European Network for Social Intelligence

Relevance of wide cognition for social intelligence. Key trends

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1. Wide Accounts of Cognition and Intelligence [300 words max]

By *wide cognition* we mean extended, embodied, enacted, embedded, and distributed cognition, which are related but distinct concepts. In contradistinction to traditional frameworks of cognitive science, they do not explain cognitive phenomena solely with manipulation of (language-like) internal representations but stress the fact that (1) minds can extend into the environment; (2) agents are cognitive insofar as they are embodied; (3) their cognitive scaffolding is enacted, or constructed, in an active fashion; (4) cognitive phenomena are always interactions with the environment; (5) and that cognitive acts are not always but sometimes paradigmatically distributed among multiple agents. There is a growing body of research that is directly relevant for understanding social intelligence, in particular in its reliance on environmental design, bodily interaction, shared cognitive and symbolic tools, and complex schemas of collaboration.

2. Extended Cognition - Robert

In the Western tradition, cognition was understood as an internal process carried out in proprietary representational language, fed by sensory apparatus, largely performed over internal representations and finally used to produce action (Hurley, 2001). Mind was considered quintessentially a private realm. Most traditional theorizing of the mind gives credit for our cognitive abilities almost exclusively to the goings-on in our brains. This outlook has been significantly challenged in recent years in both theoretical and empirical research.

Many of the insights around extended cognition were first developed by the cognitive anthropologist Edwin Hutchins (Hutchins, 1995) in his analysis of the use of artefacts and communications by the crew of a naval war ship. Hutchins' careful analysis of how the sailors got their ship into harbour showed that the crew's use of artefacts, the social organisation of the crew, and even the information processing properties of the various tools and equipment they used could be understood to play as important a role in structuring and shaping the actual cognitive task of piloting and controlling the ship as anything that took place within individual brains. Cognition could in this sense be understood as extended and understanding it implied a wider analysis than the brains of the sailors.

Since this approach has been applied in a variety of settings (e.g. the cockpit of aeroplanes, Jacobean theatre, etc ???). The implications are that real cognitive episodes can be seldom profitably understood in terms of isolated goings-on in brains alone. Instead an analysis of how brains bodies and equipment are deployed in wider interactive settings is required. Although a great deal of theoretical work has been developed in this area their remains great scope to extend the analysis beyond the range of scenarios in which these ideas have been applied.

But if cognition needs to be understood as spread out over brains, instruments and their social organisation, what of the mind itself? Might that too spread and distributed beyond the classically understood bounds of skin and skull? Andy Clark and David Chalmers (1998) suggested that rather than necessarily being a private inner realm, the mind might also stretch beyond bodily boundaries to incorporate a motley of artefacts, tools and perhaps even the brains of other persons. According the thesis of the Extended Mind, artefacts and instruments could – if used in the right ways - be considered actual parts of our minds. Whether artefacts could be profitably so considered would largely turn on their properties and the conditions of their use.

Three criteria were originally proposed to help demarcate which artefacts might count. These were: constancy, (we consult an artefact regularly and unthinkingly when appropriate) facility (we use it with ease), trust and prior endorsement (we treat information retrieved from such resources as though we can implicitly trust it). New generations of very mobile technologies information technologies such as smart phones, tablets and cloud applications, and new patterns of use suggest that an ever more widely used set of technology might meet these criteria. But should widely socially distributed technologies really count as proper parts of our minds? Sterelny (2010) suggested an extra criterion: *entrenchment and personalisation,* which holds that only those technologies that we as individuals seriously customise to our own patterns of own usage should count as proper parts of our minds.

It is not clear that this really helps us to decide how to treat web-resources (such as google maps) that individuals might heavily customize for themselves while the technology itself simultaneously relies on the aggregation of information provided by millions of users in order to work. Much seems to hang here on our intuitions about whether shared resources should ever count as parts of individual minds and thus raise important questions about social ontology: Can minds have as proper parts resources that socially shared, or also count as part of other minds? What are the implications of cognitively incorporating resources which are owned or run in the interests of others? Under the control of external agencies? Or simply products of widely distributed systems that the social web has made possible?

