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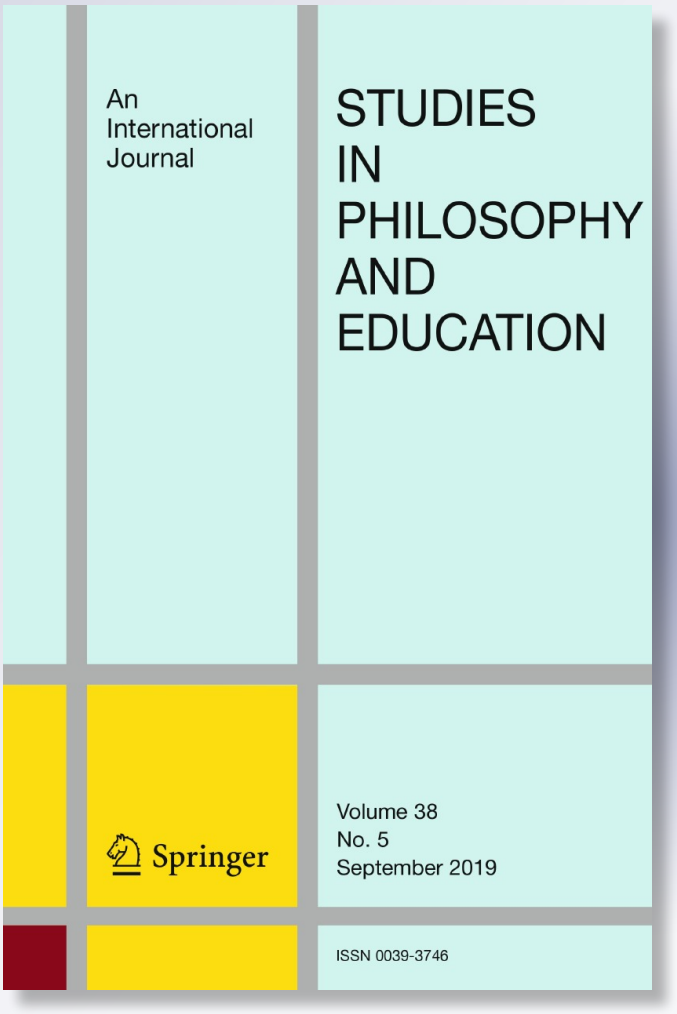

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Representationalism and Power: The Individual Subject and Distributed Cognition in the Field of Educational Technology

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Abstract
Distributed cognition, as it considers how technologies augment cognition, informs technology integration in education. Most educational technologists interested in distributed cognition embrace a representational theory of mind. As this theory assumes cognition occurs in the brain and depends on the internal representation of external information, it is informed by a mind/body dualism that separates the individual student from material things. Alternatively, the theory of the extended mind describes the mind as a dynamic system of interactions inclusive of human agents, technologies and other material things. Refusing the mind/body dualism, if one element is removed, the quality of cognitive activity declines. Across the cognitive sciences, there are debates between these representational and extended theories that have implications for what it means to be a student and for technology integration. However, distributed cognition research in educational technology ignores these debates. Instead, this research is conditioned by the discursive practices of a neoliberal assemblage of political, commercial and pedagogical institutions. In this era of high stakes testing, as the individual student is measured, evaluated and otherwise made subject through these practices, this assemblage expresses a tacit commitment to, and is productive of, the subjectivity of the individual student and thus benefits from the representational theory of mind. In this way, regardless of the recognized legitimacy of the theory of the extended mind, sustained by neoliberalism the field of educational technology will not soon question the veracity of the representational theory of mind or the mind/body dualism upon which it depends.

Keywords Distributed cognition · Educational technology · Mind/body dualism · Power relations · Theory of extended mind · Representational theory of mind

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Introduction

The field of educational technology concerns the role of technology in educational experience. There are instrumental questions about how best to integrate tablets, the potential of digital gaming to engage students, the efficient design of online learning or whether drill and practice software is effective for test preparation. As well, the field concerns issues of technology and equity in education. For example, across matters of race, class and gender, is the digital divide about access to technology or how technology is variously integrated into the experiences of student learning? Across the field, there are all manner of ways to consider how teachers and their students teach and learn with each other in technologically enhanced learning environments. Educational psychologists frequently assume that learning is an individual cognitive experience. While in classrooms across the world, technology integration is commonly designed as a social experience to involve the individual student learning with other students, the teacher and material things. How then are we to understand or reconcile the apparent contradiction between individual student learning with technology and the social experiences of technologically enhanced classrooms (Martin 2012)?

Associated with the cognitive anthropologist Edwin Hutchins (1995) and the educational technologists Gavriel Salomon (1993) and Roy Pea (1993), distributed cognition is a socio-cultural psychology concerning the mindful practices of human agents in socio-material relationships with each other, with technologies and with other material things. Famously, Hutchins (1995) questions whether the individual is really the best unit of analysis. Because of the concern for the social and cultural dynamics at the intersection of technology and pedagogy, educational research in distributed cognition predominantly takes the form of theoretical and/or empirical field studies (Angeli 2008). As it considers how technologies augment cognition, distributed cognition presents a unique approach to exploring technologically enhanced learning environments. In this context, cognitive activity, such as pattern recognition, reasoning, and memory, involves people engaged with other people, with available artifacts and technologies. From this perspective, students are thought to learn in consort with other students, and with things as well. As Schwartz (2008) explains, "learners are predisposed to function with external devices and other humans—distributed in a system of cognition" (p. 391). This seems innocent enough as most people assume this to mean that cognition occurs in the brain as a result of interactions between and among people and material things.

