Adapted from: *Review of General Psychology*, Vol. 17, no. 2, 2013. DOI: 10.1037/a0032935.
https://doi.org/10.1037/a0032935.

Enaction and Psychology

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The enactive approach to cognitive science aims to provide an account of the mind that is both naturalistic and nonreductive. Psychological activity is viewed not as occurring within the individual organism but in the engagement between the motivated autonomous agent and their context (including their social context). The approach has been developing within the fields of philosophy, artificial life, and computational biology for the past two decades and is now growing within the domain of psychology more generally. In this short paper we outline the conceptual framework of the enactive approach. Illustrative research questions and methods for investigation are also broached, including some existing examples from theoretical, behavioral, and computational modeling research. It is suggested that an enactive psychology provides the basis for the conceptual framework of the enactive approach.

Keywords: enactive approach, enaction, unifying psychology, theory of psychology, perception-action systems

Adapted from: *Review of General Psychology*, Vol. 17, no. 2, 2013. DOI: 10.1037/a0032935.
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The enactive approach to understanding the mind is a nonreductive, naturalistic approach which uses a range of conceptual and empirical tools to study psychological processes as dynamic and embedded interactions between autonomous agents and their environment.

That is, the mind is seen not as inhering in the individual, but as emerging, existing dynamically in the relationship between organisms and their surroundings (including other agents). This and other enactive ideas were initially articulated in what is now

considered the launching text for the enactive approach: *The Embodied Mind*, by Francisco Varela, Evan Thompson, and Eleanor Rosch (Varela, Thompson, & Rosch, 1991). The last decade has seen some significant development of these notions (Thompson, 2004, 2007; Di Paolo, 2005, 2009; Di Paolo, Rohde, & De Jaegher, 2010). The core observation driving enactive thinking is succinctly described by the philosopher Merleau-Ponty: The world is inseparable from the subject, but from a subject which is nothing but a project of the world, and the subject is inseparable from the world, but from a world which the subject itself projects. (Merleau-Ponty, 1962, p. 430)

Some analogies may help illustrate this basic idea.

A handshake does not exist except during its enaction. You don't carry a handshake around in your pocket, or tucked up your sleeve, fully formed and ready to deploy at a moment's notice. For enactive psychology, the same is true of your cognitive system—it is intrinsically relational and dynamic in nature.

A second, deeper, analogy is that of a dance. A dance carries on only while the dancers continue to act, and is defined by the coordination, the mutual sensitivity, and reciprocal influence between the dancers and the music. From an enactive perspective psychological activity is just such a dynamically constituted process, and, like a dance, or a handshake, should be studied and understood in dynamic, contextualized terms.

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The enactive approach thus contrasts sharply with traditional cognitivism, and other forms of functionalism that conceive of cognition mainly as information processing over internal representations. In its place it offers a theory of the mind that grounds central concepts (such as action, sense, and agency) in the autonomous organization of living organisms and in their value-laden, meaningful engagements with their environments.

In this short paper we briefly outline the core framework of an enactive psychology, give some examples of current and classic research relevant to the approach, and frame some of the many important questions with which enactive researchers are currently engaged. Enactivists have been concerned with a range of different aspects of the mind: its continuity with living processes, approaches to the self, to the role of the brain, sense-making, habits, experience, affect, social processes, language, and normativity (see, e.g., the various chapters in Stewart, Gapenne, & Di Paolo, 2010). Here we consider the potential relevance of the enactive take on these ideas for psychology.

We begin by exploring the idea of the *engagement*, the dynamic interaction between the agent and the environment that is at the heart of enactive thinking. This will outline the framework that structures and guides the enactive approach, that psychological activity is inherently contextualised.