The practical implications of these ideas turn on exactly how and under what circumstances external resources might integrate with internal or biological ones. What properties of cognitive technologies might make them integrable? The framework of *complementarity* (Menary, 2010a; Sutton, 2010) proposes that we tend to integrate tools and artefacts into our cognitive processes when they provide resources which complement our existing biological systems. Much research has been carried out into the implications of these ideas around memory (Michaelian & Sutton, 2013) but much further research is needed to understand which properties of external artefacts, contexts of use, or cultures of usage imply that cognitive technologies really do complement our mental processes. Much popular discussion of related themes has suggested that the practical implications of the cognitive integration of internet resources might be distracting and decentring (Carr, 2010) rather than genuinely cognitively enhancing. Further work into the properties of the sorts of hybrid systems human beings form with our technologies is required to give a principled answer to this sort of challenge.

Such questions imply that research on extended cognition has important ethical (as well as legal and political) implications that have so far scarcely been explored. One example of such questions: If our minds really do incorporate as proper parts technologies owned by others, might deprivation of them count as a sort of enforced cognitive impairment? Such questions might have very important implications for our usage, design and governance of cognitive technologies in the future.

3. Embodied and Grounded Cognition

In the last years the label “embodied cognition” (EC) has become more and more widespread in all areas of cognitive science – from neuroscience to cognitive psychology to cognitive linguistics to philosophy to computer science and robotics. It is starting to penetrate also reflexion on art, anthropology and on gender issues. As recently stated by Lakoff (2012), “It may be hard to think back to a time before the idea of embodied cognition, [but I was raised in that generation].” (p. 1). In a recent paper on the future of psychology, Dendre Gentner (2010) has shown how embodied cognition is slightly eroding parts of the classical studies on knowledge representation (see Figure 5, p. 8).

This success has led in the last 10-15 years to an impressive burst of experimental evidence, in particular in psychology and neuroscience (for reviews, see Barsalou, 2008; Fischer & Zwaan, 2008; Jirak et al., 2010; Toni et al., 2008; Willems & Hagoort, 2007). Recent special issues have been published by the journals Frontiers in Psychology (edited by Borghi & Pecher, 2011) and Topics in Cognitive Science (edited by Davis & Markman, 2012).

The success of the approach has not always lead to terminological precision. The term EC has been used in a variety of contexts and with different connotations (see Goldman & De Vignemont, 2009), and more moderate and more radical embodied positions are present. The unifying aspect of EC theories is the contrast with classical propositional views, according to which experience is transduced in amodal, abstract and arbitrary codes and the mind manipulates abstract symbols. In contrast, according to EC theorists cognition is constrained by our sensorimotor system, by the specific characteristics of our own brain-body system. To reduce the emphasis put on the role of the body, some authors (e.g. Barsalou, 2008; Pezzulo et al., 2011) prefer to use the more general term "grounded cognition", to emphasize the fact that cognition is grounded not only in bodily states, but also in situations, situated simulations, etc. On the neural side, some recent discoveries have given great impulse to EC: it is the case, for example, of studies on how objects are represented in the modal areas of the brain (see Martin, 2007, for a review), and of studies on the canonical and mirror neuron systems.

Many research lines have been promoted. We do not pretend to be exhaustive, but among the most important we would list the research areas on affordances, i.e. on motor activity elicited during observation of objects (affordances), on grounding of concepts and language on the perception, action and emotional systems, on emotions, on intersubjectivity, also thanks to the renewed interest for the mirror neuron system, on the sense of our own body, of the peripersonal space etc.

Obviously EC has not been free from attacks and criticisms, and on some occasions debates have been hot. For example, in a famous paper Mahon and Caramazza (2008) have argued that nobody questions the involvement of the motor system in conceptual and language processing, but this involvement would be only epiphenomenal, and the process of comprehension would not necessarily imply the motor system involvement. In contrast, proponents of EC (at least in its strong version) argue that the involvement of motor system is constitutive of the comprehension process. In the recent years some mixed approaches are emerging, which try to combine a propositional and an embodied approach (e.g., Dove 2009; Chatterije 2010; Louwerse 2011). Among the most debated issues, one is the issue of representation – representational and anti-representational, enactivist approaches coexist (e.g., Gallese & Sinigaglia 2011; Van Elk et al., 2010; Chemero 2009). Another important issue concerns the way in which abstract concepts and words without an object as referent (e.g., truth) are represented. An interesting issue, which hasn't been dealt with enough in psychology and neuroscience, concerns the possible relationship between embodied and extended approaches (e.g., Clark, 2008; Borghi & Cimatti, 2010).

