This article explores how Dewey’s pragmatism could help build a framework enabling us to practically apply research in the cognitive and neurosciences to architectural practice.

John Dewey and the dialogue between architecture and neuroscience

Sarah Robinson

‘Everything changes according to the interacting field it enters.’ – John Dewey, Art as Experience

Many observers have suggested that we are in the midst of a revolution in the cognitive and neurosciences that is as significant as the Galilean revolution in physics and the Darwinian revolution in biology. This revolution has been precipitated by the work undertaken in more than twenty-five different disciplines – some key contributions have been made by classical disciplines such as philosophy, and others by those that are emerging, such as neurophenomenology – together they are working to expand, corroborate, falsify, and refine each others’ findings. Indeed, the study of the human mind and body, the ultimate subject of this research, cannot be anything other than an interdisciplinary pursuit. Over the course of the last three decades, the foundations on which Western culture has been built are creaking under the weight of their collective work. In this post-Kuhnian landscape, no-one unwilling to transform their practice will survive this paradigmatic shift. Research programmes in both the sciences and the humanities have been scrapped and redirected; new programmes are forming, those now obsolete are dissolving; yet we architects seem curiously unmoved by these events. The once healthy heterogeneity of our architectural theories have ill-prepared us to deal with such developments, and we have been thrust into the mandate for sustainability without a coherent theoretical framework.

‘[...] the urgent call for sustainability demands going beyond merely technological solutions to modify behavioural patterns, cultural habits and even our deeply ingrained ideas about ourselves.’

How neuroscience is relevant to architectural theory and practice

Architecture has always been a hybrid profession – as much an art as a science, poised between nature and culture, we promiscuously integrate the achievements of diverse disciplines into our work. Not immune to the winds of fashion, we appropriate trends in other fields, regardless of their inherent relevance to their architectural consequences. It is this very vulnerability, the fact that we must serve two masters, that we are at once called to embody cultural and psychic aspirations while keeping out the rain, that holds the potential to be our greatest strength. This is not a criticism of a necessary and vital plurality, but rather a wake-up call to restate our theories in the common soil of our evolutionary human past. In our searching for the next new thing, we have forgotten that our original task is ‘to facilitate (human) homecoming’, as Aldo Van Eyck reminds us. The findings and implications of the biological sciences, and particularly the

doi:10.1017/S1359135515000627

‘The findings and implications of [...] the neurosciences can renew our thinking – the essential precursor to reorienting our practice to more generative, sustainable ends.’

neurosciences can renew our thinking – the essential precursor to reorienting our practice to more generative, sustainable ends.

“We have learned more about our biological selves in the last 30 years, than we have in the last three hundred,” writes Harry Francis Mallgrave. This new knowledge has blurred the categories of culture and nature, without reducing the unique forces of the former to that of the latter. More so than other professions, we are situated at the threshold of these new developments; capitalising on this position could elevate our status, empower our practice, and dignify our work. Integrating this knowledge can provide us with new practical and theoretical tools and principles for design that are biologically, culturally, and psychologically sustainable.

For over a decade, a conversation has been taking place between architecture and neuroscience. The Academy of Neuroscience for Architecture in San Diego has almost single-handedly directed that discourse, yet recently the relevance of the subject seems to be finding a larger audience. The past few years alone have seen a handful of conferences dedicated to the interchange, and surely more will follow. Neuroscience has already amassed much research that could be applied to architectural practice, and new studies directed to architectural experience are only now beginning to be conducted. Yet, in these early stages, the existing research is overwhelming, and the experiments taking place seem scattered and distant from one another.

Further, the language used in scientific papers and the reductionist methodology of science is alienating to many architects – while the architect’s role as a generalist frustrates the neuroscientist who must, by necessity, narrow their field of inquiry. Developing a shared philosophical framework could at once order the existing work, contribute to directing future research, and render that research more readily amenable to immediate application. As one of the original pragmatists, John Dewey’s philosophy was intended for practical application, one of the many reasons that his work could contribute to building such a framework.

