his environment as in his relation to the prey or to his mate or to his pack, and the mark of it is that we habitually estimate characteristics that belong to the object as a member of one system by those which belong to it in another”* (p. 75).

A second sense in which something is social has to do with requirements of adjustment as changes accompany passing increments of time, rooted in Mead’s conception of the historical constitution of the present: *“in the passage from the past into the future the present object is both the old and the new, and this holds for its relations to all other members of the system to which it belongs. So in the history of a community, the members carry over from an old order their characters as determined by social relations into the readjustments of social change. The old system is found in each member and in a revolution becomes the structure upon which the new order is established. . . . (Thus) I*

*have referred to the increase in mass of a moving object as an extreme example of sociality* (p. 77). There is “an answer in the community in the meadow or in the forest to the entrance of any new form, if that form can survive” (1932, p. 73)... “I am using the term ‘social’ with reference not to the new system but to the process of readjustment” (73).

A third and stronger sense of sociality is tied to Mead’s notion of perspective taking: “*It is only in so far as the individual acts not only in his own perspective but in the perspective of others, especially in the common perspective of a group, that a society arises and its affairs become the object of scientific inquiry. The limitation of social organization is found in the inability of individuals to place themselves in the perspectives of others, to take their points of view. ...* In the field of any social science the objective data are those experiences of the individuals in which they take the attitude of the community, i.e. in which they enter into the perspectives of the other members of the community (1932, p. 175).

Mead’s conception of sociality as expressed in *Philosophy of the Present* is intended to serve only as an example of a framework compatible with our own, yet it will be helpful to specify the points of compatibility through we understand the biomedical engineering laboratories and the sociality of the objects and artifacts of practice therein. We focus here on the example of cultured cells, central as these are to the work of both laboratories. Thus cells are clearly social in the sense of “being several things at once”; a cell in a construct (a local term for a manufactured blood vessel) is part of the system that is the blood vessel as well as the system of the tissue engineering project of which the manufactured blood vessel is a part, which is itself a part of the larger laboratory system, itself part of the wider field of tissue engineering. A cell in a cultured dish of neurons in lab D is similarly part of the system of the ‘dish’ just as it is part of the wider systems of practice (the specific applications of biomedical engineering) involving the dish. The second sense of social extracted from Mead is reflected in our conception of the laboratory as an evolving distributed cognitive system, one that is continuously adjusting not only to the entry and departure of particular researchers and other laboratory staff, but adjusting at every level to the solving of new problems or with instances of failure and frustration. Similarly, our construal of laboratory artifacts and devices (including cells) as historical objects, even as they constitute the present substance of the working laboratory is relevant to this second sense of social.

The sense of social as *perspective taking* might appear initially harder to relate to the case of cells, yet interview data with biomedical engineering scientists suggests at least one important sense in which researchers appear to engage discursively in something like perspective taking with cells. Here, for example, a researcher in the tissue engineering lab invokes a cell’s perspective to explain a procedure to the interviewer:

I. How about the—how about the size of the chamber. Is that—is that part of the, ah, is that an approximation, or...

A10: *Well, um, no in the sense that it doesn’t really approximate. Like, most arteries we look at are going to be smaller than that surface. But from a cell’s*

*perspective, the cell sees basically a flat surface. You know, the curvature, is maybe one over a centimeter, where as the cell is like a micrometer. You know, like 10 micrometers in diameter. It's like ten thousandth the size. So to the cell - it has no idea that there's actually a curve to it.* (2002-07-09-A-i-A10).

The involvement of the cell in even this stronger sense of sociality as perspective taking enables us to construe cells and researchers as co-participants in the science practices of the innovation seeking biomedical engineering laboratory. Thus social psychological frameworks traditionally reserved for human to human interactions are opened to theoretical exploration.

Our claim is that positioning theory in particular offers untapped potential for describing social relations germane to all aspects of science practice, including relations of science practitioners to the material environment and the objects and artifacts of science practice.

### **Overview of positioning theory**

The concept of positioning is currently adopted as a central unit of analysis within discursive psychology, a newer movement or branch of social psychology that analyzes meaning structures within local contexts of practice (e.g. Edwards, 1997; Harré & Gillett, 1994). The specific province of positioning theory is the dynamic shift in relational space consequent to particular dialectical strategies, that is, the illocutionary force of speech acts. Thus Davies and Harré (1999) attribute “the constitutive force of each discursive practice” to “its provision of subject positions” (p.46). Like discursive psychology more broadly, positioning theory has conceptual roots in many places. Precursors are as varied as psychoanalytic object relations theory (e.g., Fairbairn, 1952), Vygotsky’s theory of cognitive development (1978), and the sociological analysis of Erving Goffman (1981). In construing discourse as an act or practice and eliminating the boundary line distinguishing acts from knowledge, discursive psychology also coheres with earlier pragmatist theory, including Mead.