4. Enactive Cognition - Marek

The enactive approach to cognitive science recognises a crucial inter-dependency between an autonomous agent and the world it inhabits. It is essentially impossible for the agent to act without an environment in which to do so, while the environment to which the agent responds and with which it works is precisely those aspects of the world relevant to the agent's goals and needs, and with which its body can interact. Cognitive activity is therefore wholly defined neither by the agent themselves, nor their environment. Rather, it is emergent from their interaction.

This core observation lies at the heart of the enactive approach, and forms the basis for the mode of analysis and understanding in enactive thinking (Di Paolo, De Jaegher & Rohde, 2010; Thompson, 2007).

For enactive theorists, cognition is founded in a system's autonomous organisation (Di Paolo, 2005; Thompson, 2005, 2007; Varela, 1979, 1997; Weber & Varela, 2002), which is to say that the operation of the system's own components give rise to and support their own organisation. This continual process of self-production provides the drive for the system's interaction with its environment, setting out a minimal, simple form of value and normativity for those interactions. Such normative activity, emergent from the system's organisation, is the hallmark of agency for the enactive approach (Weber & Varela, 2002; see also Barandiaran, Di Paolo & Rohde, 2009).

Such autonomous systems are perforce embodied, instantiated in the physical processes that make them up. Their activities – what they are sensitive to, can be affected by, but also of what they are capable – are structured and constrained by that embodiment.
In order to maintain themselves autonomous agents must coordinate their activity with their environment. Opportunities must be taken and constraints or demands met, such that the system maintains its organisation, which will inevitably be precarious, facing constant potential dissolution (Di Paolo, 2005; 2009). In doing so, the relevant aspects of the environment are effectively incorporated into the on-going actions and dynamics of the system. The agent makes sense of its environment (Di Paolo et al, 2010; Thompson & Stapleton, 2009).

The concept of cognitive activity as sense-making challenges internalist modes of thought and commits enactive theorists to a "wide" conception of cognition. To understand the mind we must understand not just the agent, but the value-driven, normative interactions between the agent and its environment. We must examine not just the agent, nor their actions, but the context, the entire situation in which the agent is embedded and with which they are engaged (Di Paolo, 2009).

Social interaction is a special case of such engagement with the environment, in which the agent's activity are not simply coordinated with a physical world but with another agent. Sense-making in such situations is not simply coordinated but negotiated, a process termed participatory sense-making (De Jaegher & Di Paolo, 2007). Where effective social coordination is achieved, participatory sense-making produces meaning and cognitive activity that is shared across the participants, and must be understood as much in terms of the conversation or interaction as a whole as the combined activities of the individuals involved.

From an enactive perspective, then, the cognitive system is not a fully-formed, stable thing, but a collection of tendencies that dynamically interact with the environment. Cognitive activity is somewhat like a dance, or a handshake – something that only exists during its enaction, not something that is kept stored or continually present, and then activated or switched on as required. Viewing cognition as such a dynamic, almost ephemeral thing, means that enactive research tends to draw heavily on the tools of dynamical systems theory, and emphasise the manner in which behaviour is structured by skills (stable, reliable patterns of goal-directed behaviour) – examining change over time, the processes of emergence, transformation and disappearance, rather than attempting to catalogue or categorise specific cognitive functions, or identify specific contents of cognition that might be examined.

5. Embedded and Situated Cognition

At present, there is no clear consensus on what exactly is meant by the terms "embedded mind" and "situated cognition". However, recent debates in philosophy of mind and cognitive science suggest it is helpful to keep notions of causal dependence and constitution separate (e.g. Menary, 2010b). For it is one thing to argue that cognitive processes can be causally dependent on the body and its interaction with an environment and it is another to argue that the body and its interactions actually constitute or realize cognition. In this regard, Rowlands (2010: pp 60-61) argues that embedded mind is the claim that for some cognitive processes, there is a (perhaps essential) causal dependence between environmental structures and bodily movement. If, following Robbins and Aydede (2009: p3), we think of situated cognition as consisting in the general claim that cognition can depend on structures in an agent's environment (for a review, see Anderson, 2003), then we can think of embedded mind as the targeted working out of this claim.