Educational technologists researching distributed cognition, with few exceptions, embrace a representational theory of mind. This theory informs the assumptions that cognition occurs solely in the brain and that learning depends on the internal schematic representation of external information and knowledge. Alternatively, there are philosophers who theorize that cognition is interactions of brain and body with material things. Instead of describing cognition as representational, i.e. internal, algorithmic and governed by inputs and outputs, cognition is theorized as dynamic interactions between and among an embodied subject, other human agents, and material things (Chemero 2009). Referred to as the theory of the extended mind, each element actively contributes to

and jointly governs cognitive activity; if one element were to be removed, the caliber or robustness of cognitive activity would be diminished (Clark and Chalmers 1998).[1]

Across the cognitive sciences and analytic philosophy, there are competing research agendas and theoretical debates between those who embrace the representational versus extended theories of mind. The distinctions between these theories have theoretical, political, economic and pedagogical implications associated with the integration of technology to advance learning, with what it means to reason and learn, and with the very idea of what it means to be a student. Representational theories of mind assume a Cartesian mind/body dualism. And as they focus on the mind of the student, they are consistent with what I discuss as the individualizing practices of the neoliberal regime of accountability in the field of education. Challenging this dualism, theories of the extended mind assert that the mind is material and that cognition is embodied and extends into the world of digital tools and other material things. However, as I demonstrate, research in distributed cognition in the field of educational technology takes little notice of these debates. And I conclude that the field implicitly assumes representational theories of mind. As well, I discuss implications of this assumption for what it means to be a student and for the broader field of education. My intention is to exploit the relative efficacy of these opposing theories of mind as I question institutional relations of power (Youdell 2006). Indeed, regardless of the robustness of the empirical research into the theory of the extended mind, because of these relations of power, I maintain, educational technologists researching distributed cognition will not soon explore its pedagogical potential.

For this essay, I employ a form of discourse analysis to identify historically specific discourses and institutional practices that position the representational theory of mind within the discourse on distributed cognition in the field of educational technology and to consider how this discourse is enrolled in the neoliberal turn across the broader field of education. Associated with the work of Michel Foucault, the form of discourse analysis I embrace is concerned with the organization of what can be known through historically specific practices of institutions, such as the field of educational technology, the cognitive sciences, and the federal government. Arribas-Ayloon and Walkerdine (2017) distinguish Foucauldian discourse analysis. "When referring to 'discourse', Foucault does not mean a particular instance of language use—a piece of text, an utterance or linguistic performance—but rules, divisions and systems of a particular body of knowledge" (p. 114). These bodies of knowledge, in turn, are associated with historically specific practices with institutional affiliations. Referred to as discursive practices, such practices are not limited to the implementation of educational policy, the integration of technology in education, or the design of research in the cognitive sciences. Therefore, meaning in Foucauldian discourse analysis concerns historically, politically, economically and culturally contingent interests, rules, and norms of discourses with specific institutional locations.

One such institution, educational technology is a diverse academic field. It includes a multiplicity of theoretical traditions, from behaviorism and cognitive psychology to cultural theory and feminism. As well, the field concerns a broad range of applied sub disciplines that relate media, technology and design to education broadly conceived. Just as feminist theory has unique expression in this field, like distributed cognition, it does not define the field. Given these boundaries, the object of this analysis is the discourse on distributed cognition as it has expression in the field of educational technology.

[1] The theory of the extended mind is one choice from among many and it has many variations. What I discuss may be closer to "radical embodied cognitive science" (see: Chemero 2013).

There are markers that distinguish a discourse on distributed cognition unique to the field of educational technology. First among these is its status as an applied theory concerned with advancing individual academic achievement through technology integration. I am concerned to analyze how this discourse constrains understandings of what it means to be a student. Throughout, I refer to this student as the *individual* student. Across the field, this individual student is researched, measured, and assessed. These discursive practices are to determine the student's capacity to reason. And of equal consequence, such capacities are premised on the assumption of the autonomy of this individual student from other human agents and from things in the world.

As I develop throughout this essay, emphasis on the capacity to reason and individual autonomy associate the discourse with a Cartesian mind/body dualism that is antithetical to the theory of the extended mind. This student participates in learning experiences where cognition is thought to be distributed between and among other students, the teacher, and with those digital technologies available in the classroom. However, for this individual student, learning is to result in the internal representation in the brain of external information and knowledge that can be assessed. In this way, the discourse on distributed cognition in the field of educational technology corresponds with the prevailing discourse on neoliberalism in the broader field of education that has come to reduce learning to the achievements of the individual student.

With Foucauldian discourse analysis, I am interested in relations of power to knowledge. However, it is not a form of power that is possessed. And having knowledge is not power, per se. Nor is it a "power over" that stops things from happening or people from acting. Instead, it is a productive power, exercised through everyday human and material activity, acting upon the actions of people to produce knowledge of what is legitimate to know and how to think and act. In this way, it is productive of the law, educational policy, theories of mind, and human subjectivity as well. The focus of this essay is the production of the individual student as the subject of this discourse. From this perspective, the discursive practices of the cognitive sciences and education as well, do not so much apply theories, models, and research techniques to *discover* properties of the individual subject. Rather, these discursive practices are *productive* of this subject (Arribas-Ayloon and Walkerdine 2017). Foucault uses the term *subjection* to refer to the production of subjectivity through relations of power between and across institutions.

> This form of power applies itself to immediate everyday life which categorizes the individual, marks him [sic] by his own individuality, attaches him to his own identity, imposes a law of truth on him which he must recognize and which others have to recognize in him. It is a form of power, which makes individuals subjects (Foucault 1982, p. 781).

Indeed, techniques of subjection, as discursive practices, concern the historical and political *production* of the individual student with a representational mind as the subject of the discourse on distributed cognition in the field of educational technology.

