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Situating Distributed Cognition

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Although nearly a generation old, we are justified in calling Distributed Cognition (D-cog) a "new" approach because of its juxtaposition to the "Good Old Fashioned" alternative, regarded as classical or "canonical" cognitive science (Hutchins, 1995, p. 266). D-cog represents a clear departure from a view that computational processes take place over representations "bound by the brain," (Adams and Aizawa, 2008); that is, at the level of the individual cognitive agent (e.g. Newell & Simon, 1972). Correspondingly, D-cog's method of investigation, cognitive ethnography, is also new to cognitive science, even if adapted from anthropology. As reflected in the aims of the Special Issue, the philosophical implications of D-cog have yet to be evaluated fully. In this paper our evaluative gaze is retrospective, because an assessment of any novel or alternative contribution on conceptual grounds should include reflection on the aspects of the new approach that are genuinely new and any aspects or assumptions that have been forwarded before, even in analogous form. Furthermore, analogous historical frameworks can be useful for considering the limitations or challenges that confront a new approach and for opening areas for future research. There is value in examining what implications might be drawn from the

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comparison for evaluating the new framework, especially where criticisms and cautions have been levied against the former representative.

Features of D-Cog

A central effort of D-Cog is to re-conceptualize representational systems as brain-*and*-environment systems. A brain-and-environment differs from a brain-*in*-environment system because it does not assume or prioritize the brain or its representational processes. Instead, cultural and cognitive processes are not merely interrelated but are co-implicated; they are, as Hutchins makes clear (this issue), shared processes. As is assumed in "environmental perspectives" (Nersessian 2005) in cognitive science including D-cog, cognitive achievements are made possible or impeded by the specific properties of environments, including their socio-cultural features. Cognitive achievements are shared achievements, relying on communal practices and representational media (charts, graphs, manuals). Boundaries of the cognitive system are conceptually expanded to the levels of local and broader cultural organization. This need not mean that cognition 'begins' at a specific point – such as a brain – and extends outward. It does mean that cognition as "stretched over" (Lave, 1988) or shared across actors and environments. Hutchins (1995a, 1995b) is pioneering in this regard in forwarding a view of cognition as distributed. His approach derives from ethnographic analysis of "real world" problem solving processes. In "How a cockpit remembers its speed" (1995a), Hutchins portrays the task of remembering the speeds on a typical descent from 30,000 feet followed by a successful landing as situated within the entire 'cockpit system' of crew members with various responsibilities, their communications, the instruments, equipment, and rules of procedure. In our

efforts to understand the cognitive practices of scientists and engineers in research laboratories, we have adopted a D-cog framework because it enables incorporating specific technologies into the analysis of cognitive achievements (Nersessian et al. 2003, Nersessian 2005, Nersessian 2012; Osbeck & Nersessian 2006).

What is purported to be genuinely new is not the system level analysis in itself, of course, but "examination of the role of the material media in which representations are embodied, and in the physical processes that propagate representations across media" (Huthcins, 1995b, p. 266). Computations take place via the generation, manipulation, and "...propagation of representational states across media" within a cognitive system. (Hutchins, 1995b, p. 373). The cognitive system comprises an agent (or multiple agents), traditions of practice, and material artifacts, devices, instruments, the characteristics and functions of which in multiple ways support the dissemination of information across the system. Internal media (memory, experience) intertwine or "couple" (Nersessian 2009, Osbeck & Nersessian 2006) (it is stronger than merely "interact") with external media (data, diagrams, flow charts, graphs, instrument panels, and so forth) in the array of cognitive processes that result in successful navigation. In *Cognition in the Wild* (1995b), Hutchins broadens the application to all real life problem solving and recommends that cognitive science make increased use of ethnographic methods to interpret the practices of expanded broader cognitive systems, effectively dissolving the boundary around the individual knower.