Many lines of inquiry offer support to embedded mind (and by extension situated cognition). In this short section, I will identify only two (see Clark 2008, and Robbins and Aydede 2009, for further examples). Behaviour-based robotics (BBR), as pioneered by Rodney Brooks (1991), demonstrated that it was possible to build robots capable of performing simple tasks despite those robots having no detailed, internal knowledge of the environments in which they were operating. Such robots were designed to be "set up to be set off" by certain features of their local surroundings, bypassing the need for complex, internal cognitive machinery. The work of Brooks and many others showed that basic cognitive functions could be causally dependent on movement and structures in the local environment (see Steels and Brooks (eds), 1995, for an overview of these and related issues). As such, BBR arguably supports the claims made by embedded mind and situated cognition.

Further evidence comes from work on what is called animate vision (Ballard, 1991). The human eye only has high resolution in a small region near the optical axis (the fovea) yet nonetheless encompasses a large field of view. This discrepancy between high resolution at the centre and low resolution at the peripheries is compensated for by the fact that the eye is in constant motion and mechanisms of gaze fixation ensure that the fovea can automatically target whatever is of interest. Ballard (1991) argues that our ability to seamlessly fixate on objects of interest simplifies our access to the environment since for many basic physical tasks we do not need to build elaborate internal models of our local environment. Instead, we just need to register those aspects of the environment we deem immediately relevant to the task in hand.

This is nicely illustrated in Ballard et al (1997). Subjects were asked to copy coloured blocks from one area into another on a computer screen. By tracking eye movements, it became apparent that subjects were utilizing "minimal memory strategies" in order to complete the task. That is, rather than construct internal models of the colour and location of the blocks that needed to be copied and then using working memory in order to perform the task, subjects instead used repeated eye saccades and accessed the colour and location information only when and where it was required. Ballard et al (1997, p. 739) conclude that subjects were deploying "just-in-time" representations, that is, subjects were leaving important information out in the world and only accessing it on a "just-in-time" or immediate need-to-know basis.

Two things seem to follow from this. First, this supports the claim that the eye functions as a deitic or pointing device which enables subjects to fulfill "do-it-where-I-am-looking" strategies (Ballard et al, 1997, p. 725). Second, the eye has a determinate computational role since its "pointing movements bind objects in the world to cognitive programs" (ibid, p. 726). Deitic computation offers support for claims about embedded mind and situated cognition. The Ballard et al study demonstrates that subjects do not build detailed internal representations of their local environments in order to fulfill physical tasks. Rather subjects exploit features of their bodies and features of their environment in order to minimize reliance on internal processing and accomplish computation 'on the cheap'. There are thus demonstrable complex causal dependencies between the subject and their environment for the completion of certain tasks.

6. Distributed Cognition - Łukasz & Witold

Distributed cognition approach (DCog) does not focus on cognition as a property of an individual organism/agent. Rather, it describes larger cognitive systems which may encompass multiple individual agents. This distinguishes DCog from other approaches labeled here as 'wide cognition', which treat an individual organism as a main unit of analysis, describing, for example, the way an individual is embedded, connected to his/her environment or how his/her body matters from the perspective of cognitive processes. In the case of DCog the focus is on heterogeneous elements (e.g. biological, material, discursive ones), which take part in sequential or simultaneous processes of generation, transmission and transformation of representational states. DCog identifies those processes with cognition. It is also important that DCog does not treat cognition as a passive representational process whose primary aim is to create a model of external world. Moreover, in DCog representational states are not understood as mental states or other inner states of any individual agent. Examples of representational stares include meaningful gestures or poses of agents, written or spoken information, visualizations displayed on screens, lines drawn on navigational chart and the chart itself, but also non-symbolic cues which modify the behavior of agents (e.g. modifications of environment which make some actions more probable than others) (Zhang & Norman, 1994, p. 87–122).

DCog may be perceived as a test of how far we can proceed in explaining cognition without taking into account the central nervous system and all those processes which happen "inside the agent's head". DCog is a response to internalism, which assumed that all important cognitive processes take place inside the agent and that external factors associated with cognition (including elements of the human social and material culture) may be taken into consideration at later stages of research (Salomon, 1997). DCog shows that in many cases those excluded factors are responsible for a considerable reduction of complexity of cognitive problems which individual agents are faced with. They may also enhance human cognitive capabilities or reduce the cognitive load.