I do not explore this discourse in isolation but in relation to other discourses. Into the material world, as these discourses and discursive practices mutually condition each other, Foucault (1978) refers to them as an assemblage. While I emphasize the discourse on distributed cognition in the field of educational technology, I will suggest an assemblage of institutionally located discourses in the field of education. These discourses hail from institutions, such as state and federal government, the cognitive sciences, and the testing and dot com industries, to name several. In differing ways, each concerns the subjection of the individual student. Associated with the turn to neoliberalism in the field of education in the

1980s, this assemblage is productive of discursive practices such as the dissemination of educational policy, the creation of accountability schemes, the commercialization of educational technology and high stakes tests, and research into the nature of the mind.[2]

The discourse on distributed cognition in the field of educational technology is not a neoliberal discourse. However, there is a correspondence between neoliberal practices and implicit assumptions informing the discourse on distributed cognition that force an association. These assumptions concern the Cartesian mind/body dualism, the representational theory of mind, the valorization of cognitive reasoning and the autonomy of the individual student from other students, from the teacher, and from material things. Ultimately, this presumed autonomy traces to research into the nature of the mind that endeavors to discover, once and for all, that the representational mind is the essence of this individual student.[3]

To relate historically specific discourses associated with the cognitive sciences to the individual student, I trace discursive practices from the 17th and 19th centuries to the discourse on distributed cognition in the field of educational technology. These historical discourses are not limited to a discourse that positions the human agent as a spectator at a distinct remove from the material world. This spectator is to possess a rational objectivity associated with the Cartesian mind/body dualism. Into a psychological discourse, the individual is reduced to the mind and the body is positioned with the material world of things. With the emergence of cognitive psychology in the late 1950s, a computational model is used to understand the mind. And cognition, understood as computation, becomes the rule-governed manipulation of internal representations. The mind/body dualism and the representational theory of mind are confounded by the theory of the extended mind which is predicated on an embodied cognition and the assumption that the student is always already coupled to technologies, tools, the environment, and/or other people.

The Individual Student and the Representational Mind

Even as the discourse on distributed cognition is theorized beyond the field of educational technology, it is distinguished in the field as an applied theory concerned with the integration of technology to advance academic achievement. To realize this goal, research in the field concerns the design of technologically enhanced learning environments and how the individual student learns with material things and other people. The subject of this discourse and associated discursive practices is the individual student who learns with other students, the teacher, and with digital tools. Indicative of the presumed autonomy of this subject and germane to the coherence of the discourse is an embrace of the representational assumption that learning depends on and results in internal schematic representations in the brain of external information and knowledge. However, most germane to this essay is evidence of a discursive practice to create representational models of mind that reproduce

[2] Neoliberalism, as a theory of political economy, emphasizes market deregulation, privatization, reduced government spending, matters of accountability and market-driven competition (De Lissovoy 2013; Egea 2014; Peters 2011). Neoliberalism is associated with the economic policies of President Reagan and Prime Minister Thatcher in the 1980s. In the field of education, neoliberalism is associated with efforts to privatize public schooling, the deskilling of teachers and with the accountability movement.

[3] In discourse analysis, to "trace" is to consider the relations of power through which contemporary discourses emerge from and appropriate aspects of, historically specific discourses (Olssen 2014).

the subjectivity of the individual student. And it is through this modeling practice in particular, as evidenced by the instances that I present below, that we are invited to understand the individual student as the subject of this discourse. As this discourse emphasizes the discrete mind of the individual student that is to form internal schematic representations of external knowledge, this individual is to use these internal representations to reason, learn and remember through an indirect perception of the world (Gibson 1979). Whether teachers are thought to "deposit" this knowledge or students are said to "construct" it, the subjection of the individual student occurs through discursive practices that posit a representational mind. In this section, my intention is not to survey the educational technology literature on distributed cognition. Rather, it is to present evidence of the emphasis on the representation theory of mind, to the exclusion of the theory of the extended mind. The literature I discuss is representative of how the individual student with a representational mind is constructed as the subject of the discourse on distributed cognition.

The discourse on distributed cognition emerges in the field of educational technology in the 1990s with the publication of an essay by Salomon, Perkins and Globerson (1991). They assert that distributed cognition, or the augmentation of mind by technology, takes two essential forms, referred to as *effects of* and *effects with* technology. Along with the concept of *effects of technology* was the idea of *cognitive residue*, i.e. what is learned or represented as schema in the individual student's mind following a technologically enhanced learning experience. *Effects with technology* describe the amplified cognition of the individual student during engagement *with* technology. As Salomon et al. (1991) create the idea of *cognitive residue* to model the effects of technology, it is a tacit expression of their embrace of the representational theory of mind, and in this way productive of the individual student as the subject of the discourse.

In a related essay, Salomon (1993) discusses the use of a 'computerized tool' designed to augment writing skills. Characterizing the student work with the computerized tool as distributed cognition, Salomon (1993) wonders whether there will be any improvement in their capacity to write while using the tool. And, of greater significance, he wonders if this improvement will persist as cognitive residue in the mind of the student after the tool is removed from the learning environment. Here Salomon (1993) uses the concept of cognitive residue to account for the marked improvement of the individual student. In short, for the discourse on distributed cognition in the field of educational technology, the distributed system is to foster the cognitive development of the individual student. "[O]ne should neither consider solo competencies without considering activities entailing distributed cognitions, nor consider distributed cognitions without considering their possible cognitive residues" (Salomon 1993, p. 125).

For Salomon (1993) the very idea of distributed cognition describes an intellectual partnership between two or more autonomous individuals or between an autonomous individual and educational technology. It is the location of the mind that is at issue. "Intelligence is not a quality of the mind alone, but a product of the relation between mental structures and the tools of the intellect provided by culture" (Salomon 1993, p. 112). In this way, Salomon (1993) conflates the mind with internal mental structures. Thus the mind resides within the individual subject and in this mind is to be found mental structures, variously referred to as cognitive residue, schema, or internal representations.