Recent versions of positioning theory in social psychology specifically address the “subtly varying presuppositions as to right of access to the local repertoire of acceptable conduct” as well as “presuppositions as to the distribution of duties to perform the necessary action” (Harré & Moghaddam, 2003, p. 4). Positions themselves are defined as “patterns of belief” as distributed among “members of a relatively coherent speech community” (p. 4). Research methods associated with positioning theory include observation of action and interaction and interpretation of “participant’s justificatory and interpretive accounts” focusing on expressed (if implicit) beliefs as these reflect positions (p. 3). The focus of analysis within positioning theory, as with discursive psychology more broadly, is the set of tacit though discernable rules that shape and confine human practices within the context analyzed.

Position implies location, and indeed, “people are seen as locations for social acts” (van Langenhove and Harré, 1999, p.14). However, the “substance” or “matter of social reality” (p. 15) from this perspective is assumed to be in continuous flux. Thus the

concept of position is more fluid than that of the social *role*. Role implies a static location in a social order; positions, in contrast, are always dynamically shifting and renegotiated, both in their first order (tacit) and second order (intentional or conscious) forms. Positioning, then, “can be seen as a dynamic alternative to the static conception of role” (p. 14).

Harré and Moghaddam (2003) emphasize two features of positions which clarify the nature of their social effects. First, positions serve to establish the possibilities of action (i.e. analysis focuses on what actions are “socially possible for any social actor at any moment in the flux of social life”) (p. 4-5). A second, related point is that a position “can be looked at as a loose set of rights and duties that limit the possibilities of action” (p. 5)... it “may also include prohibitions or denials of access to some of the local repertoire of meaningful acts” (p. 6). This feature has enabled the concept of positioning to be extended to the analysis of group interactions (e.g. Aberdeen, 2003; Harré & Slocum, 2003).

### **Positioning in the laboratory**

As a linguistic phenomenon, positioning is analyzed in person to person or group to group interactions (or person to group), with emphasis on the bidirectional effects of various linguistic strategies, understood as shifts in discursive communities. Our view of the research laboratory is that it constitutes a discursive (speech) community in its own right. Its rules and conventions of conduct, even some of its terms and concepts are locally established through interaction particular to that community. Yet each laboratory community is embedded within wider discursive communities, including the field of biomedical engineering of which it is a part, and the tradition that sustains the field itself (not to mention the discourse of innovation and science practice writ large).

In our framework, the constituent members of each biomedical engineering community include not merely the researchers and other laboratory staff, but the objects and artifacts of biomedical engineering practice. At a minimum the community includes living cells, which are **cornerstones of the engineering practices in the laboratories under our observation**. A brief digression onto the role of cells in each laboratory is necessary to establish the status of cells as the cooperative partners of researchers.

Lab A is a tissue engineering laboratory which seeks to develop substitute cardiovascular devices such as artificial blood vessels for eventual implantation in human bodies. An important component of this work is the design of environments that replicate relevant features of the bodily environment, such as an artery. **Blood vessel cells, smooth muscle cells, and endothelial cells are cultivated in the laboratory or obtained from other laboratories; they are embedded in various scaffolding materials in order to replicate and test the effects of mechanical forces of blood flow in the body.** Cultivated cells embedded in different forms of engineered scaffolding must replicate as closely as possible the properties and functioning of bodily cells.

In lab D, a neuroengineering laboratory, neurons are cultured in dishes or flasks to enable researchers to simulate neural networks and record their patterns of activity, for the

broader purpose of better understanding human learning.

In bringing positioning theory into our ethnographic analysis of laboratories A and D, we extend the analysis of positioning to include person to object or person to artifact relations, focusing on relations with cells. Central to this effort is the concept of dynamic tension or *resistance* (a counterpart to the concept of constraints by which the notion of a 'rule' is understood in positioning theory) effected by the status of cells as living objects. Here interesting links might be made to the tradition of dialectical biology, which posits tension-producing and mutually transformative relations between an organism, including a human subject or society, and its environment. For example, the notion of dialectic in this context is clear in Levins and Lewontin's assertion that although both organism and environment are transformed by their interrelatedness, they "do not completely determine each other" (Levins and Lewontin, 1985, p. 136). In the biomedical engineering laboratories, despite the best efforts of researchers to culture and nurture living cells, cells "act" in unpredicted ways, the most radical and challenging of which is to die. Cell death, the very possibility of cell death creates a dynamic, even 'dialectical' tension between researcher and cells. The actions of cells determine what range of actions is possible for the researcher. Cells and researchers thus position one another with their actions, with analyzable social effects.

Here we illustrate the application of positioning concepts to researcher-cell relationships with an example from Lab D, the neuroengineering laboratory. This interview with a student researcher took place in the fall of 2005, shortly before he was to graduate with a degree in biomedical engineering; he had been working in the Lab D since the summer of 2004. Prior to this interview he had given more enthusiastic accounts of his experience in the laboratory and his relationship to laboratory research. Early in the interview he declares his recent interest in going to medical school after graduation, a goal he had never identified before to the interviewer. Although medical school is only one possibility he is considering, he is definitely ruling out graduate school in biomedical engineering or a related research field. In the interview he ties his change of career plan to his experience of cell death in Lab D:

D32 *Well...after working in the D lab I was like 'I really don't want to do this.' I don't want to have to do research that fails all the time and...have to write papers and...It didn't seem that fun (2004-08-04-D32-I)*

Interviewer: Well, the last time I talked to you it was really fun. When did it stop being fun?