We look at the many mutually influencing facets of the psychological engagement—primarily the physical and social. Using this array of factors we outline how enactive thinking is not relegated, as some critics suggest, to the “lower” or more basic forms of cognition. We unpack this idea in terms of the still ill-disciplined concept of *skill*. Finally, we explore the aspect of the psychological situation in which most psychological research places everything of interest—the *individual agent*. With a few brief comments about the role of the brain and social interactions we conclude that the enactive approach provides a coherent view of the autonomous agent whose psychology exists in the dynamical interaction between agent and

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world. This approach offers the possibility of a genuine and rigorous science of mind that does not reduce the mind, meaning, or experience to mechanical processes or attempt to explain them away as “merely” biological phenomena.

The Cognitive Engagement: Coupling Agent and Environment

Psychological activity, cognition generally considered, occurs as an agent copes with or makes sense of its environment. Such coping is not generic—actions are specific to a given situation. Even if similarities exist, actions still happen at particular times, and each action has a particular history and particular details. Any example of sense-making that we might care to circumscribe and examine unavoidably involves both a specific agent and situation.

Understanding context and situations on their own terms, rather than as things that modulate or inflect pregiven psychological processes, means that an enactive psychology is more interested in the dynamics of coupling between an agent and its environment than the stipulation of the characteristics of either. The idea of coupling is quite simply the mutual influence between the agent and the environment from which emerges the meaningful behaviour into which we are seeking insight. A well-known dynamical systems definition (in terms of mutual influences between variables and parameters of the coupled systems) makes coupling an operational, empirically observable phenomenon (Beer, 1995; Kelso, 1995, 2009; Saltzman, 1995).

In trying to understand coupling, enactive researchers examine the perception_action loop as involving the coupling (and hence dynamical modulation) between brain, body, tools, objects, other people, and context in general. Our actions involve an exploration of the environment as much as they are an attempt to change it; our perceptions are about acting in tune with the world as much as they are about tracking or identifying it. Much of the recent work on

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sensorimotor bases for perception (e.g., O'Regan & Noë, 2001a, 2001b; Auvray, Hanneton, & O'Regan, 2007; Proulx, Stoerig, Ludowig, Knoll, & Auvray, 2008) is encompassed by an enactive perspective, as are many classic studies highlighting this interdependence between perception and action and exploring its nature (e.g., Harris, 1965; Held & Hein, 1963; Kohler, 1964; Taylor, 1962).

The broad research question here concerns how agents and their environments can be coupled, what affects that coupling, and what that tells us about the emergence and unfolding of a cognitive and affective engagement—how situations come to be, what their development involves, and what this entails for the agent.

There are a number of methodological toolkits available for such research. Frequently used are various computational modelling techniques (particularly that of evolutionary robotics) (Beer, 2003; Harvey, Di Paolo, Wood, Quinn, & Tuci, 2005). Such modeling techniques allow us to explore the parameter space of coupling between agent and environment, while providing proof of concept of the constitutive role that embodiment plays in psychological activity. These models offer us one means of simplifying the emergence of contexts and situations to the point that their basic principles (the universals, if such there are, of enactive psychology) can be brought clearly into view. The value of these models is that they can both help clarify the complex dynamical relations that make up a particular cognitive performance (such as learning or categorization, see, e.g., Beer, 2003 or readaptation to inversion or prismatic distortions of the visual field, Di Paolo, 2000). They can also speak to specific empirical situations and generate predictions, for instance, in social interaction experiments (Di Paolo, Rohde, & Iizuka, 2008; Froese, Lenay, & Ikegami, 2012), in the explanation of linear synergies in pointing movement (Rohde & Di Paolo, 2005), or dynamical models of plasticity in the A-not-B error (Wood & Di Paolo, 2007).