Conceptualizing the design of technologically enhanced learning environments, Salomon's colleague, Roy Pea (2004) discusses the significance of the scaffolding of the individual student's learning within the context of the social and material dimensions he associates with distributed cognition. His concern is whether to fade or not to fade these scaffolds. Implicit in the practice of fading scaffolds to learning is the assumption that

the individual student can be prepared to engage autonomously in cognitive activity. In this way, there is an implicit concern, following Salomon (1993), for the cognitive residue remaining in the mind. While, he does not directly question the veracity of representationalism, Pea (2004) poses significant questions about the design of technologically enhanced learning environments: pedagogically, when are we to fade social and/or material scaffolds to learning? For Pea (2004), the very idea of fading assumes that an autonomous individual subject, within a network of distributed cognition, forms internal representations.

Exploring debates between internal representation and the extended mind in a mathematics classroom, Sørensen (2012) asserts that the location of the mind, whether extended, internal or simultaneously both, depends on the learning environment and the nature of the learning experience. There is no need to choose, once and for all, between these theories of mind. Sørensen (2012) explains "It has theoretically most in common with distributed approaches, but it is critical towards these approaches' refusal of the notion that cognition may take place as processing of representations in the mind" (p. 718). Thus embracing the representational theory of mind and the individual student, for Sørensen (2012) there are forms of knowledge that are located in the mind and performed socially and materially as distributed cognition.

Unlike Sørensen, Martin (2012) initially distances distributed cognition from representationalism. He asserts that learning can be understood as enhancing the coordination between complex systems. Yet in the end, Martin's (2012) explication of distributed cognition is recuperated within the prevailing narrative in educational technology. This occurs through a series of rhetorical moves. First, Martin (2012) crafts a presence for the individual mind as he writes "The boundary between person and environment, while not meaningless, is not so important in this formulation" (p. 90). A few sentences later, he shifts towards a version of representationalism by acknowledging the internal mental effort of the individual student. And then, Martin (2012) fully embraces the representational theory "In constructivist pedagogies, we give children objects to explore that reveal to them properties of the world such that the children can modify their internal schemas" (p. 91). It is here where Martin (2012) recuperates learning, not as coordination as he initially proposes but more conventionally, as the passing of information through a cranial divide. Martin (2012) writes "Indeed, the Piagetian notion of equilibration can be read as an effort to better coordinate the internal and the external" (p. 91). In the end, Martin's (2012) version of "coordination" no longer concerns an extended mind as it conforms to a representational theory of mind.

In their essay about distributed cognition and the 'copy and paste' functions in word processing, Morgan et al. (2008) also position the individual student as the subject of the discourse on distributed cognition. This is accomplished by locating a disembodied mind within the subject's brain while adhering to the representational schema theory. They develop the concept of *drift* as they model how information enters the internal recesses of the human mind to be encoded as schema. "The concept of drift can be used to describe the capacity of cognitive processes to be transferred from the environment to the internal resources of the individual or visa versa. In one direction drift leads to the internalization of external resources in the form of schema" (Morgan et al. 2008, p. 127). As they refer to coordinating the internal cognitive resources of the learner with the external resources of the learning environment, Morgan et al. (2008) conflate the mind with the brain to express a representationalism based on schema theory.

Valanides and Angeli (2008) discuss the integration of a computer tool for middle school science designed to address the study of light, color, and vision. For them, distributed cognition is about creating a learning system to scaffold the cognitive burden

experienced by the individual student until the system can be faded away. Cognition is reified as a thing to be "stretched over" or distributed among a system of elements, including students and technologies. In turn, each element becomes independently responsible for different aspects of a cognitive task. For instance, they assert that a science inquiry protocol "was employed to scaffold students' collaborative inquiry with different tools, such as the simulator that simulates the effects of the color of a light source" (Valanides and Angeli 2008, p. 309). They conclude that "distributed cognition is an alternative and rich way to examine the representation of knowledge both inside the heads of individuals, and among different individuals, tools, and artifacts" (Valanides and Angeli 2008, p. 311).

Emerging across the discourse on distributed cognition in the field of educational technology is the embrace of the representational theory of mind producing the individual student as the subject of the discourse. This theory of mind is enacted in the field of educational technology through modeling practices such as those I disclosed in this section. Indeed, the articles I discuss do not use the same techniques to model the mind, nor do they create the same concepts. Rather, what is significant is that they find creative ways to reproduce representationalism and to position the individual student within the discourse. With the ubiquity of these discursive practices, the representational theory of mind has risen to a level of unquestioned common sense. Indeed, few scholars across the field of educational technology challenge its veracity (Hammond 2010). Conversely, the representational theory of mind is associated with a range of theoretical explications, from an embrace of the veracity of both the representational and the extended, to a slippage from the extended to the representational, to an exclusive embrace of a representational mind.

Such a range is not uncommon across the cognitive sciences, where there are varied perspectives and understandings (Spackman and Yanchar 2014).[4] However, unlike the cognitive sciences, there is an absence across the field of educational technology of scholarly or pedagogic practices informed by the theory of the extended mind. The reasons for this absence cannot be reduced to a single cause or origin but to a multiplicity of discursive practices. To consider these, in the next section I introduce a genealogical accounting of this absence as I trace historical conditions contributing to the current emphasis in the field of educational technology on the discourse on distributed cognition.

From the Individual Student to Cartesian Thought

In this section my intention is not to pursue the origins of the discourse on distributed cognition in the field of educational technology or of the representational theory of mind. Rather, my intention is to trace multi linear and discontinuous discourses and discursive practices through which the past inheres in the present. In the instance of the representational theory, these are not limited to the durability of Cartesian thought, including its mind/body dualism, the autonomous individual who emerges as its subject, and the valorization of the capacity to reason. As well, the durability of the individual subject is associated with historical shifts in the present, including the neoliberal turn to assessment and

[4] Across the cognitive sciences, there are proponents of an extended mind that entertain theories of representationalism—theories of mind that assume an embodied subject (Spackman and Yanchar 2014). Such positions are consistent with an intellectual history of distributed cognition that takes little notice of this contradiction. It combines aspects of cognitive psychology and the representational theory of mind, tracing to Descartes, with an ecological psychology, tracing to Charles Darwin and Henry James (Chemero 2013).

accountability in the field of education. This I trace to the early twentieth century and the governmental appropriation of psychometrics for purposes of population management.

