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Against Strong Reductivism in Neuroscience Education : a Three-pronged Argument

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Against Strong Reductivism in Neuroscience Education: A Three-pronged Argument

Przeciw redukcjonizmowi
w kształceniu neurobiologicznym.
Potrójny argument

1.

This paper discusses certain problematic assumptions involving ‘strong reductivism’ and ‘eliminative materialism’ in current neuroscientific research in education. I provide some definitions and follow with a discussion of recent neuroscience literature in education that discusses the reduction or elimination of ‘mind’ in favour of neurologic or brain states. I define causality as the claim that brain-states are the source and basis of cognitive states such as attention, emotion, pain, sense perception, memory and intelligence. The sense of cause I am invoking is that of ‘strong causality’; causality without remainder or additional factors involved in the bringing-into-being of cognitive states. I define mind as the set of attributes commonly referred to by cognitive scientists as ‘mental’ properties of brain-states, including the aforementioned.

KEY WORDS

neuroscience education,
neurophilosophy, strong
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materialism, prag-
matism

SŁOWA KLUCZOWE

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Artykuły i rozprawy

Articles and Dissertations

I define functionalism as that school of thought insisting upon properties common to cognitive science (such as those, above) that, while causally dependent on brain-states, are not materially exhausted by them.¹ I will follow Paul Churchland in defining ‘eliminative materialism’ as that philosophical school of thought claiming there is no mind or mental states beyond the anatomy and physiology of the brain.² I will follow Patricia Churchland in defining ‘strong reductivism’ as that theory able to reduce in terms of explanation, cognitive theories (such as mind and mental states) to brain states with little or no remainder.³

It should be clear by now that the rhetorical strategy the media offers us in regards to neuroscientific research, both for and against, is woefully inadequate.⁴ What matters is to establish the ways neuroscientists doing educational research and educationists perceive the claims of brain-based research; what school of thought, if any, they understand themselves to be following; and (most importantly) what following one or another school of thought (but particularly reductivism or eliminative materialism) means for educational research.

¹ The history of the debate between functionalism and reductivism (including eliminative materialism) was played out at various times and in various places. Reductivism rose in the 19th century, with individualist behaviourism and the rise of stimulus-response theory. Leading pragmatists of the day such as William James and John Dewey (and later, George Herbert Mead) countered this behaviourism through the denial of the reflex-arc and through ‘socializing’ the individualist tendencies therein. Theories of consciousness that reduced mind and sociality to brain states or neurological mechanisms were challenged by Mead in the 1920s. In the 1950s with the growth of neurology, the distinction between functionalism and reductive and eliminative notions of mind came to the fore. Functionalists such as Fodor, Putnam, did battle with reductivists and materialists such as Richard Rorty and later, the Churchlands. The vast majority of philosophers and social sciences sided with the functionalists, however broadly they understood mind. However, the strong reductivists and eliminative materialists did not go away. The Churchlands in particular, grew their influence in the 1980s and 1990s. Though they remain a minority viewpoint in cognitive science and education, they are recognized.

² P. Churchland, *Matter and Consciousness*, Cambridge, MA 1984.

³ P. Churchland, *Neurophilosophy: Towards a Unified Science of Mind-Brain*, Cambridge, MA 1986.

⁴ U. Goswami, *Cognitive Development: the Learning Brain*, Hove & New York 2008.

I shall offer two theses here. The first is that neuroscientists doing educational research have been, and continue to be, functionalist in their thinking about causality, though there is also evident reductivist and eliminative materialist thinking regarding this issue. The second is that, though educational researchers are largely functionalist and there is a groundswell of criticism regarding the issue of causality in regards to brain-based research, there is philosophical and empirical argumentation that denies anything other than a brain-based explanation to psychological states, including learning.

2.

Though an empirical study of neuroscientific researchers' self-understandings of their positions on causality has to the best of my knowledge, never been undertaken, a quick survey of the literature of the past 20 years reveals that the majority clearly see themselves operating within a functionalist understanding. This is so because they are keen to corroborate their findings with existing cognitive-scientific results, as opposed to attempting to reduce or otherwise eliminate the latter.⁵ Jessica Scott and Christopher Curran found that researchers often speak only in terms of subjects' brains, rather than attributes of the mind, such as emotions or experiences⁶ when discussing their research. But the more interesting finding they noted among neuroscientific researchers' understandings of the connection between the mind and brain was skepticism regarding the limitations of neuroscience.

⁵ L.J. Nyberg, J. Eriksson, A. Larsson, P. Marklund, "Learning by Doing versus Learning by Thinking: An fMRI Study of Motor and Mental Training", *Neuropsychologia* 2006, vol. 44, p. 714; M. Delazer, F. Domahs, L. Bartha, C. Brennis, A. Lochy, T. Trieb, T. Benke, "Learning Complex Arithmetic—an fMRI Study", *Cognitive Brain Research* 2003, vol. 18, p. 78; P.E. Turkeltaub, L. Gareau, D.L. Flowers, T.A. Zeffiro, G.F. Eden, "Development of Neural Mechanisms for Reading", *Nature Neuroscience* 2003, vol. 6, no. 6, p. 771; R. Poldrack, "Can Cognitive Processes be Inferred from Neuroimaging Data?", *Trends in Cognitive Sciences* 2006, vol. 10, no. 2, p. 60; J.D. Van Horn, "Cognitive Neuroimaging: History, Developments, and Directions", in: *The Cognitive Neurosciences III*, ed. M. Gazzaniga, Cambridge, MA 2004, p. 1285.