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There is also much empirical work examining the relationship between different forms of coupling and people's behavior and experience. Building on classic work in areas such as sensory substitution (coupling a person to their world in non-standard ways such as by blindfolding them and linking head-mounted cameras to vibrations on the skin, Bach-y-Rita, 1972; see also Auvray & Myin, 2009, for a useful review) enactive researchers have explored what kinds of interaction enable people to make sense of the world in different ways, sometimes bringing certain sensory modalities (tactile or auditory) to play perceptual roles belonging to others (e.g., visual) thanks to the voluntary modulation of action by the agent. For example, Auvray, Lenay, and Stewart (2009) use a minimalist setting—a single point of pressure on the skin in response to the movement of a mouse along a single line—to examine the patterns of a person's actions and perceptions in a simplified space, but this study also reveals how the dynamics of their actions, and in particular of their interactions with other participants in the same simplified space, allows them to make sense of their environment and solve basic problems. These studies on different kinds of coupling illustrate one of the core ideas of enactive thinking – that situations are meaningful for the agent. The process of coordinating and adapting to various constraints on our actions is a process of sense-making. Sense-making involves coordinating the needs of the agent (biological, affective/cognitive, social) with environmental factors (either facilitating or hindering). For enactivism, sense-making is intimately related to the agent's autonomy at various levels, such as that of living processes of material self-construction. The needs and demands for the continuation of a precarious form of life both literally, in terms of biological needs, and metaphorically, in terms of sustaining a psychological and a social autonomous identity explain why agents have a meaningful perspective on their interactions with the environment, why things matter to them (Di Paolo, 2005, 2009, Di Paolo et al., 2010, Thompson, 2007). In these terms,

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enactivism offers an approach to naturalizing notions such as meaning, value, significance and normativity, in ways that can still be examined using dynamical systems tools.

Dynamical systems theory makes available a generic set of tools that can provide significant insights into coordinative dynamics. Though not explicitly enactivist in his thinking, the coordinative dynamics of Scott Kelso provides us with a host of useful dynamical tools for examining the mechanics of engagement. Kelso’s work (see Kelso, 1995, 2009, for an overview) shows how the dynamics of a situation are emergent, and rarely if ever controlled by either the person or their surround. Kelso examines how patterns in behavior are best understood in terms of mutually constraining interactions and the evolution of emergent state spaces in the system based on the intrinsic dynamics in both the agent and its environment. These dynamical characterizations may be translated into empirical tools to measure concepts such as the fluidity of the coupling, whether the behavior is skillful, or whether there are breakdowns. For instance, Van Orden, Holden, and Turvey (2005) have studied long-range dynamical correlations under stochastic conditions to measure the overall quality of the coupling. In this way it is also possible to say whether one of the systems (the agent or the environment) is driving the other or neither is.

In a similar vein, Fred Cummins’s work on synchronous speech provides a fascinating illustration of this kind of research (Cummins, 2003, 2009, 2010, 2011). Cummins asks two participants to speak in synchrony with one another reading from the same text, a fairly impressive feat of coordination that most people find very easy to do without any practice. Despite near-perfect synchrony, typically speakers are within 40 ms of each other (60 ms at the beginnings of phrases), neither participant drives or controls the interaction. Though one speaker might be dominant at times, there is never a consistent “leader” or “follower.” The rhythm, pace and even intonation are coordinated by the sensitive coupling of the speakers through the sound of the spoken text—a mutually constituted, reciprocal influence (see

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related findings by Noy, Dekel, & Alon, 2011 on improvised motion). The domain of synchronized speech is largely artificial. Such speech, which is different from choral speech or group recitations, generally only happens because a cognitive scientist has requested it. Nevertheless, it provides one laboratory example in which we might examine how quickly and easily a person can couple with their environment (particularly a social one), and explore the dynamics of such coupling. Periodic forms of coupling are also relevant to our point (there is a plethora of finger tapping studies looking at leader_follower dynamics, e.g., Konvalinka, Vuust, Roepstorff, & Frith, 2011), but aperiodic synchronization presents us with a much more compelling evidence of the central role of coupling in explaining performance since the task has no pregiven or uniform rhythmic markers that can help drive performance internally. The agents must remain constantly engaged and jointly modulate their action or face a breakdown of the action. For instance, an error by one speaker tends to produce the sudden cessation of both as the second participant's speech, entwined with the first, is brought to a juddering halt. Cummins (2011) compares such catastrophic failures with competitors in a three-legged race, where pairs of runners are tied firmly to each other by one leg, and if one stumbles, both will collapse. The coupling in the race is whatever is tying the runners together; in the case of synchronized speech, it is something much less obvious but equally powerful.