Most significant of the discursive practices are individualizing practices predicated on the representational theory of mind. This theory emerges in relation to the Cartesian mind/body dualism. Reduced only to their mind, the individual is distinguished from the material world of the body, other people and things. A prevailing tendency across the cognitive sciences is to differentiate, theoretically and through quantitative research, the somatic world of things from the mind, i.e. from the individual subject of psychology. Conceptually, the mind is positioned internally within the cranium. "In the Cartesian framework, the basic stance of mind toward the world is one of representing and thinking about it, with occasional, peripheral, causal interaction via perception and action" (Van Gelder 1995, p. 380). Deeply historical and unique to Western thought, this dualistic thinking produces and affirms the individual subject through a series of discursive practices that ignore the body and reduce the subject to the mind.

Positioned on the outside, distinguished from material things, and reduced to the rational functions of the mind, this individual subject has historically been positioned as a spectator (Toulmin 1982). There was thought to be little interaction between mind and body, or between the human spectator and, as an extension of the body, the material world of things and other people.[5] This dualism has formed a doctrinaire binary that "had the effect of setting rational, thinking humanity over against causal, unthinking nature, and so enthroned the human intellect within a separate world of 'mental substance'" (Toulmin 1982, p. 239). This dualistic emphasis on the interior 'mental substance' of the individual subject continues in present day schooling as the individual student learns to observe and analyze an independent material world. Subject/object, human agent/technology, male/female, white/Black, culture/nature, cognitive/affective, instances of this dualistic thinking are multiple and persist across the field of education. This human spectator is to observe and analyze this independent material world. A central principle across the disciplines of the sciences and philosophy was an autonomous and rational objectivity most notably associated with the Cartesian dualism.

In this way, the individual subject, also referred to as *homo rationalis*—the subject of reason, emerges as the subject of a broad range of discourses (Venn 1984). Today, in schools across the United States, the individual student, as a spectator and as *homo rationalis,* is subjected to and formed through pedagogical practices that emphasize the individual's capacity to reason. This is evidenced by the preponderance of STEM (science, technology, engineering and math) initiatives and an eclipse of social-emotional competencies in composition instruction across the Common Core Standards (Spring 2016). It is further evidenced by the persistent emphasis on Bloom's taxonomy for lesson planning. This taxonomy features a reductive hierarchy of reasoning competencies in what is referred to as the cognitive domain. This comes at the expense of any social-emotional competencies associated with an affective domain (Bertucio 2017). Indeed, as Descartes would trust only his mind and his ability to reason, sense data alone could not be trusted (Crossley 2001). And so emerged an arbitrary separating of the cognitive from the affective; emotion is to be bracketed as schooling is to emphasize the student's capacity to reason.

The production of this individual subject in discourse also traces to late nineteenth century psychology and the governmental need for psychometric data to manage the growing

[5] Needing to forge some kind of connection between mind and body for explanatory purposes, there are historical references to the pineal gland. More recent references are to the cerebral cortex (Toulmin 1982).

population of people and their affiliations with schools and other institutions such as prisons and factories (Rose 1996). Throughout liberal Western democracies, the governmental management of the population begins with the management of individual differences (Shutkin 1997). Carrying the authority of science, it is assumed that the truth about the individual emerges through the techniques of this applied psychology. First among these techniques is the normative test. "The test, in all its forms, is a device for visualizing and inscribing individual differences in a calculable form" (Rose 1996, p. 89). As well, the test and other techniques of data production are productive of the individual subject even as the subject cannot be disentangled from these psychometric techniques (Rose 1996).

The emergence of the modern field of psychology, as an individualizing discipline, is associated with a current regime of accountability—of a counting and measuring of the individual. In the contemporary field of education, this regime is associated with a neoliberal discourse that relates the autonomy of the individual subject to governmental accountability, human capital development, and testing and measurement (Egea 2014; Lewin 2016; Peters 2011; Vassallo 2013). This is readily evident across the field of education. From the state house to the classroom, since the 1980s the field of education has been transformed through a neoliberal regime of accountability into a pedagogic and curricular array of standards, assessments and statistical data (De Lissovoy 2013). This neoliberalism inheres in and is productive of the subjectivity of the individual student through procedures to monitor, test and assess, such as standardized testing (De Lissovoy 2013). In this way, De Lissovoy (2013) concludes "the point is to ever more continuously organize and verify the subject as the effect or property of control (assessment) itself" (p. 428).

These discursive techniques and procedures, as they are productive of the autonomy of the individual student, are informed by the Cartesian mind/body dualism. While this student might learn with tools and other people, these would not be considered part of an extended mind. Instead, in the discourse on distributed cognition in the field of educational technology, they are distinguished from the individual student as aids to cognition. Ultimately, the individual student's mind is located inside their head and is theirs alone. It is assumed that the quality of this mind, or the reasoning ability of the individual student, dissociated from other people and educational technologies, can be measured and its effectiveness or value determined through practices of accountability. Associated with neoliberalism and state sponsored high-stakes testing, this regime of accountability is to measure the individual student's capacity to reason. And as it focuses on the internal mind of the individual subject it reduces the mind to an information processor and cognition, as a form of computation, to the rule-governed manipulation of internal representations—schemata located within the cranium of the individual student (Van Gelder 1995).