D32 *I was actually going to do an experiment where we were measuring uh, measured the effective simulation range of a single electrode on an MEA, like that whole semester. I mean, I talked to you and then after that that's when D4 had all the cell death so I couldn't do anything and so I just did grunt work.*

Later in the interview he provides more detail about the events surrounding the cell death. It is clear that the cells have died despite best efforts:

D32...*they were using the same protocol but with mice...they'd been doing the same thing over and over again and one day they just kept having cells die. And they were like "That's kind of weird." So they'd plate cells again and after two weeks they'd die and they'd just keep on doing this and they were like "What's going on?" So then they started like in the middle of the fall last year. They basically made a big chart and they were like "Okay, we're going to test for this, this and this, and they delegated everything and they called all the people that provided chemicals and found out that some of them had bad batches and they tried a different chemical, no change. I mean, they found there was a little problem with their system. They fixed all the problems and they were still having cell death.*

The wide-scale cell death has effected a shift in position for researcher D32 in relation to his work in the laboratory. Rights are lost- he views himself as unable to do *anything*. New duties are assumed—he now does *grunt work*. The impact of this change in rights and duties is weighty. Rights D32 previously assumed to be unproblematically his own, such as the right to do his experiment, the right to be a full-fledged participant in the intellectual process of the laboratory, is suddenly and seemingly permanently denied him. His previous right was to propose work that would give him status in the lab. He had a right and duty to generate data for the whole lab that would advance their understanding of cell interaction over time. His plan was to make a contribution by advancing understanding of how cells in cultures interact. The cell death, however, signals a kind of resistance or 'stance'. The cells have deprived him of his contribution, have shut down his work and even altered his career plans. They have, in effect, transformed him into a 'grunt worker.' This is not to claim that the cells have agentive intent, only that they behave in ways that are not determined by the researcher and that constrain and limit his learning and problem solving with their 'actions' (They are agents in the way that storms are agents) That rights and duties are invoked in the process for the researcher establishes the basis for construing this constraint as a form of positioning.

The cell death also appears to be associated with new disciplinary alignments. That is, changes in identity through the experience of cell death are evidenced in the new appeal of health care and the assumption of a stance of wanting to help others:

*I never really considered that cause its really health care but they can tie that to the sensory like they can really make prosthetics that are tied to the nerves and that would be really awesome for me... I want to improve people with problems and that would be the perfect way to do it, I think...I want to have that patient interaction, I think.*

This would appear to have a positive spin did it not stand out against a background experience of feeling ineffectual and *incomplete*:

Interviewer: You put in a lot of time in that lab.

D32: *Yeah, but I feel like I haven't accomplished anything. I feel like I just did the bare minimum. I don't feel like I did the best I could do for D4's lab, so I feel like I kind of owe*

*it to him to do something big, or...*

Interviewer: It sounds like it was the cell death that... like you were all lined up to do something, right?

*D32: Yeah, that's why I feel incomplete, I guess. It's not really my fault.*

Also of interest is the way in which this narrative is suggestive of the network of relationships in the laboratory, connected in various ways to the event of the cell death and its effects. D32 identifies the cell death as an event for someone else: “*that's when D4 had the cell death*”, yet D32 is affected. Thus D4's position in relation to the cells impacts the position of D32 in relation to his own work (and learning). Moreover, the effects of the cell death are described here as broad in scale across the laboratory. D32 affirms that all the graduate students were angry (“super pissed off”) and that the experience was *demoralizing* for them.

## **Conclusion**

To clarify what we are claiming here: We are proposing a view of cell death as analogous to a speech act in its potential to shape and constrain human action. We have illustrated this in the context of a young researcher's experience, whereby the death of cells effects a shift in position with implications for his learning, motivation, ambitions, and identity. Given the dynamic nature of positioning we make no claims as to the permanent effects of the cell death on the researcher, only that in the context of this interview event the positioning effects can be analyzed as constraining his actions in the directions analyzed. We have used a single case study to underscore the usefulness of positioning theory for analysis of researcher-cell relationships, illustrating the means by which a novice biomedical researcher might be viewed as positioned by the responses of material objects, in this case dishes of cultured cells in a neuroengineering laboratory. More broadly, the illustrative value of this case material points to the potential for extending the social psychology of science to include laboratory objects and artifacts in their intricate relations to scientists.

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PAGE

PAGE 6

Harré consults Mead, for example, for terminology appropriate to express the experience of singular selfhood against the collective other which is a precondition for selfhood, and calls Mead's solution to the problem of understanding selfhood 'ingenious' (Harré, 1998,

p. 125).

For a broader application of positioning theory to science practice (specifically the writing of science) see van Langenhove & Harré, 1999)