Why the work of John Dewey is important for cognitive and neuroscience

For John Dewey, theory and practice were not ontologically separate domains, but two distinct yet inseparable aspects of engaging in the world. Theory informs practice, and practice reshapes theory, enriching and refining one another in a reflexive loop. Which is perhaps why Dewey influenced more fields outside of his own than any other philosopher of his time. “This fact alone tells us something about the relevance of his thinking, and his success in restoring philosophy to its original mission – which is not the surveillance of the human condition from an ivory tower, conveniently removed from the untidy details of daily life – but the intelligent direction of a life worth living.” Alfred North Whitehead classed John Dewey with the ancient stoics, St Augustine, Aquinas, Bacon and Locke, for his success in directing philosophical inquiry to contemporary needs and purposes. Grounded in the best biology of his time, Dewey published works in psychology, sociology, medicine, pedagogy, and aesthetics. His experimental approach prefigured modern neuroscience and he arrived at many of its key operational principles without the benefit of advanced technology. He acknowledged the edifying role of artistic and architectural experience and particularly advocated the formative role of the latter. Furthermore, his philosophy was always socially oriented – and emphasised how language and culture were socially distributed. Though pragmatism never made it to the centre of mainstream philosophy, it broadly impacted the social sciences, making it relevant to contemporary discourse at the intersection of science and culture, that ripe juncture at which architecture is so firmly stationed.

Dewey’s work needs to be understood in the broader context of pragmatism, a philosophical movement that is now enjoying a renaissance. Numerous major contemporary philosophers – Richard Rorty, Hillary Putnam, and Susan Haack among them – identify themselves within the lineage of pragmatism. And, it is now widely recognised that the pragmatists prevailed in every major issue on which they disagreed with the positivists. Dewey is finally gaining the recognition that Joseph Brodsky attributed to the classics; posterity is granting him the readership he deserved in the first place. Through his empirically informed philosophical reasoning, Dewey arrived at many of the same conclusions that the cognitive sciences are only beginning to discover. We would be wise to take our cue from those in neuroscience related disciplines who have found a rich resource in his work.

‘Mind is a Verb’ – John Dewey and dynamic systems theory

The full import of Dewey’s work is only beginning to be recognised, one of his many distinctions was to not only dismantle behaviourism but to usher in its successor. As one of his strongest advocates, the philosopher and dynamic systems theorist, W. Ted Rockwell writes, ‘If Dewey had been your ordinary run-of-the mill prophetetic genius, he would have used his classic 1896 article, “The Reflex Arc Concept in Psychology” to predict the downfall of behaviourism and the rise of cognitive psychology almost a century later.’ Rockwell goes on to say that, ‘What makes Dewey’s insights interesting today is that modern cognitive science has discovered plenty of indicators that these insights are not only true, but significant...
enough that those who wish to really understand the mind ignore them at their own peril.\textsuperscript{15}

In this article I use the terms cognitive science and neuroscience interchangeably, though they are distinct disciplines that approach their shared subject using different methods. Neuroscience is a subdiscipline of neurology, a branch of biology that studies the anatomy and physiology of the nervous system. Cognitive science is a branch of psychology, concerned with the study of human thought and cognition. The advent of fMRI allowed cognitive scientists to substantiate their ‘soft’ science of mind with the ‘hard’ biological facts of brain function. At the same time, fMRI made it possible for neuroscientists, who formerly conducted their experiments on ‘lower animals’, to perform experiments on human subjects. The technology opened the way for a convergence between the two disciplines – and that convergence has made the rapid advances in our understanding of the human mind possible. The general consensus is that expressions or manifestations of mind: language, decision-making, and ultimately consciousness itself cannot be understood apart from their biological underpinning.

Over the last decade, dynamic systems theory, or DST, has emerged as a promising paradigm for understanding and researching the mind. DST does not locate the mind inside the cranium, or reduce behaviour to the neural functions for which it has been programmed, but rather understands mind as the pattern that emerges when a living body interacts in the world. The mind is irreducible to an organ, and is understood instead as a ‘system of tensions’. A theory of mind, therefore, cannot only be a biological summation, but must be a theory of full-bodied human beings interacting in their environments. In this rendering, mind shifts from preoccupation with the cortex, to an effort to understand the meaningful intimate, cultural, social and ecological relationships of the living self-interacting in the world. In looking beyond the cranium for the mind, we turn our attention to our complex relationships with our environments – environments that we have largely built for ourselves.