Dynamic Interactions of Embodied People and Things

It is not only in the applied field of educational technology that research into distributed cognition assumes a mind/body dualism and a representational theory of mind. There is a long history across Western thought that assumes dualistic ways of understanding our humanity while placing undue emphasis on the capacity to reason. Placed in this historical context, the likelihood of an extended mind seems most implausible. Yet, it is in this context that I discuss aspects of the discourse on the extended mind that formulate one of

numerous challenges to the representational theory of mind.[6] As I do, I take care to characterize discursive practices, including an emphasis on debate and theory building. These practices establish how the cognitive sciences question and explore alternatives to the representational theory of mind and render plausible theories of an extended mind. Indeed, it is through such discursive practices that claims to truth are both asserted and challenged. While the cognitive science that I describe is situated within research and debate of the relative merits and implications of an extended versus a representational mind (e.g. Adams and Aizawa 2008; Chemero 2009; Menary 2010b) it is germane to reiterate that in the applied field of educational technology the discourse on distributed cognition assumes the veracity of the representational theory of mind and its individual subject (Angeli 2008; Hammond 2010).

From the fields of artificial intelligence and analytic philosophy and throughout the cognitive sciences, there are theories of mind, including the theories of the extended mind, which conceptualize cognition as an embodied practice. Such practices implicitly, though quite literally, change the subject of the cognitive sciences. Indeed, this scholarship describes a wholly different cognition, without representationalism. It is the cognition of an embodied subject extended into and made part of dynamic interactions of people and material things (Chemero 2009; Van Gelder 1995). By extending the boundaries of analysis beyond the individual to a system of human agents, technologies, and other material things, such practices are productive of alternative models and theories. As well, these practices, as they refuse the Cartesian dualism and the autonomy of the individual student, are at variance with the neoliberal regime of accountability. Indeed, across the field of education, from the classroom to the halls of Congress, without this individual student, the practices and lived experiences of testing and the meaning of the data they generate would be significantly transformed.

Instead of embracing a priori, the assumption of representationalism that informs most thinking about the mind, Menary (2010a) questions why people spend so much time and effort developing and maintaining environments replete with notational, linguistic and otherwise external tools.

> We often, for example, write out mathematical problems, rather than completing them 'in the head'. Often humans directly manipulate the environment to complete cognitive tasks (…) If cognition is bounded by the brain, why do we not complete all these cognitive tasks, and many others like them, 'in the head' (Menary 2010b, p. 231)?

A cognitive "internalist," such as Salomon, might respond that these external tools support internal cognitive processes; they are helpful aids to cognition. Thus the internalists would stop well short of asserting that external tools form part of an extended mind. To this, Menary (2010a) responds "the coordination of bodily processes of the organism with salient features of the environment, often created or maintained by the organism, allows it to perform cognitive functions that it would otherwise be unable to" (p. 231). In this way, the theory of the extended mind begins with embodiment, an understanding of cognition in relation to bodily engagement with things in the world; cognition is simultaneously embodied and extended (Menary 2010a). The theory of the extended mind has immediate expression in the common use of a word processor. Is it realistic to assume that composition

[6] Including situated learning (Sawyer and Greeno 2009) and sociocultural psychology (Valsiner and Rosa 2007) there are numerous epistemological challenges to representationalism.

is even possible without these or related tools? Composing, revising and reordering paragraphs, correcting syntax, such cognitive labor is difficult, if not impossible, to do "in the head." Indeed, it is plausible that there is a reciprocal relationship between student and word processor that affords higher order cognition (Menary 2007b).

Among researchers of embodied cognition, the extended mind often begins with a symmetrical feedback relation between an embodied subject and the environment described as *reciprocal coupling*.

> When body and environment co-ordinate, the environment becomes part of the resources the organism has for acting, thinking or communicating. How, though, ought we to understand the coordination, or reciprocal coupling, of body and environment as accomplishing thinking? Reciprocal coupling is a symmetrical relation, the organism manipulates its environment in one direction, but the result of this environmental alteration feeds back to the organism prompting further bodily actions (Menary 2007a, p. 78).

Reciprocal coupling counters an internalist embrace of the individual subject, the mind/body dualism, and representationalism. In a frequently debated example of a human agent suffering from chronic memory loss, internalists assume that this subject *becomes* coupled with a notebook and together they form an integrated memory system. However, Menary (2007a) cautions, the embrace of a dualistic epistemology occurs exactly when it is assumed that the notebook *has not yet been* coupled to an autonomous individual subject who, by definition, would precede the coupling relationship with the notebook. He describes this as "a residual form of internalism," and goes on to explain "If we accept the picture of a cognitive agent as implementing a discrete cognitive system, before they ever encounter an external vehicle, then we will have accepted the very picture of cognition we set out to reject (…)" (Menary 2007a, p. 63). It would be a cognition requiring internal representations prior to and necessary for any future encounter with a material thing (Chemero 2009). Alternatively, through reciprocal coupling, it is assumed that material things, other human agents, and the embodied subject are *always already coupled* and mutually constitutive of cognitive processes.

Conversely, research into the representational theory of mind assumes an autonomous individual subject. Another way of articulating this Cartesian assumption is that the individual subject's cognition is independent of the body and occurs prior to any relationship with other people or material things. In other words, it assumes that the individual subject, construed as "mind" is in Van Gelder's (1995) words, "the causal underpinning of our intelligent behavior" (p. 380). This representational theory of mind positions the individual subject as ahistorical and eschews the idea of an ongoing, direct and real-time interaction of the subject as a part of a changing world. Outside of time and in no particular place, the disembodied Cartesian subject is to synthesize the succession of atomized or fragmented instances, the data of sense, with their internal representations (Ingold 2000).

As Menary (2007a) defines reciprocal coupling as coordination between body and environment, Shapiro (2011) uses this coupling metaphor to describe brain, body and environment as a dynamic system.

> From the perspective of the dynamical approach to cognition, *embodiment* refers to the fact that the brain is dynamically interacting with the body. The term "situated" is often used to draw attention to the fact that the body is embedded in and dynamically interacting with an environment. Thus, there is a coupling relationship between three components, (…) brain, body and world (p. 124)

In his explication of dynamic systems modeling and the theory of the extended mind, Van Gelder (1995) considers three questions. Could cognition have more than one explication? Could the prevailing explication of cognition be due to the limitations of available theories or models? And thirdly, could cognition be described more accurately as a dynamical system? Van Gelder (1995) explains that describing cognition as systemic, iterative, and mutually conditioning of the elemental variables of cognition (and specifically not the symbolic inputs and outputs of a representational model) offers a plausible model of cognition. From this perspective, a cognitive system is not reduced to the intracranial brain, Van Gelder (1995) asserts "since the nervous systems, body, and environment are all constantly changing and simultaneously influencing each other, the true cognitive system is a single unified system embracing all three" (p. 373).