⁶ J. Scott, C. Curran, "Brains in Jars: The Problem of Language in Neuroscientific Research", *Mind, Brain, and Education* 2010, vol. 4, no. 3, p. 153.

Within these studies, we found several phenomena related to the limitations of neuroscience, such as skepticism on the part of researchers and other professionals about what neuroscience can tell us about certain behaviors or emotions, as well as a fear of misuse or overgeneralization by others of the results of neuroscientific research.⁷

It is not uncommon to see claims such as this in the literature (though *not* in the actual experimental design studies).

In sum, the education profession could benefit from embracing rather than ignoring cognitive neuroscience. Moreover, educationists should be actively contributing to the agenda of future brain research. That is, a cognitive neuroscience-education nexus should be a two-way street. Whereas cognitive neuroscience could inform education by providing additional evidence that confirms good practice, helps resolve educational dilemmas, or suggests new possibilities in pedagogy or curriculum design, education could inform cognitive neuroscience by providing a source of complementary behavioural data, especially on children, as well as posing new worthwhile lines of investigation.⁸

This is clearly *functionalist* in expression: nevertheless, it augurs for a more pronounced role for neuroscientific research than we are currently capable of offering. As such, it gestures towards the rhetorical. Others have also made functionalist claims on behalf of neuroscience research. Indeed, most of the representative literature makes functionalist claims; especially claims about the need for neuroscientists, cognitive psychologists, and educators to work together. The very claim that there are ‘neuromyths’⁹ prevalent in educational research and practice is premised on distinctions made between brain-states and the cognitive activities that follow.¹⁰

Nevertheless, there are neuroscientific researchers and educationists asserting the future of neuroscience will demonstrate something

⁷ Ibidem.

⁸ J.G. Geake, “Educational Neuroscience and Neuroscientific Education: In Search of a Mutual Middle Way”, *Research Intelligence* 2005, vol. 92, pp. 10–13.

⁹ Neuromyths in education include the claim that there are distinctive learning styles and that children learn best when they learn according to their style; that right/left brain dominance has a demonstrable role to play in learning differences; and that coordination exercises (such as briefly touching your toes) plays a role in integrating right/left brain function.

¹⁰ J. Geake, “Neuromythologies in Education”, *Educational Researcher* 2014, vol. 50, no. 2, pp. 123–133.

beyond corroboration and correlation. In the case of Goswami, a leading functionalist in matters of neuroscience, a hedging on the issue of causation is evident. Goswami first concludes (strongly) that in the cognitive neurosciences, studies are correlational, not causal, and that causation is not implied by correlation.¹¹ Cognitive neuroscientific studies do not give us a foundation on which to base further cognitive-scientific insights, such as those involving memory or learning. Instead,

Intervention studies are also required when reliable correlations are found, in order to manipulate the variables in any association. This enables the study of ‘dose-response relationships’: if a particular factor is having a particular effect, then receiving more of that factor should increase the effect.¹²

However, Goswami seems to shift his rhetoric toward causation and foundationalism when he claims,

Nevertheless, cognitive neuroscience offers an empirical foundation for supporting certain insights already present in pedagogy and disputing others. The evidence from neuroscience is not just interesting scientifically. It enables an evidence base for education in which mechanisms of learning can be precisely understood.¹³

This suggests that for Goswami, cognitive neuroscience (or in any event, the neuroscientific correlates) *is* foundational for education. And if this is so, then cognitive neuroscience provides for a more predictive causal basis than cognitive psychology.

There are other claims that go well beyond this one in regards to causality. For example, a recent article in *Educational Researcher* dismisses philosophical objections to reduction of learning behaviors to neural networks and brain-states on the bases of documented fMRI imaging showing activity in certain brain centers during learning tasks. The philosophical claims are merely dismissed—not refuted. In response to objections to reductive strategies in the neurosciences, the authors claim, “Neuroscience *might* help to resolve some of the balkanization within education because it provides a *common biological vocabulary* for describing phenomena and a common reporting

¹¹ U. Goswami, *Cognitive Development*, op. cit., p. 386.

¹² *Ibidem*.

¹³ U. Goswami, *Cognitive Development*, op. cit., p. 396.

scheme for describing the results of neuroimaging experiments”.¹⁴ This *is* reductionist in expression: the very idea of a common biological vocabulary assumes the reducibility of the vocabulary of the cognitive sciences to the vocabulary of biology—presumably in this case, brain-states.

Yet another account first implies a functionalist understanding of the relationship between neuroscientific research, the cognitive sciences, and education, but then goes on to make a reductionist move. First, it is claimed,

It is highly doubtful that any single given study in neurology will have a direct application to the classroom but, on a more hopeful note, it is almost certain that aggregations of findings from several studies, mediated through higher levels culminating in the behavioural and educational levels will indeed provide new teaching methodologies.¹⁵

However, this functionalist sentiment is followed by a reductionist one in discussing the future of neuroscience research. In a claim remarkable for its similarity to Paul and Patricia Churchland’s claims about the future likelihood of a neuroscientific (common) vocabulary, it is said,

It must be mentioned that the divide between the cognitive neuroscience level of mechanisms and the psychological, functional level of mechanisms is likely to be an artificial one, a product of our time which exists due to the fact that the vocabularies between the physical and the functional sides *appear to be* at different levels (because researchers have *not yet discovered how to translate psychological terms into biological terms (and vice versa)*)...This implies that the separation between the terms *brain* and *mind* could perhaps more appropriately be seen as different perspectives of the same thing, much like the famous figure / ground images where a viewer can see either an old lady with a large nose or a young woman’s profile. Both levels have been included in this model *for the time being* due to the historical separation between these notions of the physical and the functional¹⁶.