\textit{‘A theory of mind, therefore, cannot only be a biological summation, but must be a theory of full-bodied human beings interacting in their environments.’}

Dynamic systems theorists differ from their predecessors because they study cognitive systems in terms of processes rather than atomic units. In their influential 1995 anthology on DST entitled \textit{Mind as Motion}, Robert F. Port and Timothy Van Gelder argue that a dynamic system is not digital, it does not consist of atomic bits, but is fundamentally analogue, that is, composed of moments within a flux.\textsuperscript{16} Similarly, Dewey understood the mind as a process continuous with the rest of nature, calling the mind a verb.\textsuperscript{17} Port and Van Gelder’s title is a sympathetic homage to Dewey’s understanding of natural processes; and his philosophy contains the modern principles of DST in embryonic terms. In describing physical processes, Dewey wrote, ‘There is nothing which can be set off as a stimulus, nothing which reacts, nothing which is response. There is just a change in the system of tensions.’\textsuperscript{18} Again, this understanding is an accurate description of experience as advanced by modern neuroscience. Both admit that experience is shaped by contextual factors – our emotions, our intentions, our history, and our goals. Dewey understood reality to be a continuity; problems arise when we artificially divide that continuity into absolute dualities – mind and matter, stimulus and response, method and subject matter, centre and periphery – all are moments in a flux, whose character is defined by their relationships within that flux.

Another key text, \textit{Mind in Life}, by the philosopher Evan Thompson with neuroscientist Francisco Varela, outlines the enactive approach to cognitive science. Enactivism, as it also called, combines DST with embodied cognition, understanding mind as a non-linear, dynamic, temporal, embodied system that is in turn embedded in other systems. At the heart of enactivism is an affirmation of ‘the deep continuity between mind and life.’\textsuperscript{19} Rejecting the notion of mechanical atomism that focuses on cognition as the linear assembly of parts, enactivism focuses instead on the external and internal forces that shape trajectories as they unfold in time. This temporal, developmental dimension of cognitive systems is fundamental to their approach. They describe stimuli as ‘perturbations to the system’s intrinsic dynamics, rather than as instructions to be followed, and describe internal states as self-organised compensations triggered by those perturbations, rather than as representations of external states of affairs’. Causality here is neither linear nor mechanical, but triggered by conditions that activate probabilistic outcomes. Not only does Dewey’s philosophy contain the core principles of DST, but in its emphasis on continuity, emergence, and the historical character of individual experience, contains the basis for DST’s enactivist refinement, as well.

\textbf{Dewey’s continuity principle}

Coming into the discipline of neuroscience from architecture, one is struck by a similar feeling to the one Dewey recounts in \textit{Experience and Nature}, that: \textquoteleft\textquoteleft […] those who talk most of the organism, physiologists, psychologists, are just those who display the least sense of the intimate, delicate and subtle interdependence of all organic structures and processes with one another. The world seems mad in preoccupation with what is specific, particular, disconnected in medicine, politics, science, industry, education […] recovery of sanity depends on seeing and using these specifiable things as links functionally significant in a process. To see the organism in nature, the nervous system in the organism, the brain in the nervous system, the cortex in
the brain is the answer to the problems which haunt philosophy. And when thus seen they will be seen to be in, not as marbles are in a box but as events are in history, in a moving, growing, never finished process. In this passage, Dewey clearly frames an alternative vision to the mechanistic reductionism that has characterised so much of Western science on the one hand and the disembodied theoretical treatment of architecture on the other. A careful consideration of this directive could help to steer the course of future inquiry towards more fruitful and collaborative ends.

The restoration of context
Dewey asks us first to understand the organism in nature. This seems obvious enough, but needs to be restated because traditional theories have separated human life from nature and mind from organic life. We have evolved to flourish in a world that fits us. The often-used word ‘fitness’ means exactly that – that we are adapted and tuned to the world in which we live and operate. We then tune and adapt that world to fit us, in a reciprocating, reflexive cycle. Our perceptual systems evolved within the limits and affordances of the natural world. A paper authored by The Natural Environments Initiative, an interdisciplinary group directed by the Harvard School of Public Health, synthesises the vast amount of recent research confirming the salutogenic effects of natural settings. People who live in surroundings with more green space have consistently lower incidences of depression and anxiety, asthma and chronic obstructive pulmonary disease, diabetes, and coronary heart disease. The researchers conclude, ‘Given that natural environments within urban settings support health through increased opportunities for exercise, stress-reduction, and social cohesion, they are a critical component in the design and development of future healthy, resilient cities.’