The empirical methods of cognitive science assume relationships between data, models and theories. From this perspective, a theory is a *guide to discovery*; it's useful for generating models used with data to get a sense of things in the world (Chemero 2009). Dynamic systems models, as models, explain things in mathematical terms in relation to the data, on the one hand, and the theories that inform them, on the other. But it has only been through modeling that cognitive science explains cognition. As Menary (2010b) quips, to date, cognitive scientists have yet to extract a thought or a memory from a subject's hippocampus to prove, once and for all, the veracity of the representational theory of mind.

While the intention might be to discover the *truth*, Van Gelder, Chemero, and their colleagues are not expecting to overturn the representational theory any time soon. Instead, through dynamic systems modeling they conceptualize an alternative epistemology. As Chemero (2009) explains "if cognitive systems really have no representations, then there should be some explanation or model of them that need not refer to internal, mental representations" (p. 68). The Haken-Kelso-Bunz model is such a model as it has been used successfully in controlled experiments to explain cognition without mental representations (Chemero 2009). The challenge was to use dynamic systems to model higher order cognition such as thinking about the past, the future, or some distant place (Chemero 2009). Including Salomon (1993) and Clark (2011), many argued that these forms of cognition require internal mental representations. However, experimental applications of dynamic systems modeling, such as the 'gear problem,' challenge this assumption. As Chemero (2009) explains, the gear problem qualifies as a dynamic model of higher order cognition because to solve the problem thinking is focused on analyzing how the gears *will* move, an event to take place in the future.

As the theory of the extended mind conceptualizes cognition as embodied and extended, it constructs a subjectivity without a representational mind. It is a wholly different subjectivity where cognition is a dynamic system of embodied human agents and material things. Additionally, the central idea of reciprocal causal coupling challenges the basic assumptions of a representational mind, as all elements of a cognitive system play an active and causal role in cognition. And, if one material element were to be removed, it would lead to a decline in cognitive competence (Clark and Chalmers 1998). Furthermore, scholarly practices to extend the boundaries of analysis, from the individual to the dynamic system, as they are productive of alternative models and theories of cognition, are antithetical to the mind/body dualism and the representational mind. Indeed, the theory of the extended mind is antithetical to the historical legacy of Cartesian thought. And as it would challenge the integral continuity and autonomy of the individual student, it is also antithetical to the neoliberal turn in the field of education.

In this section, my intention has been to describe the theory of the extended mind and to establish that the fields of cognitive science and analytic philosophy recognize its

plausibility. Indeed, there are lively theoretical debates and criticisms of both the experimental research and associated representational and extended theories of mind. Special issues of journals and edited books are dedicated to these debates and frequently include chapters critical of the theory of the extended mind written by cognitive internalists (Adams and Aizawa 2008; Menary 2010b; Shapiro 2011; Spackman and Yanchar 2014).

Conclusions: The Representational Mind and the Effects of Power

Unlike my approach to discourse analysis, the sciences, broadly conceived, assume there are independent processes or entities, such as human perception, cognitive development, or empirical research, which exist beyond discourse and thus would determine the composition of a discourse or what could be asserted within discourse. Such assumptions inform matters of epistemology in analytic philosophy and cognitive psychology. Simplifying, as theories and models break down through the practices of theory development and empirical research, it is commonly assumed that this is because they are 'bumping into' an unrecognized or as yet undiscovered truth and thus point to the external or independent existence of this truth. In this way, the sciences, including the cognitive sciences, are assumed to be positioned outside of discourse as guarantors of what is possible to know and how that knowledge is to be discovered (Venn 1984). Such a position assumes, metaphysically, that truth exists independent of discourse and that this truth can be discovered and verified through scientific procedures. However, this scientistic discourse offers little to explain why the theory of the extended mind, whose plausibility has been established through empirical research, has been eclipsed by the field of educational technology.

Alternatively, embracing a standpoint epistemology, Foucauldian discourse analysis questions the very conditions of such an outside or independence from discourse (Haraway 1991). Indeed, it is assumed that there can be no position within science, or anywhere else, where the researcher could assume an independent position or perspective beyond discourse (Haraway 1991). By definition, such scientistic perspectives ignore relations of power. Whether defending the epistemological claims of representational theories or their extended alternatives, such an epistemological project, emanating from the cognitive sciences, includes initiatives to establish the rules and procedures that guarantee what is legitimate knowledge and thus affirm relations between the claims of science and what is true (Venn 1984). As a discursive practice, disagreement regarding these rules and procedures often results in debate across the pages of journals. Venn (1984) explains that participating in such debates, involves "placing oneself on the terrain of epistemology and in the end accepting the grounds claimed by orthodox [re: analytic] philosophy or by positivism for the ultimate guarantees of truth and rationality" (p. 120). However, a Foucauldian discourse analysis is not concerned with developing an epistemological challenge to the representational theory of mind. Alternatively, it serves to underscore that such approaches to research, without explicit recognition of their political, economic and social assumptions, ignore how such practices participate in historically specific relations of power (Popkewitz 1992).