¹⁴ S. Varma, B. McCandliss, D. Schwartz, “Scientific and Pragmatic Challenges for Bridging Education and Neuroscience”, *op. cit.*, p. 145.

¹⁵ J. Tommerdahl, “A Model for Bridging the Gap between Neuroscience and Education”, *Oxford Review of Education* 2010, vol. 36, no. 1, p. 99.

¹⁶ *Ibidem*, p. 101 [italics mine].

These examples demonstrate the range of positions regarding what neuroscientific research can (and does) claim in the name of causality. The strong claims for the causal reduction or elimination of psychological vocabulary to neuroscientific vocabulary (and presumably, psychological theory to neuroscientific theory) clearly have some philosophers and educationists concerned, as I will now discuss.

Criticism amongst educators regarding the claims of neuroscientific research is not new. For example, as early as 1997, Breuer claimed, “Neuroscience has discovered a great deal about neurons and synapses, but not nearly enough to guide educational practice. Currently, the span between brain and learning cannot support much of a load. Too many people marching in step across it could be dangerous”.¹⁷ Indeed, it is the reduction of “learning” to a common vocabulary that is *precisely* what certain philosophers of education fear, as Scott and Curran have noted.¹⁸ Against more hopeful attempts at bridging the gap between neuroscience and education, skeptics of reductive and eliminative claims believe is doubtful whether we could *ever* overcome this difference through getting better at describing what it is in physiological terms to have a neural connection or correlate that manifests as improvement in learning. Attempts such as these, as Purdy and Morrison have aptly pointed out, are “attempt[s] to reduce the irreducible uncertainty of the mental”, and are bound to fail.¹⁹

In relation to education the indeterminacy of psychological attributes (such as understanding) is not removed by a computer-generated print-out of neural processing, because this form of measurement creates a quite different concept. In the light of Wittgenstein’s philosophy we might therefore conclude that cognitive neuroscience can certainly reveal much about brain functioning, but there can be no logical link between fMRI data and educational attributes. Cognitive neuroscience may offer detailed pictures of neural networks, but, just as a thermometer fails to measure pain, so a brain scan fails logically to measure understanding: the concepts involved are simply different and the indeterminacy remains. Cognitive neuroscience therefore at best offers insights into the neural *concomitants* of thinking, but it offers no privileged access into the

¹⁷ J.T. Breuer, “Education and the Brain: a Bridge Too Far”, *Educational Researcher* 1997, vol. 26, no. 8, p. 15.

¹⁸ J. Scott, C. Curran, “Brains in Jars”, *op. cit.*, p. 153.

¹⁹ N. Purdy, H. Morrison, “Cognitive Neuroscience and Education: Unraveling the Confusion”, *Oxford Review of Education* 2009, vol. 35, no. 1, p. 108.

hidden world of the inner, that inner world being already manifest in external behaviour. Rather than representing a panacea to education, the cognitive neuroscientific enterprise in relation to education is therefore necessarily limited.²⁰

However, some critics of reductive and eliminativist claims think that swinging too far the other way—to distinguish too sharply between mind and brain—is tantamount to constructing a new dualism.²¹ Howard-Jones claims,

However, brain processes are clearly more than just a reflection of our mind's attempt to assign and contemplate meaning, since the suppression of brain processes [...] can reduce such mental abilities. Biological processes in the brain thus appear intimately bound up with our cognitive abilities, even if they cannot be considered as the same thing. Indeed, our personalities, our values and the recall of what we have learnt and experienced can all be influenced by the biology of our brains. Furthermore [...] we know that our mental life, as stimulated by our experiences, can influence our brain development at a number of different levels. Thus, whilst dualism can become, for purely pragmatic reasons, an attractive philosophy for educators and scientists alike, it seems unwise and often nonsensical to consider the mind and brain in separation from each other.²²

In this, he agrees with Paul Churchland, who also argues against dualisms in understanding mind.²³ However, while Churchland clearly sees himself as an eliminative materialist, Howard-Jones is critical of any reductive or eliminative strategy.

3.

Few if any neuroscientific researchers in education wish to do away with the functions of mind: this much seems clear from a review of the literature. We should perhaps be happy that the vast majority of the research community does not entertain a full-on reductivism or eliminative materialism. Debates that suggested the ob-

²⁰ Ibidem, p. 105.

²¹ P. Howard-Jones, "Philosophical Challenges for Researchers at the Interface between Neuroscience and Education", *Journal of Philosophy of Education* 2008, vol. 42, no. 3–4, pp. 361–380.

²² Ibidem, pp. 370–371.

²³ P. Churchland, *Matter and Consciousness*, op. cit., p. 21.

vious shortcomings of both were undertaken in the 1960s and 1970s and, despite the Churchlands and other outliers, do not seem to have convinced many in the field of education. However, minority voices may certainly grow louder. In the next section I want to deny not only the positions of strong reductivism and eliminative materialism, but expand the debate. In so doing, I will discuss three prongs of a comprehensive argument against these. The first prong will claim that it is semantically impossible to reduce the vocabulary and descriptions of cognitive science to neuroscience. This prong has affinities with Putnam's claim for descriptive differentiation. The second prong echoes concerns about logical independence raised by Fodor. Here, I will claim that any attempt to reduce the vocabulary, descriptions, and theory of cognitive science to neuroscience commits a set of fundamental fallacies: what A.N. Whitehead calls 'the fallacy of misplaced concreteness', William James and John Dewey respectively, 'the psychologist's fallacy', and 'the psychological fallacy', and M.R. Bennett and Peter Hacker 'the mereological fallacy'—all pertaining to the taking of a part for the whole. The third prong will be to question the implied dogmatism at the heart of eliminative materialism and strong forms of reductivism; a dogmatism that threatens the claim to be able to work alongside the evolutionary programs of 'mind-brain' that Dennett and Chalmers promote.