While the benefits of natural settings, such as those cited in the research noted above is amply documented, we know very little about the features of the built environment that support, enhance, or erode the inseparable dimensions of mental and physical health. These are questions of critical importance since according to the US Environmental Protection Agency, Americans spend 90% of their time indoors, reflecting a broad trend in developed nations. This shift to increased time spent indoors correlates with well-documented generational increases in depression, anxiety, and behavioural disorders that have taken place most noticeably over the last ten to fifteen years. The Harvard paper notes that these declines in mental health ‘have been occurring in concert with generational increases in narcissism, and marked declines in empathy, concern for others, and perspective-taking.’ With some notable exceptions, studies of the built environment have focused on indoor air-quality and pollution, rather than on the more difficult to quantify emotional factors that, if understood, could ameliorate the psychic degradation that coincides with the transition to more time spent indoors. Given the increasing pressures of rapid urbanisation – the forecast that within the next few decades 86% of those who live in developed nations and 67% of those in developing nations will likely live in cities, for a projected total of 1.35 billion new urban residents by 2030, it would seem that such studies are long overdue. Advancing this area of research will require broad-based transdisciplinary, cross-cultural collaboration and translation.

Restoring body to mind
Once we have restituted ourselves in our environment, Dewey asks us to understand the nervous system in the organism. An electrically charged network of astonishing complexity, the nervous system extends throughout our entire body and functions to orient us to our environment. The brain is in the nervous system and the cortex is in the brain. Cortex comes from the word for husk or shell, it indicates the uppermost part of the encephalon. It may be the most recent addition to the human nervous system, but that does not make it the most important. The brain belongs to the whole of the nervous system and cannot be understood apart from it, nor can it be understood apart from the environment in which the organism interacts. These specified ‘parts’ are nested within and inseparable from one another; the notion of parts being a heuristic that permits closer analysis. Further, we must bear in mind that the cargo gleaned from such analyses are not ends in themselves but links whose significance can only be understood in terms of their function in a larger, integrated, ongoing, historic process.

‘Because the structures of our body-mind developed according to the structures of the world in which we exist, we naturally find some structures harmonious and others less so.’

Dewey, who was profoundly influenced by both Charles Darwin and William James, continually stressed the complex evolutionary nature of the organism in its context. Because the structures of our body-mind developed according to the structures of the world in which we exist, we naturally find some structures harmonious and others less so. Since mind cannot evolve except where there is an organized process in which the fulfilments of the past are conserved and employed, it is not surprising that when mind evolves it should be mindful of the past and future, and that it should use the structures which are biological adaptations of organism and environment as its own and only organs. In ultimate analysis the mystery that mind should use a body, or that a body should have a mind, is like the mystery that a man cultivating plants should use the soil; or that the soil which grows plants at all should grow those adapted to its own physico-chemical properties and relations. This passage beautifully portrays the manner in which Dewey understood the body-mind to be continuous with the rest of nature. To elaborate on
‘Understanding the mind as an organic process that is structured, modulated and conditioned by environmental factors, certainly raises the stakes for architects.’

his metaphor of the soil, he understood the body, like the soil, to designate that which is continued and conserved, the nexus of animate and inanimate factors that typify the natural world; while mind designates the character of differential consequences, or the ‘system of tensions’ to which that organic substrate gives rise. The mind indicates ‘features which emerge when “body” is engaged in a wider, more complex, and interdependent situation’. Here is the very definition of mind that dynamic systems theorists and enactivists have converged upon. The pursuit to locate the ‘seat’ of the mind in the brain is the consequence of thinking of the organism as merely a static structure. Dewey insisted instead that the organism is a characteristic way of interacting, a way that would not be possible without structures for its functioning, but one that differs from its structure as, ‘walking differs from legs or breathing from lungs’. The nervous system is not the locus of an idea, but the structure that facilitates and enables ‘the connection and integration of acts’.

Of course the implications of restoring body to mind in the way that Dewey prescribes has significant implications for architectural practice. Understanding the mind as an organic process that is structured, modulated, and conditioned by environmental factors, certainly raises the stakes for architects. The psychologist David Sbarra, who has studied disruptive attachment in the context of divorce has found that those children who adjust more readily tend to have stable, comforting physical environments. He suggests that physical spaces can assume supportive emotional roles, essentially offloading the energetic burden of traumatic situations. Here, the dwelling is an active agent in an individual’s health and well-being. Similarly, the cognitive scientist and philosopher Alva Noë compares cities and urban layouts to mneumonic systems, that function to distribute our long-term memory, and concretise our daily habitual patterns into effortless, unconscious background features, freeing up our cognitive load for more pressing concerns.