In order to explain this, one may reflect on various cognitive functions of artifacts. First of all, artifacts reduce the cognitive load of human memory – they may function as external memory systems or automate selected actions. Furthermore, they may reduce complexity by helping to integrate dispersed data, allowing the agent to focus only on the phenomenon's selected features or dimensions. As a result, they turn complex issues into more abstract ones; that is, the agent may solve the problem performing fewer mental or manual operations. Moreover, artifacts reify (or enact) innovations developed during the process of evolution of larger, distributed cognitive systems. Let us consider the example of modern nautical chart, a basic cognitive tool of pre-GPS-era marine navigation. It is a device developed through decades of practice which consolidates a whole array of small local technical innovations introduced by successive generations of seamen and navigators. It is also an ingenious "analog computer", which integrates navigational data and allows for computation-like operations, which take form of manual manipulation and transformation of two-dimensional graphic representations. It is important that all navigational operations could be performed without the chart and manual manipulations performed thereon (one can imagine marine navigation as purely mathematical computations), but this kind of approach would be far more complex from the perspective of a human navigator and transmission of navigation skills would be hindered. In "Cognition in the Wild" E. Hutchins presents many other examples of analog computational devices. In order to fully understand cognitive functions of artifact's one should closely analyze what part they take in processing of representational states in particular larger cognitive systems (Hutchins, 1995a).

DCog does not suppose any precise vision of larger cognitive system. Particular distributed system may encompass many individual agents or only one. It may include material artifacts and symbolic media, but it is not determined what types of material objects it should include or what their function is. Literature includes such examples of distributed cognitive systems as teams of nautical navigators, financial brokers' offices, air-traffic controllers, teams of surgeons, and crime scene investigation teams. In each case, an important part of a system consists in human personnel utilizing overlearned problem-solving heuristics and means of work coordination, but, nevertheless, technical equipment (tools, material external representations, coordinating artifacts) also plays an important role. In case of distributed cognitive system, one cannot distinguish between the core and the periphery of the system. A given object (biological, material, cultural) will be considered a part of a system only if it fulfills an important function.

Representatives of DCog stress that a larger cognitive system works in a different manner and has different properties than individual agents who may be part of the system. In other words, the effect of actions performed by a larger system is not a sum of the effects of actions performed by human and nonhuman "components" of this system. Let us consider a Chinese room known from Searle's famous thought experiment as a model of a distributed cognitive system (Searle, 1980). In this case an individual system is the human agent inhabiting the room. The individual does not know Chinese. One cannot attribute the property "knows Chinese" to the individual, nor to any object gathered in the room (e.g. instruction of symbol usage, baskets with symbols). But the room as a whole (agent + objects) functions as an interlocutor who is of communicating with agents using Chinese.

DCog reinterprets in a radical way many basic categories of cognitive science and epistemology, including cognition, representation, cognizing agent and its boundaries, agency. For instance, according to DCog, a process is not cognitive simply because it happens inside an individual, nor is a process non-cognitive because it happens within the interactions among many individuals. One can put forward a complaint that DCog abuses epistemological categories which have their standard and consistent use. Some researchers, including R. Giere (2004), suggest that claims of DCog can be expressed also in the frame of more traditional approaches in the field of cognitive science or epistemology. However, even if we again treat individual human beings as units of analysis, and assign to them full computational functions and full agency, it still remains a fact that the other elements of the context are responsible for providing agents with such problems and representations whose complexity has been reduced in some way.

Moreover, if we defend the traditional understanding of cognition and transformation of the representational states, we do not necessarily simplify the description of problem-solving process. It is especially true in situations where the key moment of transformation takes place outside the agent in the traditional sense of the term. Moving away from the traditional sense of cognition, it should be noted that DCog cannot be automatically translated into 4E approach (embodied, embedded, extended and enacted cognition) that takes a biological organism as its object of focus. DCog approach is also disproportionate with respect to cognitive neuroscience, as it focuses on a quite different group of objects and processes. Extended cognition is relatively the closest to the DCog approach (Dror & Harnad, 2008). A possible attempt at connecting DCog, embodied and situated cognition and cognitive neuroscience is extremely difficult. 4E can be treated as an attempt of this kind of approach, but it is not fully rewarding. Another attempt to integrate the DCog approach can rely on the assumption that DCog provides a specification of the problems that the agent, seen as an embodied and situated being, has to deal with.