Prong One

All who claim neuroscientific reduction or elimination of mind and learning admit this cannot (yet) be currently done. This goes for Paul and Patricia Churchland, (early) Rorty, and (early) Dennett. The claim, however, is not simply that we aren't currently able to reduce or eliminate mind, but that we *will* once our neuroscience is further developed. We will, in Paul Churchland's estimation, be able to talk in a different vocabulary about such mundane things as learning and teaching, reading and writing, eating and conversing. And this vocabulary will belong to the neurosciences, not psychology. Churchland is not alone in his hope; some neuroscientists have pressed for a common vocabulary based in the neurosciences,²⁴ while eschewing

²⁴ S. Varma, B. McCandliss, D. Schwartz, "Scientific and Pragmatic Challeng-

the overt elimination of cognitive psychological vocabulary. There even seems to be a demand on the part of educators unfamiliar with the neurosciences to have a common vocabulary of this sort in place to discuss terms and findings across psychology, education, and the neurosciences, as Pickering and Howard-Jones have shown.²⁵ To skeptics who claim a common vocabulary is speculation, Both Paul and Patricia Churchland respond that we cannot be dogmatic about what possibilities lie ahead for neuroscience, and that, if things continue on as they are, it is plausible to envision the reduction and/or elimination of mind. Both back up this speculation with analogues from the history of science. As Phlogiston and the ethereal account was replaced by oxygen and the elemental account, and Einstein's theory of relativity replaced Newton's theory of solar gravitation, so (one day) neuroscience will replace or otherwise eliminate psychology.²⁶ However, the analogy fails to convince because it works to demonstrate the likelihood of psychology to reduce or otherwise be eliminated by neuroscience *if and only if* the reduction and/or elimination of psychology to neuroscience *is identical with or at least very similar to*, the reduction of one scientific theory to another. But this

es for Bridging Education and Neuroscience”, *Educational Researcher* 2008, vol. 37, no. 3, p. 145; J. Tommerdahl, “A Model for Bridging the Gap between Neuroscience and Education”, op. cit., p. 101.

- ²⁵ S. Pickering, P. Howard-Jones, “Educators’ Views on the Role of Neuroscience in Education: Findings From a Study of UK and International Perspectives”, *Mind, Brain, and Education* 2009, vol. 1, no. 3, p. 111.
- ²⁶ This is along the lines of a Kuhnian revolution in science. One paradigm replaces outright another. Of course, in the case of Einstein and Newton, relativity has not replaced the laws of motion, as any first or second year physics student studying classical mechanics will attest. Rather, the *theory* of relativity has replaced the *theory* of (solar) gravitation, through inter-theoretic reduction, as Patricia Churchland rightly claims. What can be said of the laws of motion under the theory of solar gravitation can be said of the laws of motion under the theory of relativity; but more can be said (and better) with the laws of motion under a theory of relativity than with the laws of motion under a theory of solar gravity. Yet, this still leaves the laws of motion intact, with qualifications. And they operate in the pure and applied sciences in ways that go beyond mere historical interest. My point is that even in paradigmatic scientific examples of reduction, there is still a role left for instances of the earlier theory. Thus, it cannot be called a *complete* reduction. And even with the role left, there is still benefit to understanding the instances (laws of motion) under the aspect of the original theory (of solar gravitation).

is precisely what has yet to be proven. We would have to wait for the scientific community to claim consensus on this issue. As such, we can only speculate that it will reduce. But even this prediction has fatal flaws, as I will discuss below.

Consider again the claims of eliminative materialism and reductionism: we can either eliminate psychology or reduce it to brain-states. Brain states are physical states involving oxidative phosphorylation, glycolysis, increased capillary blood flow, increased oxygen uptake, increasing concentrations of specific neurochemicals at key synapses, electrical discharges, regional anatomic involvement, together with the artefacts of analyses such as imaging potentials, regional blood flow analysis, localization of specific neural networks and the brain regional geography on the basis of these, with the results gleaned using statistical processing packages. From these results, it is said we can introduce a new vocabulary, set of descriptions and explanations, and ultimately a theory at the level of brain-states that replaces the older theory of mind. (As the descriptions are causal, we can even say they are explanatory.) Mind includes psychological descriptions and accounts of experiencing, feeling, believing, desiring, choosing, attending-to, judging, memorizing, giving and taking reasons. Mind of course, also includes learning. Thus, the reduction or elimination of mind will mean that the basis for these is not only explainable under a theory of brain-states, but that the vocabulary and descriptions we currently use in discussing these will disappear (at least, for eliminative materialism), to be replaced by other vocabulary and descriptions. For example, instead of saying

—My arm hurts

I might now say,

—My C-fibers are activated in region ϕ due to pain receptor stimulation

And instead of saying,

—Johnny is doing a good job memorizing

I might now say,

—Johnny has pronounced activation of his left angular gyrus

Likewise, whereas I might have said

—Sally is imitating her sister

I might now say,

The stimulation of Sally's retina has actuated the visual centres and cortex responsible for what was formerly called image production

and recognition (her sister), and this is further actuating the posterior part of her inferior frontal gyrus, or what was formerly called imitation.