Dewey’s emergentism and biocultural historicity

Finally, once we have restored body to mind and the organism to its environment, Dewey asks us to consider both as evolving, interdependent members dwelling within a dynamic, open-ended process. To restate his earlier words, we are thus seen ‘to be in, not as marbles are in a box but as events are in history, in a moving, growing, never finished process’.

Actualisation of potential is open-ended, contingent upon circumstances, and can only be understood as the consequence of interactions in the world. In this interpretation, it is not necessary to arbitrarily introduce chance in the world to account for indeterminacy and uncertainty – instead we acknowledge that individuality exists and that time is real. The two are interdependent and mutually arising: ‘The mystery of time is thus the existence of real individuals’, he wrote.

Our individuality emerges from and is shaped by our encounters in the world. In the same way that individuality emerges from myriad environmental and biological factors, so do higher order systems arise from lower level forms of order. Emergence exemplifies how a higher order is founded upon and subsumes a lower order, while simultaneously integrating new structures that cannot be explained by those that underlay it. Increasing levels of organic complexity exclude the possibility of being reduced to one identical type and cannot be parcelled into autonomous, self-existing categories. Emergence is an organisational and functional feature of continuity.

Neuroscience corroborates this Deweyian view of emergence: Consider the manner in which the brain is organised; newly-evolved regions build upon older regions and integrate their functioning – so while brain regions may be functionally distinctive, they are in no way separate, nor can they be unravelled or understood apart from their evolutionary antecedents. Our ancient limbic system, for example, was long considered to be the seat of emotion, but in
his comprehensive survey of the literature on brain regions traditionally associated with emotion and those for cognition, the neuroscientist Luiz Pessoa concluded that, ‘parceling the brain into cognitive and affective regions is inherently problematic and ultimately untenable’. Emotion and cognition are interdependent dimensions of behaviour that result from the activity of multiple brain regions that are neither intrinsically emotional nor cognitive, but contribute to behaviour in distinct ways depending on the broader neural context in which they participate.

Further, Dewey understood the brain’s inherent plasticity and observed that, ‘use reshapes the prior materials so as to adapt them more freely and efficiently to the uses to which they are put. [It] is not a problem to be solved: it is an expression of the common fact that anything changes according to the interacting field it enters’. Indeed, architects organise and create the field that gives rise to culture, education, and individuality. Such fields serve to enable some behaviours while impoverishing others, sedimenting and reinforcing habit patterns and providing the framework for the accretion of culture. Education was a central concern for Dewey because it structures habit formation. Dewey empirically observed that, ‘habit-forming wears grooves; behaviour is confined to channels established by prior behaviour’. Which is an early statement of Hebb’s Law, commonly described as neurons that fire together, wire together.

Further, we know that critical time windows exist in human development and if certain skills or aptitudes are not actualised within those time frames, irreparable damage results. Again, potential does not passively unfold but must reach into the environment and circumstances for its fruition. Because the continuity principle presupposed these basic operational principles of neuroscience, and neuroscience has in turn provided the continuity principle with further empirical validation, it provides a model for understanding the way in which humans are moulded by, and actualised within their environmental contexts; while the notion of emergence obviates the need for reductionist-determinist explanations of that complex process.

**Charting a future course**

The elaboration of Dewey’s continuity principle can help us in charting a course for future research and dialogue. First we need to reaffirm that naturalism is assumed: mind and nature are continuous. As stated earlier, ample studies confirm that views toward nature reduce stress in urban settings and classroom situations and increase healing in hospitals – very few analyse the particular features which elicit these effects – is it colour, sound, texture, movement, organisational structure and if so, in what combination? Paying attention to the natural history of our sensory systems is critical to sound design. The evolutionary, adaptive nature of our sensory systems should inform our basic hypotheses about the kinds of design interventions that are more likely to have beneficial effects. For example, the neuroscientist Tom Albright has pointed out that ‘selective pressures over the course of human evolution have yielded a visual brain that has highly specific and tunable organizational properties for representing key statistics of the environment such as commonly occurring features and conjunctions of features’. In particular he refers to Hubel and Weisel’s work on orientation selectivity, relating our preference for vertical lines to the architectural prevalence and popularity of columnar arcades and cable stay bridges. Certain visual patterns yield a sense of order because they tap into the neuronal substrates that adapted according to features in the environment. The ecologist Paul Shepard made a similar suggestion when he attributed the emotionally calming effect of trees and forest settings, to the arboreal origins of early humans.