Historical Precedents

The ideas Hutchins offers are new for cognitive science, but are they historically new in a broader sense? Most obviously, the attempt to dissolve the boundary around the individual knower is not itself a novel theoretical contribution. The conception of at least a very porous

boundary between cognitive and social processes has numerous philosophical and psychological precedents in the 20th century (Segall, Campbell and Herskovitz, 1966; Wittgenstein, 1953) and long before it (Vico, 1730/1984). And the acknowledgement of a relationship of deep reciprocity between organism and environment made manifest in the intelligence of the species finds precedents both philosophical (Reid, 1785/2002) and scientific (Darwin, 1859). Thus there are plenty of efforts old and new to reconcile the "problem of context" (Dilley, 1999), or a relational, interactional, systems level view of human capacities with the general goals of scientific inquiry. Moreover, as Michael Wheeler argues, "the supporting case for the hypothesis of embodied-embedded cognition has been successfully argued over and over again" (2010, p. 247). Among the most relevant predecessors are the transactional theory of John Dewey (Dewey & Bentley, 1949), Russian activity theory (Vygotsky, 1978) and ecological psychology (Gibson, 1979). Clear relevance to D-cog, however, requires more than mere similarity in underlying philosophical assumptions. It requires translation of those assumptions into a research program that challenges the prevailing framework in its discipline in both conception *and* method.

Functional Psychology

Because of its status as a scientific alternative to the dominant "school" or framework in relation to the question of consciousness, the Functional Psychology movement of the early 20th century is an especially relevant comparison (Angell, 1907). Proponents of extended mind (Clark, 2003) and D-Cog (Hutchins, 1995b) acknowledge Dewey as an important influence but rarely spell out in detail the means by which Dewey's philosophically infused psychology and psychologically informed philosophy provide conceptual grounding for newer approaches to cognitive science. Ironically, it is "Functionalism" in its more contemporary form – that of cognition as a functional abstraction independent of the medium in which is it implemented ("physical symbol system"

Newell & Simon, 1972) that is Hutchins' target for critique. This serves as a reminder that there are many available conceptions of "function" and "functionalism." Wheeler (2010) and Clark (2008) link the "canonical functionalist" point of view in philosophy of mind (e.g. Putnam, 1967) with the thesis that cognition is extended, at least ("extended functionalism" (Clark, 2008), because it "provides a principled basis for concluding that creatures whose brains happen to be built out of physical stuff different from our own may still be cognizers," enabling the study of cognitive processes in animal, human, or machine (Wheeler, 2010, p. 248). However, Shook (2001) calls the latter movement "neofunctionalism," though finds it "curious" that the label was used to label "a philosophy of mind that the original Chicago functionalists had opposed." (Shook, 2001, p. ix). That is, early functionalists opposed the view that context or medium is irrelevant. Functional psychology's emphasis on interactive agents *in context*, of agent and environment as the "entire situation" is in an important way incompatible with neofunctionalism, precisely because the "medium" – the perceiving, acting agent with its particular body in its particular environment – is indispensable to, even inseparable from cognitive processes:

> In so far as you attempt to analyze any particular state of consciousness you find that the mental elements presented to your notice are dependent upon the particular exigencies and conditions which call them forth. .. the very sensations themselves are determined in their qualitative texture by *the totality of circumstances subjective and objective within which they arise*. (Angell, 1907, emphasis added)

Variably called "Functionalism" (Titchener, 1899), "Functional Psychology" (Angell, 1907), "The Chicago School of Functionalism" (Shook, 2001), and "Chicago Functionalist Psychology" (Carleton, 2001), the defining feature of the program is a view of mental life as an

adaptive process. As expressed by Angell: "We shall regard all the operations of consciousness as so many expressions of organic adaptations to our environment, an environment which we must remember is social as well as physical" (1908, p. 7). Proponents regarded functional psychology as an outgrowth of evolutionary theory though it lacked an emphasis on natural selection or heredity. The accent on adaptation, analysis of function, and concern with the dynamical relation of person and environment took root most enthusiastically in a young, dynamic faculty group Dewey lured to the University of Chicago, during a time when the city was besieged by social challenges including overpopulation, housing shortages, increased crime, and political corruption (Smith, 2013). Traditionally, historians view functional psychology's reach as encompassing William James (e.g. Boring, 1957; Ratner, 1963; Shook, 2001), and, occasionally, James Mark Baldwin's "social heredity" (1902), and Robert Woodworth's dynamical psychology (1918) (Benjamin, 2007). The core group of proponents eventually included Harvey Carr, who carried forward the tradition at Chicago in modified form after Angell's departure.