It should be noted that the previous analyses in the field of DCog have usually focused on the function of human collectives equipped with more or less advanced artifacts performing routine cognitive functions. Their goal was to solve well structured problems with maximum reliability and high accountability. The majority of the systems known from the DCog literature are characterized by high redundancy and a kind of "prodigality" manifested in the fact that they contain a number of control loops compensating for the errors of the subsystem and ensuring not only confidence in the obtained results, but also the possibility that eventual errors will be used for improving the system (it can be noted that the process of learning in the case of a broader cognitive system is not identical to staff acquiring knowledge) (see, e.g., Hutchins, 1995b, p. 265-288). However, one can specify DCog systems that have been designed not for reliability, but for speed or for creativity. The main utilized areas of application of DCog are design and evaluation of digital environments, human-computer interaction, information visualization processes, human factors in aviation, multimodal interaction (see: Perry, 2003, p. 193-223; Woods, 2003, p. 37–53; Ross et al., 2007).

7. Short comparison? [300 words]

8. References (include a commentary?)

Anderson, M. L. (2003). Embodied Cognition: A field guide. Artificial Intelligence, 149, 91-130.
Ballard, D. (1991). Animate Vision. Artificial Intelligence, 48, 57-86.

Ballard, D. H. & Hayhoe, M. M. & Pook, P. K. & Rajesh, P. N. Rao (1997). Deitic Codes for the Embodiment of Cognition. Behavioural and Brain Sciences, 20 (4): 723-742.

Barandiaran, X., Di Paolo, E., & Rohde, M. (2009). Defining agency:individuality, normativity, asymmetry and spatio-temporality in action. *Adaotive Behavior*, *17*(4), 1–13.

Brooks, R. (1991). Intelligence without Representation. Artificial Intelligence, 47, 139-159.

Barsalou, L.W. (2008). Grounded cognition. Annual Review of Psychology, 59, 617-645.

Borghi, A.M & Cimatti, F. (2010) Embodied cognition and beyond: Acting and sensing the body. Neuropsychologia, 48, 763-773.

Borghi, A.M., Pecher, D. (2011). Introduction to the special topic Embodied and Grounded Cognition. Frontiers in Psychology, 2, 187.

Carr, N. (2010). *The Shallows: How the internet is changing the way we think, read and remember*. London: Atlantic Books.

Chatterjee, A. (2010). Disembodying cognition. Language and Cognition, 2-1, 79-116.

Chemero, A. (2009) Radical Embodied Cognitive Science. Cambridge, MA: MIT Press.

Clark, A. (2008) Supersizing the Mind: Embodiment, Action and Cognitive Extension. Oxford: Oxford University Press.

Clark, A., & Chalmers, D. (1998). The Extended Mind. *Analysis, 58*, 10-23.

Davis, J. I. & Markman, A. B. (2012), Embodied Cognition as a Practical Paradigm: Introduction to the Topic, The Future of Embodied Cognition. Topics in Cognitive Science, 4: 685–691.

De Jaegher, H., & Di Paolo, E. (2007). Participatory sense-making. *Phenomenology and the Cognitive Sciences*, *6*(4), 485–507. doi:10.1007/s11097-007-9076-9

Di Paolo, E. (2005). Autopoiesis, Adaptivity, Teleology, Agency. *Phenomenology and the Cognitive Sciences*, *4*(4), 429–452.

Di Paolo, E. (2009). Extended life. *Topoi*, *28*, 9–21.

Di Paolo, E. A., Rohde, M., & DeJaegher, H. (2010). Horizons for the enactive mind: values, social interaction and play. In J. Stewart, O. Gapenne, & E. Di Paolo (Eds.), *Enaction: Towards a new paradigm of cognitive science*. Cambridge, Mass: MIT Press.

Dror, I. E., & Harnad, S., eds. (2008). *Cognition Distributed: How Cognitive Technology Extends Our Minds*. Amsterdam: John Benjamins.

Dove, G. (2009). Beyond Conceptual Symbols. A Call for Representational Pluralism. Cognition, 110, 412-431.

Fischer, M. & Zwaan, R. (2008). Embodied language: A review of the role of the motor system in language comprehension. The Quarterly Journal of Experimental Psychology, 61, 825-850.