However, what is often overlooked (or in any event, explained away) is that neuroscientific states *are different than* the psychological states they seek to reduce or eliminate²⁷. One way we can see the difference is by trying to develop semantic equivalents for each²⁸ Here, we can take our cue from W.V.O. Quine²⁹ and ask how, for example, to translate the exact meaning of

The felt sense of successful solution to a problem involving the calculation of the descent of variously weighted falling bodies along a chord as all falling at the same time

into

Increased dopaminergic activity in the intra-limbic gyrus as a result of specified visual and tactile cues

without incorporating semantic content from the first into the second.³⁰ Translating the first statement into the second is intuitively implausible absent a suitable semantic equivalent. And there is no semantic equivalent to be found without presupposing some incorporation of the former into the latter. However, running them together, reducing one to the other, or eliminating one outright in favour of the other constitutes a grave fallacy of oversimplification. Thus, it will not do to say that psychological states are akin to Priestley's Phlogiston, or Newton's laws of motion, as Churchland does, because psychological states are different descriptors having different semantic contents. We can agree with materialists insofar as brain-states *cause us* to have psychological states, inasmuch as brain-states are necessary for there to be psychological states (this is of course an empirical claim). But we need not, and may not, proceed on that basis to claim *all* psychological states are *therefore* isomorphic with brain-states

²⁷ N. Purdy, H. Morrison, "Cognitive Neuroscience and Education", op. cit., p. 109.

²⁸ All of these are "attempt[s] to reduce the irreducible uncertainty of the mental" in Purdy and Morrison's words.

²⁹ V.W.O. Quine, *Word and Object*, Cambridge 1960.

³⁰ J. Fodor makes a similar claim, in his "Materialism", in: *Materialism and the Mind-Body Problem*, ed. D.M. Rosenthal, Indianapolis 2000, p. 117.

(identity theory); or that psychological vocabulary, descriptions, and theory is reducible to brain-state vocabulary, descriptions, and theory (reductivism); or that psychological states, vocabulary, descriptions, and theory are eliminated by the new vocabulary, descriptions, and theory of brain-states (eliminative materialism). Why not? Because the semantic understandings of the events and situations we describe and explain as psychological cannot be isomorphic with, reducible to, or eliminated down to their material substrate without also presupposing that a shared set of semantic-pragmatic understandings, common to *both* psychology *and* neuroscience, is *already* in place and operative. Identity, reduction, and elimination of states or theories only make sense *in*, and can only take place *within*, a semantic-pragmatic understanding in which the rival states or theories are understood to consist of the same meaningful symbol-systems (in sociological terms) or semantic-pragmatic equivalents (in linguistic-philosophical terms) and not *between* rival semantic understandings that don't. But this is precisely what the differences between psychological states and theories and neuroscientific states and theories come down to: distinct and rival semantic-pragmatic understandings. There are no equivalents because there is no shared semantic-pragmatic understanding in which to have these, and to think otherwise is to invite the *reductio ad absurdum* of presupposing an already smoothly reduced system in which all understandings are already isomorphic.

Now claiming distinctive semantic-pragmatic understandings may seem to invite the criticism of property dualism Howard-Jones³¹ charges certain accounts with—that there is a distinctive non-material set of properties of material brain-states to which and only to which we can affix psychological descriptors³² I do not think this is a concern, however, because I am not claiming a new dualism for material *vs.* immaterial properties. That is to say, I do *not* claim that neu-

³¹ P. Howard-Jones, *Philosophical Challenges for Researchers at the Interface between Neuroscience and Education*, op. cit., p. 370.

³² Howard-Jones thinks that distinguishing between the brain's material matter and cognitive states such as emotions or feelings invites a dualism of material matter versus a mind that creates meaning. Put this way, no position other than a thoroughly eliminative one could avoid being dualistic (Ibidem, pp. 370–371).

ral processes play *no role whatsoever* in psychological states.³³ These play both a causal *and* a functional role. Without the adrenalin and nor-adrenalin released into our system during fearful episodes, we would not manifest the flight response we would need to escape from the situation. Certainly, this impacts the choices we would have to make in regards to staying and fighting or fleeing. (The choice itself, however, is made partly on the basis of available possibilities within the environment.) Is this, then, a property dualism? No, because it does *not* reflect the view that the mind alone creates mental meaning. However, it does claim a semantic-pragmatic distinction between brain-states and their explanatory apparatus, and the characteristics of mind and their explanatory apparatus.

Furthermore, it is unlikely we would ever be able to do without psychological descriptors for our understandings of the world and ourselves. Why is this? Because we operate within and upon, an environment—a world we are a part of—and it is this environment and world that we refer to in our existing basic descriptions and vocabulary of what it is to learn, know, and to be human. The environment/world conditions not only our existing basic descriptions and vocabulary, but conditions *any possible* descriptions and vocabulary, including brain-based ones. (Only if the environment/world ceases to have any role to play for us will this possibility cease, and that is extremely unlikely.) Only on a reductive and physicalist understanding, one in which we are merely responding to sensory stimuli and all the work of constructing and living goes on inside our nervous systems, does it seem appealing to claim that psychological descriptions and vocabulary reduce to or are otherwise eliminated by, brain-state descriptors and vocabulary.³⁴ Neither Tommerdahl nor Varma, McCandliss and Schwartz address the fatal flaw in reductive accounts of mind to brain-states, but both do recognize the implausibility of eliminating one vocabulary in favour of another, and this is to their credit.

³³ For the view I am opposing, see F. Jackson, “Epiphenomenal Qualia”, *The Philosophical Quarterly* 1982, vol. 32, pp. 127–136.

³⁴ Of course, this is just the claim that reductivists and eliminative materialists make, and the one I am attempting to refute. It would be question-begging on both sides of the debate to merely conclude with this.

