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The cognitive labour of mathematics dis/ability: Neurocognitive approaches to number sense

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ABSTRACT

In this paper we discuss neurocognitive research into number sense to show how it reconfigures the cognitive labour of the mathematics student. Neurocognitive research is redefining mathematical proficiency and student agency in terms of the activation of "neuronal populations". We show how this research deploys a particular image of number that stresses cardinality rather than ordinality. An emphasis on cardinality effectively reduces the time-value of students' cognitive labour, produces new kinds of dis/abled bodies, and recruits new kinds of value from those bodies. We discuss current research on dyscalculia in mathematics education, and situate this work in relation to literature in critical dis/ability studies and inclusive materialism. We suggest that the concept of 'student alienation' must be radically reconfigured in contemporary contexts in order to address the biopolitics of current education research. Our aim is to direct attention to the need for new kinds of neurocognitive research, not to reject it altogether.

1. Introduction

In this paper we discuss neurocognitive research into number sense to show how it reconfigures the cognitive labour of the mathematics student. We use the term 'labour' in order to situate our work in relation to theories of capitalist labour and alienation. In Marx's early work, alienation identified facets of *industrial* labour that were dehumanizing and destructive of both the individual and the collective (Geyer & Schweitzer, 1976).[1] The mechanized factory labour of the industrial revolution alienated the worker from himself and his co-workers, from the product of his labour, and from labour itself. Marxist theories of alienation have since evolved in an attempt to incorporate other kinds of unpaid labour—for example, the labour of the housewife and student. Sociological studies of education, for instance, have tracked the cultural and symbolic capital of student labour. Williams (in press) writes "substitute grades for wages, learning for labour, schools for factories, teachers and headteachers for managers, the state for the owners of factories, and you have alienation of learners from learning, and from teachers, in schooling (see also Engestrom, 1987, 1991)" (p. tba). In other words, learning is an *intellectual* labour, and can thus be studied for how it incorporates and is incorporated into capitalism.

More recently, the term "cognitive labour" has been introduced to address new developments in contemporary capitalism. Cognitive labour refers to the distinctive forms of contemporary labour that emphasize knowledge, information, affect and communication, and that are characterized by a new phase of digital technologies and internet-based economies

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[1] The term alienation was used by other philosophers, such as Rousseau and Hegel, prior to becoming part of Marxist terminology.

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(Peters & Bulut, 2011). This kind of labour is "cognitive" because it de-emphasizes manual or physical skills – except for typing and viewing – while emphasizing the *distributed cognition* of communication networks and the production of "immaterial" products, such as information. Berardi (2009) suggests we use the term "semiocapital" to describe the cybernetic substitution of information for material objects, and that we focus on the "endless cognitive stress" that the individual undergoes in digital times. Since students participate in this cognitive labour, they are named part of "the cognitariat", and are themselves a "semiotic labor flow" (p. 105). We see in this theoretical shift, an attempt to track new convolutions of capital and labour that radically reconfigure what it might mean *to labour* and what it might mean to be alienated from one's labour.

Alongside this development, and historically linked to it through the cybernetic movement, has been an increase in neurocognitive approaches to the study of mathematical dis/ability and number sense (Dehaene, 2011). Neurocognitive research into "number sense" began in earnest in the 1950s and 1960s exploring animal, infant and trauma victims' ability to perform tasks that entailed some sort of quantitative discernment (Mechner, 1958). With the advent of brain imaging technology, cognitive neuroscientists have shown that a particular group of neurons in the brain – in the intraparietal sulcus (IPS) – are always "activated" whenever humans, and many other animals, are given a calculation task (see Bugden & Ansari, 2015; Neider & Dehaene, 2009). These scientists are searching for the "number neuron" where they believe number sense resides. Such research has popular appeal, and is taken up in the press often without any critical reflection (de Freitas, 2014). The impact of this research on education is potentially profound, as many dis/ability theorists cite it as evidence that number sense is biologically innate (see, for instance, most of the thirty-one chapters of the *Routledge International Handbook of Dyscalculia and Mathematics Learning Difficulties* (Chinn, 2015)).

In this paper, we show how this research is re-configuring number sense as a kind of *neuro-cognitive labour* that mirrors computational informatics. We track the way the student body is recruited in such cognitive labour, indeed how the human organism is reconfigured so that the concept of *human* capital becomes *neuro-cognitive* capital. By focusing on the neurocognitive research on number sense, we aim to show how biopolitics infiltrates cognitive labour, where value is extracted from the labour of the neuron. Through these research practices, the human body is tapped in new ways; the body is retrained to produce new kinds of value: "What is at stake within the social definition of cognitive labour is precisely the body, sexuality, mortal physicality, the unconscious" (Berardi, 2009, p. 106).

We examine recent cognitive neuroscience on dyscalculia that claims to identify the biological source of number sense, and we argue that this research rests on tacit assumptions about the nature of number, with implications for how we understand cognitive labour. The experiments that are typically used in this research depend on automatic, near-instantaneous participant responses, which are more suitable for judgements of cardinality than of ordinality (Lyons & Beilock, 2011). Similarly, theories of 'number neuron' activation present an image of number that is almost exclusively cardinal. We argue that this bias towards the cardinality of number is a significant biopolitical issue because of the way it mobilizes the cognitive labour of children. Ordinality has a significant *temporal* dimension because counting unfolds in time, unlike semi-instantaneous judgements of the cardinality of sets. Indeed, number becomes a temporal event *through* ordinality, and we argue that this temporal dimension of number is crucial for reclaiming the labour involved in computation. In other words, we aim to show how the concepts of labour and alienation are newly inflected by current neurocognitive approaches that effectively *deny* the ordinality of number, and thereby *deny* the time-value of cognitive labour. Thus our argument operates at two levels: on the one level, we show how this kind of research produces dis/ability in human bodies through its image of what constitutes number sense, and on the other level, we show how this research assumes that cardinality is the fundamental function of number. This dual focus allows us to show how mathematics *itself* is strongly linked to historical embodied practices, and that particular images of number are validated through particular kinds of research and policy.

This paper raises questions that are urgent in the wake of the increasing reliance on brain research in education: How does this new research change what it means to know mathematics? Where is the agency of the student when we turn to neuronal activation? And how is value being extracted from the body through these tests of numerosity? Our aim is to direct attention to the need for new kinds of neurocognitive research, not to reject it altogether. In this, we follow Fitzgerald and Callard (2015) who urge social scientists to engage with the experimental practices of the neurobiological, to take up and consider these practices in detail, so that a more open ethos of experimentation might be pursued as we grapple with the entanglement of "sociocultural webs and neurobiological architecture" (p. 3). This paper contributes to efforts in rethinking the relationship between sociocultural and neurocognitive work, examining the specific experimental practices that are being used to forge a new image of 'biosocial' life.

2. Dis/abled bodies

We begin with the assumption that education operates through the student body, and that particular kinds of bodies are produced and sustained through education. As Goodley (2009) suggests, "educational institutions and discourses require (children's) bodies to be measurable, accessible, easily treatable and understood. Bodies that morph in ways that are unintelligible – that are not dis/abled enough or fit the typology of dis/abled used by educational institutions – are not easily included" (p. 264).

We situate our work within an inclusive materialist approach to the study of mathematics education (de Freitas & Sinclair, 2014a, 2014b). Inclusive materialism maps the diverse materialities at work in school mathematics, with particular attention

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