Gallese, V. & Sinigaglia, C. (2011) What is so special about embodied simulation? Trends in Cognitive Sciences, 15 (11): 512-519.

Giere, R. N. (2004) The Problem of Agency in Scientific Distributed Cognitive Systems. *Journal of Cognition & Culture* 4, no. 3/4, 759-774.

Goldman, A.I. & de Vignemont, F. (2009), Is social cognition embodied? Trends in Cognitive Sciences, 13(4):154-9.

Gentner, D. (2010). Psychology in Cognitive Science: 1978–2038. Topics in Cognitive Science 2, 328-344.

Hurley, S. (2001). Perception and action: Alternative views. *Synthese, 129*(1), 3-40.

Hutchins, E. (1995a). *Cognition in the Wild*. Cambridge, Mass.: The MIT Press.

Hutchins, E. (1995b). How a Cockpit Remembers Its Speeds. *Cognitive Science* 19, no. 3, 265–288.

Jirak, D., Menz, M., Buccino, G., Borghi, A.M., & Binkofski, F. (2010). Grasping language. A short story on embodiment. Consciousness and Cognition, 19, 711-720

Lakoff, G. (2012). Explaining Embodied Cognition Results. Topics in Cognitive Science, 1-13.

Louwerse, M. M., (2011). Symbol interdependency in symbolic and embodied cognition. TopiCS in Cognitive Science, 3, 273-302.

Mahon, B. & Caramazza, A. (2008). A critical look at the embodied cognition hypothesis and a new proposal for grounding conceptual content, Journal of Physiology, 102, 59-70.

Martin, A. (2007). The representation of object concepts in the brain. Annual Review of Psychology, 58, 25–45.

Menary, R. (2010a). Cognitive integration and the extended mind. In R. Menary (Ed.), *The Extended Mind* (pp. 227-244). London, England: Bradford Book, MIT Press.

Menary, R. (eds) (2010b). The Extended Mind. The MIT Press: Bradford Books.

Michaelian, K., & Sutton, J. (2013). Distributed Cognition and Memory Research: History and Current Directions. *Review of Philosophy and Psychology*(4), 1-.

Perry, M. Distributed Cognition. (2003). In: *HCI Models, Theories, and Frameworks: Toward an Interdisciplinary Science*, edited by John M. Carroll, 193-223. Amsterdam: Morgan Kaufmann.

Pezzulo, G., Barsalou, L.W., Cangelosi, A., Fischer, M.A., McRae, K., Spivey, M. (2011). The mechanics of embodiment: A dialogue on embodiment and computational modeling. Frontiers in Cognition, 2(5), 1-21.

Robbins, P. & Aydede, M. (2009). The Cambridge Handbook of Situated Cognition. Cambridge University Press.

Ross, D., Spurrett, D., Kincaid, H. & Stephens, G.L., eds. (2007). *Distributed Cognition and the Will: Individual Volition in Social Context*. Cambridge, Mass: The MIT Press.

Rowlands, M. (2010). The New Science of the Mind: From Extended Mind to Embodied Phenomenology. The MIT Press: Bradford Books.

Salomon, G., ed. (1997). *Distributed Cognitions: Psychological and Educational Considerations*. Cambridge, Mass.: Cambridge University Press.

Searle, J. (1980). Minds, Brains and Programs. *Behavioral and Brain Sciences* 3, no. 3, 417–457.

Semin, G.R., & Smith, E.R. (Eds.*), Embodied grounding: Social, cognitive, affective, and neuroscientific approaches*. New York: Cambridge University Press.

Steels, L. & Brooks, R. (1995). The "Artificial Life" route to "Artificial Intelligence": Building Situated Embodied Agents. Hillsdale, NJ: Lawrence Eribaum Associates.

Sterelny, K. (2010). Minds: extended or scaffolded? *Phenomenology and the Cognitive Sciences, 9*(4), 465-481.

Carr, N. (2010). *The Shallows: How the internet is changing the way we think, read and remember*. London: Atlantic Books.

Clark, A., & Chalmers, D. (1998). The Extended Mind. *Analysis, 58*, 10-23.

Hurley, S. (2001). Perception and action: Alternative views. *Synthese, 129*(1), 3-40.

Hutchins, E. (1995). *Cognition in the Wild*. Cambridge MA: MIT Press.