Prong Two

I am claiming that reductivism and eliminative materialism shrink the world to one of sensory inputs and motor outputs, with all the higher-order functions taking place within the brain as understood by neurophysiologic theories and vocabularies. I am also claiming we cannot possibly commit to this understanding. However, prong one is not enough: demonstrating that we cannot commit to the above understanding requires further argumentation. This will constitute the second prong of my argument. I want to consider the reductive and eliminative materialist claims under the rubrics of ‘the fallacy of misplaced concreteness’, ‘the psychologist’s fallacy’, and ‘the mereological fallacy’. In regards to the fallacy of misplaced concreteness, reification of parts of nature to the detriment of the whole must be avoided on pain of committing a logical fallacy. A.N. Whitehead defines the fallacy as “... merely the accidental error of mistaking the abstract for the concrete”.³⁵ If we consider the issue of reductivism and eliminative materialism, we see that what they bracket out when it is insisted that one vocabulary, set of descriptions, explanations, and/or theory reduces to or replaces another is the concrete context (including the environment/world) in which the brain exists and operates within and upon. To forget this context in the zeal to reduce the world to a physicalist account of nerve endings and brain-states without replacing this new account back into the context of the world, is to mistake the abstracted (brain-states) for the concrete (brain-world).

William James and John Dewey had a similar term for this false process. They called it (respectively) “the psychologist’s fallacy”, and “the psychological fallacy”—of taking the products of inquiry for essences and the part for the whole.³⁶ More recently, R.M. Bennett and Peter Hacker³⁷ have called a linguistic variant of the “psycholo-

³⁵ A.N. Whitehead, *An Enquiry Concerning the Principles of Natural Knowledge*, 2nd edition, Cambridge 1925, p. 21.

³⁶ W. James, *Principles of Psychology*, vol. 1, New York 1918, pp. 196–197; J. Dewey, “Experience and Nature”, in: *The Early Works of John Dewey*, vol. 1, ed. J.A. Boydston, Carbondale 1981, p. 28.

³⁷ M. Bennett, P. Hacker, *Philosophical Foundations of Neuroscience*, London 2003, p. 23; M. Bennett, P. Hacker, “Selections from Philosophical Foun-

gist's fallacy" first pronounced by James, "the mereological fallacy".³⁸ When we reduce or otherwise eliminate the surrounding context or environment that something operates within, and then claim that something shorn of this context is true, pure, correct, or otherwise paramount, we commit this fallacy. It seems highly likely that *any* form of reductivism or eliminative materialism would commit this fallacy. There is an associated problem: to commit this fallacy—to abstract brain-states from their context and then eliminate and/or reduce what are not brain-states—runs up against this undisputed fact: that psychological descriptions and explanations (mind) already do so much for us. One reason we give in clinging to our existing cognitive-psychological accounts is *that they work*. And this is the opinion of neuroscientific researchers. Scott and Curran noted that, among neuroscientific researchers' understandings of the connection between the mind and brain, scepticism regarding the limitations of neuroscience was evident. "Within these studies, we found several phenomena related to the limitations of neuroscience, such as scepticism on the part of researchers and other professionals about what neuroscience can tell us about certain behaviors or emotions, as well as a fear of misuse or overgeneralization by others of the results of neuroscientific research".³⁹ Among the reasons we have for keeping existing cognitive-psychological accounts owes to their deep historical, sociological, and philosophical pedigree—these accounts bear on theories of experiences, social interaction, the development of selves, and human nature and conduct. To champion basic brain research over and against the legacy of existing cognitive-psychological research is a false and ultimately inhibiting path, for the former lacks what the latter offers; theories of experience, functional social psychologies and sociologies of human nature and conduct; and organic and systematic understandings of how behaviour and practices

dations" of Neuroscience", in: *Neuroscience and Philosophy: Brain, Mind, and Language*, ed. M. Bennett, P. Hacker, New York 2007, p. 48.

³⁸ Bennett and Hacker draw on the later Wittgenstein in describing the taking of a part for the whole as 'the mereological fallacy'. I note the congruence of this fallacy with the earlier descriptions of 'the fallacy of misplaced concreteness' and 'the psychologist's fallacy' and run them together for the purposes of this paper.

³⁹ J. Scott, C. Curran, "Brains in Jars", *op. cit.*, p. 153.

operate within these. In regards to human behavior, we already know a great deal about what to do, why to do it, and what it will net us if we do (or don't).

An organic and systematic set of understandings is *already* in place to justify behavioural and cognitive claims; a set of understandings that would be *absent* from any reductive or eliminative account that makes claims of causality on behalf of behaviours and practices. Of course, leaving these understandings intact is off-limits to reductive and eliminative accounts, because the context is also denied in the claim that mind is superfluous or mistaken, and the question of what these accounts will turn to for justification is raised (though often begged). Dewey once complained⁴⁰ that the dominant behaviorist accounts of psychology were abstracting the external behaviours of human beings from both the internal processes that co-ordinated these behaviours and the environment in which these behaviours took place.⁴¹ His solution was to re-contextualize these behaviours through an accounting of internal processes *and* environment. Both reductivism and eliminative materialism thwart any such recontextualisation. A new vocabulary, descriptors, and explanations would have to be developed that took into account not only brain-states, but the relationship between the brain and its world. This would, in my opinion, require the re-instantiation of much of the vocabulary of psychological states now in existence, though under a different description: we would have to re-invent the wheel.