Given the wide lens, Angell admitted that "functionalism" serves merely as a "convenient term" with "nothing sacrosanct about it"… "It means today a broad and flexible and organic point of view in psychology" (1906, p. 91). As Calkins (1906) acknowledged at the time, functional psychologists formed "no unified front" (p. 71) in positive claims; they are united principally by opposition to an atomistic unit of analysis (the individual knower). Yet there is a central focus on the capacity for learning and transformation: organismic "plasticity" (Dewey, 1886, 1922), and an interest that moves beyond what persons do to "how they do it" and "why they do it" (Woodworth, 1948). Correspondingly there is a focus on the organism's goal-directed action *on* the environment, entailing an emphasis on the utility of process and action

(problem-solving). Finally, the binding model or metaphor is the organism-in-environment – the situation - a system level focus that, like D-Cog, effectively dissolves any hard divide between organism and context.

The most forthright articulation of Functional Psychology's aims and assumptions is Angell's 1907 paper titled "The Province of Functional Psychology." However, the precise moment of Functional Psychology's arrival in psychology is disputed. One view is that Dewey's "New Psychology" forwarded a fully formed functionalist viewpoint by 1884 (Shook, 2001); another is that his 1896 paper on the "reflex arc" forms is the birth of the functionalist viewpoint (Boring, 1957;Heidbreder, 1933). Backe (2001) considers James to be the first to articulate the relevance of a biological model for psychology, and Dewey and Angell to be those who developed it into an oppositional approach to structuralism. However, Raphelson traces the roots of the Chicago flowering to Dewey's interactions with Charles. S. Peirce, G. Stanley Hall, and George S. Morris at John's Hopkins (Raphelson, 1973), and Woodworth (1948) identifies a set of European functionalist contemporaries to the American movement, of which Edouard Claparède and David Katz are most representative. More broadly, Angell (1908) and Titchener (1921), in distinguishing structural from functional psychologies, trace the conceptual roots of functionalism to Aristotle.

An alternative view is that Functional Psychology originated in Angell and Moore's (1896) analysis of reaction time experiments showing a dissociation between simple sensorial and muscular response. Angell and Moore purported to offer support for Baldwin's type theory but in the course of their report put forward a different "standpoint of interpretation" from that of Baldwin or the Wundtian school (Angell & Moore, 1896, p. 246). The "key to any explanation" of the fact of "two highly reflexive forms," of response, with the motor slightly faster in most

instances, "must be found in the function of attention and habit in their relations to each other," that is, function within the overall coordination of an attentive act (p. 252-253).

As Carleton points out, the data itself from the Angell-Moore study did nothing to require such a new standpoint of interpretation. Instead, it reflected Angell's awareness of a new insight from Dewey, that of the "organic circuit" model expressed in what was to become his famous discussion of the reflex-arc concept in psychology (1896), which offered a full-blown attack on existing dualisms, including those he saw reified in the description of the reflex arc offered by William James (1890). Displaying a well- documented Hegelian influence on his early thought (Backe, 2001; Ratner, 1963), Dewey assailed the "patchwork of disjointed parts," the "mechanical conjunction of unallied processes." He advocated for a view of sensory stimulus, motor response, and the connections between these as "divisions of labor, functioning factors within the single concrete whole" (1896, p. 96-97). Angell was a student of both Dewey and William James, and the interpretation offered by Angell and Moore is said to be "gotten from Dewey[3]" (Carleton, 2001, p. 378).

Drawing always on the analogy of biological function and asserting its relevance, Angell emphasized the interconnection of function and structure: "Not only are we reminded in biology that every function involves a structure, an organ, for its execution, but we are also informed that these functions modify the structures. In psychology, it might almost be said that the functions produce the structures…." The functional determination of environmental structures invokes an emphasis on the situated nature of psychological processes: cognition is "determined by the demands made upon the organism by the environmental situation," and thus i.e. that it is

[3] Note that Backe, 2001 disputes the influence of Hegel and the quest for coordination in relation to any functionalists other than Dewey.

functionally determined, and that it "will vary with each specific situation with which the organism has to cope" (Angell, 1903, p.249).