‘The elaboration of Dewey’s continuity principle can help us in charting a course for future research and dialogue.’

Further, affirming that individuality emerges from interpenetrating social, cultural, and natural contexts means that we must consider architecture not as an inert array of objects and surfaces but rather as bounded, supportive, developmental fields. Neuroscience can help by identifying features of those qualitative fields with which we interact mentally and emotionally. The emergence of human individuality from the flow of natural time should be a cause for the celebration of time’s passage. Buildings can move and be moving, tracing the passage of time in a poetic mirroring of the human condition.

The embodied nature of architectural experience and design should cause us to rethink architectural education. Disembodied learning only compounds divisive anachronisms. Perhaps it is time to revive the apprenticeship model that was the predominant method for imparting professional skill in architecture until recent times. And finally, we must accept our ethical mandate. Again – our fundamental task has always been to house the body-mind. The interwoven systems that comprise our body evolved to adapt with the systems in the rest of the natural world. This means that our buildings must not only respond to the constraints and opportunities of the given context – site, programme, and budget, but also to the limits and affordances of our perceptual systems and the whole of our physiology. This is where neuroscience can truly fertilise architectural thinking and practice, by revealing the complex, intricate, overlapping functioning of our sensorimotor systems, by deepening our understanding of how our nervous system binds us to our world, and showing how that world doubles back to shape us.
Notes


3. For a more in-depth treatment of this argument, see: Robinson, Nesting: Body, Dwelling, Mind.


12. Rockwell, Neither Brain nor Ghost, p. 22.

13. Ibid.


16. As quoted in Rockwell, Neither Brain nor Ghost, p. 22.


20. Ibid., p. 7.


24. Ibid.

25. Ibid.

26. Ibid., p. 6.


28. Ibid., p. 283.

29. Ibid.

30. Ibid.


34. Ibid., p. 285.


38. Ibid., p. 99.


40. Ibid., p. 280.

41. Harvard study, p. 22.

42. Tom Albright in Robinson and Pallasmaa, Mind in Architecture, p. 215.


Author’s biography
Sarah Robinson is a practicing architect who earned degrees in Philosophy at the University of Wisconsin-Madison and the University of Fribourg in Switzerland before attending the Frank Lloyd Wright School of Architecture, where she later served as the founding chair of the Board of Trustees. She is the author of Nesting: Body, Dwelling, Mind (William Stout Publishers, 2011) and Mind in Architecture: Neuroscience, Embodiment and the Future of Design, with Juhani Pallasmaa (MIT Press, 2015), as well as numerous literary and academic essays. She lives in Pavia, Italy.

Author’s address
Sarah Robinson
sarah@sraehitect.com
International Journal of Cultural Property

Published for the International Cultural Property Society

Editor
Alexander A. Bauer, Queens College, CUNY, USA

International Journal of Cultural Property provides a vital, international, and multidisciplinary forum for the broad spectrum of views surrounding cultural property, cultural heritage, and related issues. Its mission is to develop new ways of dealing with cultural property debates, to be a venue for the proposal or enumeration of pragmatic policy suggestions, and to be accessible to a wide audience of professionals, academics, and lay readers. This peer-reviewed journal publishes original research papers, case notes, documents of record, chronicles, conference reports, and book reviews. Contributions come from the wide variety of fields implicated in the debates -- law, anthropology, public policy, archaeology, art history, preservation, ethics, economics, museum-, tourism-, and heritage studies -- and from a variety of perspectives and interests -- indigenous, Western, and non-Western; academic, professional and amateur; consumers and producers -- to promote meaningful discussion of the complexities, competing values, and other concerns that form the environment within which these disputes exist.

To subscribe contact
Customer Services
in Cambridge:
Phone +44 (0)1223 326070
Fax +44 (0)1223 325150
Email journals@cambridge.org

in New York:
Phone (845) 353 7500
Fax (845) 353 4141
Email subscriptions_newyork@cambridge.org

Free email alerts
Keep up-to-date with new material – sign up at journals.cambridge.org/register

For free online content visit:
http://journals.cambridge.org/jcp
Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.