Varieties of Coupling: From Lower to Higher Processes

Importantly, the concept of coupling with the world is not bound to low-level physical characteristics of that world. Cummins's work hints at the broader idea that coupling can explain social phenomena. From our earliest days we engage not just with the physical dimensions of our environment, but with the social, affective, and cultural dimensions.

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We act skillfully and perceive directly in social interaction just as we do in physical interaction (De Jaegher, 2009; De Jaegher & Di Paolo, 2007; Di Paolo & De Jaegher, 2012; McGann & De Jaegher, 2009). The kinds of coupling involved are grounded in the same bodies. If cognition is relational, then some of the social interaction patterns that we engage in may even be a constitutive part of cognitive performance (De Jaegher, Di Paolo, & Gallagher, 2010) and they may provide the dynamical link between sociocultural normativity and embodied action (De Jaegher, in press). Compare this massively distributed and dynamical picture with the cognitivist notion that all complex forms of social understanding must be processed solely within the agent's head once it has passed through the appropriate epistemic filters, and that this internal processing is the precondition of successful action. Our embedding in social contexts and social interactions from the very beginning of our lives means that we develop within, and are integrated with, a social world just as completely as any physical world (De Jaegher & Froese, 2009). Attempting to make a firm distinction between the two is bound to fail.

Skill and Complexity

The concept of skill is one that remains problematic but vital to the enactive approach. Intuitively, skills concern efficient, reliable action in a given domain as a result of practice. From an enactive perspective, we see a flexible coupling between an agent and particular facets of the environment such that the agent can act successfully and reliably. This concept is broad, and the notion generic to almost all adaptive behavior for the agent regardless of its simplicity or complexity. The penumbra of the idea of skill allows us to draw continuity between basic sensorimotor capacities and higher-order actions such as playing chess, writing

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a research paper, or having an argument. For an enactivist, the logic and the approach to understanding these different domains of experiences are fundamentally similar.

Research on skill development makes it clear that in learning a skill we do not just stack higher order activity on lower order movements. What we learn changes what we know already (Kelso & Zanone, 2002; Zanone & Kelso, 1992; Zanone, Kelso, & Jeka, 1993; see also Thelen & Smith, 1994), and in any given situation we are not merely reproducing previous patterns of behavior but weaving habitual actions into the details of the present situation (Speelman & Kirsner, 2005; see also Rosenfield's, 1988, general discussion of memory). As we become more skilled our perceptions and actions shift. Our goals and intentions begin to operate in different ways. The logic of the description, however, is the same—we are still talking about a coordination between agent and environment, but now the coupling is of a different sort. The kind of meaning inherent in the activity is transformed, but it is still a valued, meaningful kind of activity, it matters to the agent, though the way in which it matters might vary depending on the form of skill being enacted.

Take the example of the guitar player who as a novice must work to play notes on plucked strings. As she becomes competent she works to play tunes, and as a virtuoso she uses the performance to play the emotions of her audience. The coupling between the skilled and her environment is different from that of the novice, but even the seemingly abstract goals of emotional engagements through musical performance are grounded in specific bodily movements, and those movements are not mechanically produced but judiciously and sensitively so—action is contextualized, and expert engagement integrates and transforms, rather than builds on, novice activity.

This has some counterintuitive implications. It means, for instance, that the virtuoso's engagement with their domain of expertise may have an identical standing in psychological processes as basic perceptual modalities such as vision, hearing, and touch (McGann, 2010).