Thus the facts in need of a coordinated understanding were expanded to include environmental processes. Dewey in particular was to understand these circumstances as fundamentally social for the human form of organism, such that in his later work the emphasis was extended to the "transaction" (Dewey & Bentley, 1949): "we are willing under hypothesis to treat all of his behavings, including his most advanced knowings, as activities not of himself alone, nor even as primarily his, but as processes of the full situation of organism-environment" (Dewey & Bentley, 1949, p. 131).

Functional psychology's rootedness in Dewey's broader thought enables us to draw connections between functional psychology and even Dewey's later emphasis on transaction. Dewey and Bentley's chapter (IV) on interaction and transaction aligns their approach with Dewey's earlier "procedure of inquiry" as laid out in *Experience and Nature* (1925) and *The Logic of Inquiry* (1938), emphasizing that "no radical separation is made between that which is observed and the observer in the way which is common in the epistemologies and in standard psychologies and psychological constructions" (Dewey and Bentley, 1949, p. 103-104). As Hutchins can be understood as rejecting or challenging canonical views of the localized symbol processor, Dewey's conclusions are rooted in dissatisfaction with and opposition to the approaches to problems of knowledge, learning, and scientific rationality considered traditional or canonical in their own time. For Dewey all previous epistemologies are based on an inappropriate conception of knowing: His specific target is the accepted relation between knower and known, by which the knower is construed as passive spectator or viewer of the known—what Dewey dubs the "spectator view of knowledge" (1916, p. 102). In contrast,

knowing is for Dewey a process or activity, rather than an acquisition (knowledge). "Problematic" and "resolved" situations substitute for the traditional categories of knower and known. We transform a problematic situation into a resolved situation through engagement in the activities of deliberation, calculation, manipulation, and experimenting. The separation between states is temporal, not ontological.

Moreover, all processes, including perceptual, cognitive, and even emotional constitute interactions or transactions that cannot be meaningfully reduced to bodily but constitute "processes of the full situation," which is saturated with meaning and values, including cultural. Given the participation of the body in the full situation, neither can they be reduced to social interactions or linguistic constructions alone. Yet Dewey acknowledges the close relation of primary or lived experience to the acquired effects of socialization, learning, and "the unconscious effects of language." These aspects relating to our social embedding affect our experience of objects: "We learn, in short, that qualities which we attribute to objects ought to be imputed to our own ways of experiencing them, and that these in turn are due to the force of intercourse and custom. This discovery marks an emancipation; it purifies and remakes the objects of our direct primary experience" (Dewey, 1925, p. 15).

Perception and action represent unified coordination, but so do emotion and cognition and cognition and social processes, including language and other forms of symbolic communication. Psychology textbooks taking a functionalist perspective, including Angell's own (1908), distinguish processes and discuss them separately for the sake of analysis and better understanding. A chapter on "*The Forms and Functions of Reasoning*" characterizes judgment as an analytic-synthetic process and catalogs differences between practical reasoning, induction, and syllogistic reasoning; these processes as a whole are separated by chapter from the "affective

elements of consciousness." Nevertheless there is an understanding that although to analyze any one function requires that we "overlook certain other factors of our consciousness" (p. 301), to do so is to artificially abstract from the coordinated functioning of the system of consciousness as a whole. The centrality of language in reasoning connects it to the wider social world; the reasoning required for any task, however personally meaningful (such as identifying the most direct route to a desired location) is thus punctuated by processes that extend beyond the individual and are situated within a social system that grounds the very intelligibility of problems and their outcomes. Goal directed selective attention is the engine of problem solving and hence learning but it is always dynamically interconnected with the environment: "Adjustment to the environment means not passive acceptance of the latter, but acting so that the environing changes take a certain turn…The organism …is also an agent – a reactor, one trying experiments, one concerned with undergoing in a way which may influence what is still to happen" (Dewey, 1917/1970, p. 10-11).

In stressing adaptation and its natural implication of agency, functional psychologists embraced a different set of epistemic values and with them, a different approach to psychological science. As Heidbreder put it: "Whereas structuralism deliberately and intentionally, in the interests of pure science, abstracted its material from its setting, functionalism just as deliberately and intentionally , in the interests of its chosen problem, kept its material in the natural environment in which it appeared" (1933, p. 203). The basic difference is one that Heidbreder attributes to the earlier opposition of act and content psychologies in Germany, though Titchener distinguishes act from functional psychologies (Titchener, 1921).