It seems both reductivism and eliminative materialism are caught on one or another horn of a dilemma. In the case of reductivism (on the inter-theoretic model discussed in part two), a full-on reduction of mind to brain-states would render superfluous the theory, explanations, descriptions, and vocabulary of mind. It seems mind could either be left in place or abandoned, to be replaced by a new theoretical and linguistic apparatus (as in eliminative materialism). If it is left in place, however, the inter-theoretic reduction becomes philosophically uninteresting, since we don't change the way we use our conceptual

⁴⁰ J. Dewey, "The Reflex-Arc Concept in Psychology", in: *The Early Works of John Dewey*, vol. 1, ed. J.A. Boydston, Carbondale 1972, p. 102.

⁴¹ G.H. Mead had a similar claim with respect to behaviouristic psychology. See G.H. Mead, *Mind, Self, and Society from the Standpoint of a Social Behaviorist*, Chicago 1934, pp. 32–33.

or linguistic apparatus *vis à vis* mind and learning. If, however, it is abandoned, a new theoretical and linguistic apparatus is needed to interface between brain-states and behaviours in our world. But this would require the re-instantiation of much of our existing theoretical and (especially) linguistic apparatus regarding mind and learning. And this, I submit, would bring us back roughly to where we are now.

I will expand on this dilemma. Consider the following (functionalist) description of a seemingly simple event:

—Karen is angry at Sally because Sally hit her with a ruler.

This is a claim that evinces both a psychological description (anger) and a reason for the behaviour. In full-on reductivism, this might conceivably be described as

—Karen is demonstrating outward behavioural signs that her amygdala has activity in response to being struck by an object.

But if we rest with this description, we are still accounting for Karen's brain-states in terms of the outward behaviour of another: *we are still giving reasons for Karen's behaviour*. But giving reasons is part of what it means to provide psychological descriptions.⁴² So we must shoot for a more thorough and causal-materialist description.

—A complex set of neural networks that has achieved consciousness (what was Karen) is demonstrating anatomic and physiologic signs suggesting its amygdala has activated in response to C-fibre stimulation due to pain and pressure receptor-activation, in conjunction with stimulation of visual-spatial neural networks (what was the ruler), in turn activating its pre-frontal cortex (what was anger) upon the stimulation of another visual-spatial neural network (what was Sally).

Now, Churchland has said that until our neurophysiologic descriptions improve, we won't be able to reduce a psychological description to a materialist and physiological one. This failure of this reduction is certainly evident in the above description. Why? The context is missing, which significantly limits our overall understanding as an event in which Karen is angry as a result of her being hit with a ruler by Sally. So context will be very important in any thorough reductive description *if* we want to get the sort of understanding that encompasses both brain-states and situation. But here is a paradox; it seems the more materialist and physiological

⁴² P. Churchland, *Neurophilosophy*, op. cit., pp. 304–305.

we get, the more the context drops out. And we would need to place our understanding of Karen's brain-states back into its context if we are to discriminate between this brain-activation and other, similar brain-activations that otherwise could not be differentiated into what we identify as the psychological descriptions of emotions (anger), persons (Sally) and representations (objects) that take place in a situation. Of course, we could say that whenever these brain-activations occur in response to activations of C-fibres as a result of pain-and pressure receptors and subsequent visual neural networks are activated (an image is formed), then a *causal relationship* has been established between brain-states and world; but then we are left in the dark as to what, beyond a causal relationship amongst the neural events involved *in the description*, is to be understood regarding the situation. The understanding we now have of the situation (Karen is angry at Sally) is certainly not expressed in the materialist and physiologic description; *indeed, the new understanding can no longer be the understanding of Karen being angry at Sally, as the description we would need to understand it this way is irrevocably lost to us in the turn to a thoroughgoing causal, materialist and physiological explanation. We lose not only our psychological descriptions, but the description of the situation, including the descriptions of Karen, Sally, anger, and the ruler.* Now, inter-theoretic reduction might choose the path open to eliminative materialism—the path of developing of a novel descriptive-explanatory apparatus. But then it would no longer be a case of reduction; rather a case of elimination.

This leads me to my next point: the situation is even more disconcerting for eliminative materialism, for it denies we need to or ought to be brought back to where we currently are, inasmuch as it insists on the new descriptive-explanatory apparatus to be fundamentally different than the one we currently use (that of mind). And it *must* develop a descriptive-explanatory apparatus *if* it is to provide a means for us to justify our behaviours (why we do things the way we do; why we ought to do things the way we do). We still need to give accounts of ourselves, and this will require the re-instantiation of vocabularies regarding the giving and taking of reasons (or some suitable analogue) *if* we are going to understand *not just brain-states, but events and situations*. This is a claim functionalists such as Putnam have long pressed against reductive accounts of

neural states. The only possibility open to eliminative materialism is the development of a novel descriptive-explanatory apparatus based entirely in neurophysiology, with no representations (as schema, as configurations, as concepts) mediating between brain and world, as is currently the case in functionalism. But this remains intuitively implausible, despite the protestations of eliminative materialists to the contrary.

Eliminative materialism must either give up the claim that we can do without representations and re-instantiate at least some of the descriptive-explanatory apparatus of mind, or risk a gamble on the development of an account of justification of human behaviour that relies solely on brain-states, with no intervening representational schemes, concepts, or configurations. If eliminative materialism chooses the former, it is no longer eliminative; if it chooses the latter, not only must it demonstrate an alternative justification mechanism, but almost everything of existing cognitive science, including learning, will have to be re-thought through a mind-less theory and descriptive-explanatory apparatus that re-demonstrates and re-proves what has already been demonstrated and proven. This is an unpalatable undertaking, to be sure.