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There is no principled distinction to be drawn between so-called higher cognition and more basic psychological operations, except as levels of expertise. Similarly, as shown by the selective breakdown of visual habits (Kohler, 1964), what is often treated as a unique perceptual modality is actually a bundle of very distinct skills (recognizing faces, assisting navigation, avoiding danger, interpreting signs, and so on).

Does this then mean that an enactive psychology simply replaces talk of cognitive functions in accounts of the mind with talk of skills? In one sense, yes; skill is a core component of any discussion of an individual's cognitive activity within an enactive view. In another sense, absolutely not; as skills are inherently contextualized and dynamic. They develop through practice in specific contexts and settings, are enacted in particular situations in a manner sensitive to the details of those situations, and, as a result, they can never be localised within the individual agent in the way assumed by more traditional approaches to cognition.

This also has implications for psychopathology. Just as skills and cognitive activity are not conceived as being in the individual, pathologies might not be either. Autism, for instance, might be characterised by a particular way of meaningfully relating to the world, determined by the person and their specific embodiment as much as by his or her (social) environment (De Jaegher, 2013). A person with autism often functions better in some types of situations than in others. It may be just as plausible to characterize the person-environment situations as problematic, describing the engagement or the interaction as "disordered", and not just the individual. The psychiatrist Thomas Fuchs (2005, 2010, Fuchs and De Jaegher, 2009) has argued that schizophrenia should be considered in just this way. Such a change of perspective on psychopathology would of course entail a dramatic shift in the treatment and coping practices associated with psychological disorder.

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Traditionally, psychology has given much privilege to the individual agent, and any approach to psychology must be able to speak about the agent themselves. Given that psychology is so situated, so coupled, so social from the point of view of an enactivist, how should the individual agent be considered?

The Embodied Agent

An enactive view of cognition is an embodied view and to describe any form of cognitive agent is to describe their embodiment. Living bodies are in constant throes of self-production, maintaining themselves by producing more of themselves, running to stand still, as it were. Enactive research has explored how this basic fact grounds the possibility of motivation and action; that the body's needs, in the first instance at least, drives the agent's engagement with their world (Di Paolo, 2005; Thompson, 2007, 2004). Bodies provide the drive, as well as some of the constraints on the interaction. For bodily needs to be met the agent must be able to make sense of its environment. By coordinating its activities with the world around it the agent effectively incorporates the environment into its own on-going behaviour. We have noted at length that this coordination is one that emerges from mutual influence, not one that is dictated or determined by any given element of the agent-environment system. Psychological activity is therefore not localisable, and thus not localised within the body of the agent; the processes of coordination and the structuring of behaviour are system-wide, existing throughout the engagement rather than in any part of it.

The organisation of an agent's activities is a product of the interaction of a myriad of constraints: biological, physical, social, cultural. But the engagement is meaningful for the agent at least partly because of the basic reality of its embodiment – its biological organisation, the continual growth and development that must be maintained if the agent is to

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continue to exist (Di Paolo et al., 2010, Thompson 2007). This idea can be investigated in dynamical systems terms. For instance, using computer models, Barandiaran and Egbert (2013) have explored how biological organisation can be seen to instantiate value and normativity, forming an operational foundation upon which we might build a rigorous conception of meaning for an agent. The development of such a science of meaning would provide us with a description and explanation of cognition that acknowledges what makes it so interesting and special in the world without sacrificing the values of science. It also explains the role of the individual agent within the broader conception of psychology as distributed throughout the wider engagement of agent and world.

Where Is the Brain in All of this?

Within more typical approaches to psychology and cognitive science, psychological processes are located in the brain, or indeed often identified with neural activity. So far, however, we have said nothing about the brain or its role in cognitive activity.