Even as I continue to explore these debates and find the research associated with the extended mind relevant to the field of educational technology, it is evident that the discourse on distributed cognition in the field of educational technology is not influenced by the evidence of this research. In fact, research in distributed cognition in the field of educational technology does not participate in these debates. Instead, its research agenda

implicitly assumes the veracity of the mind/body dualism, representational theories of mind and the individual student. To date, no empirical studies have been published in the field of educational technology informed by the theory of the extended mind. It is not plausible to assert that the reason why the theory of the extended mind is absent from the field of educational technology is because it has been proven wrong or that the veracity of representationalism has been finalized. To the contrary, Salomon (1993) asserted that research and theories of distributed cognition in the field of educational technology couldn't afford to ignore the cognition of the individual student. And more recently, Hammond (2010) concludes that theories of technologically enhanced learning that pose a challenge to the representational mind are 'unfashionable.' Perhaps they have been constructed as unfashionable. But why doesn't the research on distributed cognition in the field of educational technology explore alternatives to the representational mind of the individual student?

In the broader field of education, a significant practice is the production of the individual student as a human resource through a pedagogy of high stakes testing, data production and analysis. As previously discussed, the production of this individual student in the field of education traces, in part, to the psychometric practices of data production and analysis emerging in the late nineteenth century (Rose 1996). Such psychometric practices, including the normative test, assume an autonomous individual subject marked by the Cartesian mind/body dualism. Productive of individual differences through the analyses of the empirical data it would gather, the normative test resembles the neoliberal practices of high-stakes testing. In the present, state administered high-stakes testing is to measure the individual student's capacity to reason. These and other pedagogical practices, as they assume cognition to be the manipulation of representations located in the individual student's brain, also assume they are measuring the cognitive ability of an autonomous individual student who is independent of other students and material things.

Antithetical to the subjectivity of this individual student, the metaphysics of an extended mind emphasizes an embodied subject whose cognitive faculties are always already coupled with material things and other human agents and are thus mutually constitutive of cognitive processes. Challenging the assumption of the Cartesian dualism in Western thought, this distinction is also antithetical to the neoliberal turn across the field of education. As they are to advance the autonomy of the individual student, neoliberal practices cannot embrace an educational subject whose capacity to learn is always already embodied and extended into and among technologies and communities of learners. Quite to the contrary, the subjectivity of the student has been colonized by the procedures and categories of a neoliberal regime of accountability that positions the student as the individual student (De Lissovoy 2013).

My contention is that research about distributed cognition in the field of educational technology is informed by relations of power produced through the interactions of a broad assemblage of institutions not limited to governmental departments of education and commercial interests such as the testing industry. Significantly, the neoliberal commitments and priorities of these institutions combine the Cartesian emphasis on reasoning and the mind/body dualism with governmental concerns for population management. The issue is not the origin of these discursive practices. Rather it is how they inhere in unexpected places. Indeed, their historically specific intertwining in the field of educational technology contributes to the durability of the discourse on distributed cognition, the representational theory of mind and the individual student. In part, these practices are what institutions do and they occur through the routine activities engaged in by their agents—teachers, elected officials, sales managers, cognitive scientists, and others. And as the sheer multiplicity and frequency of these activities are associated with what is possible and what can be known, in

this case the subjectivity of the individual student, they form productive relations of power. In this way, the production of the individual student can be thought of as an outcome or *net effect* of the association of the field of educational technology with this durable, though loosely coordinated, assemblage of institutions (Foucault 1980).

To characterize the productive power associated with historically specific discursive practices, in what follows, I recognize some of the institutions enrolled in this assemblage. Taking an historical step back, in the field of education there was a marked response to *A Nation at Risk,* the landmark educational policy document produced by the Reagan administration in 1983 that combined human capital theory with global economic competition. This document marks the neoliberal turn to standards, assessment, and accountability in the field of education. A few years hence, as the field was in the midst of this change, the field of educational technology was exploring ideas about constructivism and other cognitive learning theories informed by the representational model of mind (Shutkin 2004). It is in this context that the discourse on distributed cognition emerges in the field of educational technology.

Furthermore, educational technology, as an applied field, is regulated by the state as part of the broader field of education and is thus constrained by the state's ongoing policy initiatives and regulations including the neoliberal initiatives associated with *A Nation at Risk*. More recently, the federal government, in collaboration with the states, has once again reauthorized the Elementary and Secondary School Act. And this time, complicated by a discourse on data driven decision-making, the government places even more emphasis on testing and measurement of the individual student (Klein 2017). And even as they do, they renew the individual student as the subject of this legislation. Politicians rationalize these practices with references to global economic competition and human resource development as they are lobbied to do so by textbook developers, the dot-com industry, and so forth.

As well, educational technology has close ties with the dot-com industry, such as Google and Apple, who capitalize on the educational promise of technology and with those commercial interests associated with educational testing and measurement, such as Pearson and McGraw-Hill. Even as the textbook industry produces curricular materials so schools can prepare the individual student for testing, the testing industry deploys technological apparatuses to administer to the testing and measurement of this student (Newhouse 2015). And these tests, premised on the autonomy of the individual student and their representational mind, are developed to be valid and reliable instruments by experts trained in and through the cognitive sciences. These and other practitioners from across the field of education participate in boundary maintenance as they renew commitments to particular theories and assumptions, and to their mentors and colleagues. In the academy, this is achieved through practices such as the formation of research agendas, publishing outlets, referencing practices, membership in professional organizations, and so forth. As the basic unit of analysis, the individual student is evaluated, measured, and assessed and otherwise made subject through these and other discursive practices that tacitly rely upon a representational theory of mind.

In these and other ways, the assemblage of discursive practices limits the possibilities of what it can mean to be a student and this is epistemology. And it is the epistemological, in Foucauldian terms, that emerges as power/knowledge. Because it informs a subjectivity antithetical to the individual student, without a representational mind, and where cognition is a dynamic, embodied and material, the theory of the extended mind is necessarily excluded from this assemblage and from the discourse on distributed cognition in the field of educational technology. In other words, how what is possible to know, and how

it is known, and how subjects are acted upon and invited to act with this knowledge, for instance how technology is integrated to enhance learning or to condition the individual student's experience of testing, are not about truth; they are about power.

Compliance with Ethical Standards

Conflict of interest The author declares that there are no conflicts of interest.

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