Prong Three

Now, it may be claimed that those holding the position of eliminative materialism or a strong reductivism are pragmatically in agreement with functionalists such as (later) Dennett and Chalmers, who argue for an evolutionary theory of 'mind-brain.' And this would be correct: Churchland gives no a priori reason why his program is distinct from (later) Dennett's or Chalmers' evolutionary models of 'mind-brain.' Nor does he mean to, for his claim is that there is no metaphysical substrate lying at base of our outward behaviour. He rejects this dualism. He rather claims (on pragmatic grounds) that the neurophysiologic model of explanation is the best model. He also rejects the (monist) tendency to collapse vocabularies and descriptions of folk psychology into vocabularies and descriptions of neural states, through eliminating them. As we have discussed, this poses problems for Churchland; problems regarding the replacements for these vocabularies and descriptions. Setting

that aside, however, it is the case that Churchland wants to avoid the two extremes of dualism and monism.

This suggests that Churchland and evolutionary programs of ‘mind-brain’ such as (later) Dennett’s or Chalmers’ could break bread together. This would, however, be a hasty conclusion. For while evolutionary programs of mind-brain accept the reality of biological phenomena existing on various levels of description (we might think of an agglomeration of proteins before they ultimately coalesce to form genetic material *vs.* organelles which are accumulations of tissues that have a function we discern, *vs.* our intentional stances in understanding these processes), the same cannot be said for eliminative materialism. Eliminative materialism effectively eliminates the possibility of describing the reality of biological phenomena on more than one level—the neural level. Once the evolutionary program brings us to the developed neurophysiological place we are now said to be, it comes to a close. There are no other functional levels (including the evolutionary descriptions and explanations) beyond the neural one: these too are reduced or eliminated in favour of a new set of explanations, descriptions, and vocabulary that is neural-based. Unfortunately, this extinguishes the possibility of making causal claims within or on behalf of the evolutionary program, as Churchland himself does in describing how brains evolve. This effectively cuts him off from drawing on the evolutionary program to explain further features of species’ brain development.

I fail to see how the positions of eliminative materialism and strong reductivism avoid the trap of dogmatism, here. For, while evolutionary programs of mind-brain clearly have built in to them a strong place for various levels of descriptions (proteins, tissues, organelles, organs, organisms, schemas, structures, intentions, communication, social practices, cultural practices, and species (e.g. sociobiology)), it seems neither eliminative materialism nor strong reductivisms can or do. In the zeal to eliminate or otherwise reduce vocabulary, descriptions, and explanations to the level of neural states, they effectively block the possibility of other levels of description—in this case, those beyond the level of brain-organism to include intentions and the role of these in communication and social-cultural practices. This is because the vocabulary we would

need to operate with these levels of description is largely eliminated and/or strongly reduced. (What happens, for example, to Dennett's notion of intentions in the program of eliminative materialism or strong reductivism?) Thus, rhetoric regarding the seeming parity between the functionalist projects of the mind-brain, such as the evolutionary program, and the program of eliminative materialism and strong reductivism, rings hollow.

4.

I have endeavoured to address current quandaries in the debate on the role and scope of the neurosciences and neuroscientific research on questions of causality in respect to mind and specifically, learning. This I have done through an examination of leading programs of reduction and elimination. I claim that it will not do to attempt to reduce and/or otherwise eliminate central features of mind and learning; for these are irreducible and would have to be re-instantiated if a cogent attempt to reduce them or otherwise eliminate them was made. Reductive and eliminative programs of neuroscientific research make the mistake of not returning the brain to the context in which it was found—the event or situation in which human behaviour manifests and to which it responds. They have seemingly forgotten the rule all of us as schoolchildren once learned and practiced—return your playthings to their proper place when finished with them.

Rhetoric notwithstanding, programs of eliminative materialism and strong reductivism have little in common with functionalist models of mind-brain, such as the evolutionary programs of Dennett and Chalmers. Furthermore, the vast majority of neuroscientists and neuroscientific researchers do not subscribe to a facile reductivism or eliminative materialism; they rather attempt to corroborate their results with existing cognitive-psychological findings. My best guess is that, while it may be the case that neurophysiological vocabulary and descriptions become more acceptable to account for the role of brain-states in our outward behaviour, it is extremely unlikely that these could be used to exhaust descriptions or explanations of features of learning because these are irreducible and irreplaceable.

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Summary

It is becoming increasingly clear that the neurosciences play a significant role in educational research, theory and practice. Neuroscientific researchers working in education have, for the most part, avoided strongly reductivist positions (eliminative materialism, reducibility of mental states to neural states). But there are those that do claim a single vocabulary—a neurophysiological vocabulary—will ultimately replace the current cognitive-scientific (functionalist) one. This paper argues against this happening through a three-pronged argument demonstrating the irreducibility of cognitive science (mental states) to neural states. Along the way, this paper discusses certain research findings in neuroscience education, and the controversies these have generated.

Streszczenie

Staje się coraz bardziej jasne, że neurobiologia odgrywa znaczącą rolę w badaniach edukacyjnych, jak i w edukacyjnej teorii i praktyce. Neurobiolodzy pracujący na polu edukacji w większości nie zajmują pozycji silnie redukcjonistycznych (materializm eliminacyjny, sprrowadzanie procesów umysłowych do poziomu zmian neuronalnych). Są jednak i tacy, którzy twierdzą, że tylko jeden rodzaj słownictwa – słownictwo neurofizjologiczne – ostatecznie zastąpi obecne słownictwo kognitywne (funkcjonalistyczne). W powyższym artykule



opowiadam się przeciwko takiemu stanowisku, demonstrując trojąką argumentację, wykazującą nieredukowalność nauk o umyśle (procesów umysłowych) do procesów neuronalnych. Poza tym omawiam również niektóre odkrycia w sferze kształcenia neurobiologicznego oraz wynikające z niego kontrowersje.

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