Menary, R. (2010). Cognitive integration and the extended mind. In R. Menary (Ed.), *The Extended Mind* (pp. 227-244). London, England: Bradford Book, MIT Press.

Michaelian, K., & Sutton, J. (2013). Distributed Cognition and Memory Research: History and Current Directions. *Review of Philosophy and Psychology*(4), 1-.

Sterelny, K. (2010). Minds: extended or scaffolded? *Phenomenology and the Cognitive Sciences, 9*(4), 465-481.

Sutton, J. (2010). Exograms and interdisciplinarity: history, the extended mind, and the civilizing process. In R. Menary (Ed.), *The Extended Mind* (pp. 189-225). London, England: Bradford Book, MIT Press.

Thompson, E. (2007). *Mind in Life Biology, Phenomenology and the Sciences of Mind* (1st ed.). Harvard University Press.

Thompson, E., & Stapleton, M. (2009). Making Sense of Sense-Making: Reflections on Enactive and Extended Mind Theories. *Topoi, 28* (1), 23 -30.

Toni, I., de Lange, F.P., Noordzij, M.L., Hagoort, P. (2008). Language beyond action. Journal of Physiology, Paris, 102, 71-79.

van Elk, M., Slors, M. & Bekkering, H. (2010). Embodied language understanding requires an enactivist paradigm of cognition. Frontiers in Psychology 1, 234.

Varela, F. (1997). Patterns of life: Intertwining identity and cognition. *Brain and Cognition 34*(1), 72–87.

Varela, F. J. (1979). *Principles of Biological Autonomy*. Norwalk, CT: Appleton & Lange.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The Embodied Mind*. Cambridge, Mass: MIT Press.

Weber, A., & Varela, F. J. (2002). Life after Kant: Natural purposes and the autopoietic foundations of biological individuality. *Phenomenology and the Cognitive Sciences*, *1*(2), 97–125.

Willems, R.M., & Hagoort, P. (2007). Neural evidence for the interplay between language, gesture and action: a review. Brain and Language, 101, 278-289.

Woods, D. (2003). Discovering How Distributed Cognitive Systems Work. In *Handbook of Cognitive Task Design*, edited by Erik Hollnagel, 37–53. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Zhang, J., & Norman, D.A. (1994). Representations in Distributed Cognitive Tasks. *Cognitive Science* 18, no. 1, 87–122.

Basic references:

- Dror, Itiel E, and Stevan R Harnad. *Cognition distributed how cognitive technology extends our minds*. Amsterdam: John Benjamins Pub. Co., 2008
- Clark, Andy, and David Chalmers. “The extended mind.” *Analysis* 58, no. 1 (1998): 7-19.
- *The extended mind*. Edited by Richard Menary. Cambridge, Mass.: MIT Press, 2010.
- Hutchins, Edwin. *Cognition in the wild*. Cambridge, Mass.: MIT Press, 1995.
- Hutchins, Edwin. “Cognitive Ecology.” *Topics in Cognitive Science* 2, no. 4 (October 2010): 705-715.
- Tomasello, Michael. *The Cultural Origins of Human Cognition*. Cambridge, Mass.: Harvard University Press, 1999.
- Norman, Donald A. *Living with complexity*. Cambridge, Mass.: MIT Press, 2011.
- Levine, John M, Lauren B Resnick, and E Tory Higgins. “Social foundations of cognition.” *Annual review of psychology* 44 (January 1993): 585-612.

Short reviews:

- van Dijk, J., R. Kerkhofs, I. van Rooij, and P. Haselager. 2008. “Special Section: Can There Be Such a Thing as Embodied Embedded Cognitive Neuroscience?” Theory & Psychology 18 (3): 297–316. doi:10.1177/0959354308089787.
- Anderson, Michael L, Michael J Richardson, and Anthony Chemero. 2012. “Eroding the Boundaries of Cognition: Implications of Embodiment(1).” Topics in Cognitive Science: 1–14. doi:10.1111/j.1756-8765.2012.01211.x.
- Kiverstein, Julian. 2012. “The Meaning of Embodiment.” Topics in Cognitive Science (August 14): no–no. doi:10.1111/j.1756-8765.2012.01219.x.

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- October, 2012: A draft about meaning of wide cognition areas to social intelligence
- December 2012: Final version of the first document