It is probably clear at this point that while the brain is important within the cognitive engagement, it does not hold a position of unique privilege. The brain and the dynamic, plastic organization of neural activity provide means by which the various organs, neural structures, and limbs of the body can be coordinated with each other and with the external world. The brain also provides means by which the coupling between these various elements can develop over time such that coordination between them tends to increase. The brain is an essential part of the dance between agent and environment, but it is no more a determining (as opposed to enabling or constraining) part than any other facet of the situation. Moreover, the brain would not be able to make sense without a body and being embedded in a world, as shown by Cosmelli and Thompson (2010) in their *reductio ad absurdum* of the brain-in-the-

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vat thought experiment. The details of how the brain facilitates the coupling and coordination of disparate elements of the body and world constitute a truly deep question, one that we have begun to examine in earnest relatively recently. A view compatible with enactive ideas has been offered by Fuchs (2011) who conceives of the brain as a "mediating organ," that is, as the mean to manage actual and potential dynamical loops enabled by the current situation, the body, history, and so forth. In line with this view, an enactive neuroscience will be grounded in the neurodynamic work of the likes of Walter Freeman (1991, 1995, 2000), György Buzsáki (2006) and others (Engel et al., 2010; Engel, 2010; Kelso, 2010; Wade, McDaid, Harkin, Crunelli, & Kelso, 2011) as well as a range of explicitly enactivist methods examining the brain within a context of meaning making and experience (Lutz, 2007; Lutz & Thompson, 2003; Varela, 1999).

Key to an enactive neuroscience will be the analysis and understanding of brain development and activity within the context of the engagement—that is that neural function is most interestingly situated not within the skull but within the field of ongoing interactions between the agent and their environment.

This notion has been recently explored in some depth within the domain of social neuroscience by Di Paolo and De Jaegher (2012), who outline the Interactive Brain Hypothesis. This hypothesis states that even in the absence of an actual ongoing social interaction, the skills and experiences developed within social interactions still play an enabling role in sociocognitive performance. What is apparently "off-line" or decontextualized activity is, in fact, still situated within the specific interaction history of the social agent in question. In essence, even the actions of hermits are shaped on a continuous basis by their social engagements (however much it might have been those very social engagements that drove them to become hermits)—a fact long recognized by sociology (e.g., Elias, 1939).

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Looking at the brain in this more contextualized way also enables us to keep the relations between the cognitive agent and their settings in view, and to resist the temptation to reduce psychological activity to neural activity. It is in the relations between the embodied, motivated and skillful autonomous agent and its complex environment that the meaning of the engagement inheres, and to lose sight of that relational description is to lose sight of psychology.

Conclusion: What Does This Buy Us?

Put baldly, an enactive psychology offers a genuine and naturalistic science of meaning. The meaning inherent in a behavior or a situation involves the complex of relations between a cognitive agent and their environment. With an adequate understanding of the ways in which agents and worlds are coupled and of how that coupling forms and transforms over time in a web of dynamics and constraints, a rigorous description of the relations between agent and world—a rich, disciplined and scientific description of situations— can be developed. An enactive psychology thereby promises a psychology that explains the mind without explaining away the mind as “misdescribed biology.” It places within the reach of science concepts such as meaning, intentions, identity, and experience in a form that is recognizable and operational and seeks to develop a science of them that will satisfy rather than leave us feeling victims of a bait-and-switch.

By recognizing the primacy of the interaction, enactive psychology avoids the endless tail-chasing attempts to describe a general or universal cognitive system and then listing all of the ways in which its activity can be altered or modulated by different kinds of particular context. The contextualized nature of cognitive activity is integral to the entire endeavor and offers the

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hope of real progress toward a unified cognitive science, a move away from the disparate patchwork of approaches and partial theories that characterize the discipline at present.

These are grand ambitions that are far from realized in the present state of things. Also, our only certainty in science is that our current view of things is wrong in some very interesting ways. But an enactive psychology gives us a framework in which to develop a satisfying, coherent, and encompassing science of the mind—one with which it is worth engaging.

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