An experimental school established in Chicago and various industrial locations ("industrial laboratories") are among the most notable natural settings in which functionalist

science was practiced. Functional psychologists used a plurality of methods within these field settings. They included experimentation, though the level of control was undoubtedly much lower in the field ("the wild") than in the laboratory. Importantly, too, Herdbreder highlights that Carr, at least, advocated the use of forms of data that included human productions of various sorts, including literature, art, social institutions, and scientific inventions. Though there is little room to elaborate the connections here, we can see this as an important point of compatibility with Wundt's *Völkerpsychologie* (1916). Under the direction of Carr, who took over leadership of functional psychology at Chicago in 1921, functional psychology became unapologetically eclectic and increasingly incorporated various applied efforts in psychology, including testing, industrial, clinical, and organizational eventually losing its distinctive focus and blending with American psychology at large (Greenwood, 2009), Carr's own history of reliance on experimental studies with animal problem solving some of which included collaboration with John Watson (Carr, 1910; Carr & Watson, 1908), and Carr's direction of the experimental (animal) laboratory at Chicago took functional psychology in a direction away from the natural setting, the explicitly system-level point of view, and the distinctive problems of human consciousness, while maintaining a focus on function. Carr was also more comfortable accepting dualistic conceptions of mind-body relations than were his predecessors (Carr, 1930). Thus in comparing functional psychology with D-Cog, as is the point of this paper, it is the early articulation of its point of view and its later instantiation in the transactional theory of John Dewey that most clearly provide the basis of conceptual comparison.

Comparison of Functional Psychology and Distributed Cognition

Functional psychology and Distributed cognition are aligned in several obvious ways. They both 1) take a system level, dynamical perspective, 2) focus on problem-solving, 3) oppose views of

cognition as comprising only mental states - cloistered entities removed from action, the world of objects, and social (including historical) processes, and 4) favor investigation of problem solving in real world contexts of practice rather than in artificial settings or media. Reflecting backwards, the view of cognition forwarded by functional proponents is strikingly contemporary. There is in Angell's philosophical defense of functional psychology an explicit reference to cognition as a form of practice, expressed in a manner that could have as easily been written in the 1990s: "[R]eflection and ratiocination are not only thought of as possible contributors to practice, but as constituting themselves immanently and immediately most important instances of it. For this type of view, constructive thought *is* practice in its most intelligently creative, formative stage," Similarly, as for D-Cog, the concern of functional psychology is that of descriptive accounts of problem solving in "real" situations of such practice, "what actually does occur in the knowledge-bringing operations" (Angell, 1903, p. 256).

However, it would inaccurate to claim that D-cog represents a contemporary instantiation of Functional Psychology. The two movements are situated in radically different eras, oppose different rivals, employ different concepts, and engage different aims. Yet there are sufficient similarities to warrant an examination of the challenges that faced Functional Psychology and consider the extent to which they might apply to D-cog as well. On the other hand, appreciation of the specific scientific merits of Functional Psychology despite its drawbacks or limitations engenders favorable appraisal of D-cog.

Functional Psychology proponents intended a better scientific foundation for psychology, one drawing upon biology for inspiration and analogy rather than physics/chemistry, the inspiration for structural psychology (Calkins, 1906). Dewey and colleagues were guided by evolutionary theory, from which the principle, model, or metaphor of the organism-and-

environment system, with the organism simultaneously adjusting to and acting on the environment in a continuous process of transformation is the appropriate foundation for a scientific psychology: "Any account of experience must now fit into the consideration that experiencing means living, and that living goes on in and because of an environing medium, not in a vacuum. Where there is life, there is a double connexion (sic) maintained with the environment. In part, environmental energies constitute organic functions; they enter into them" (Dewey, 1917/1970, p. 8). Angell, likewise, chided the "extremely pale, attenuated, and abstract character of such a science" (functionalism), "as compared with one which should report upon conscious processes as they are really found amid the heat and battle of the actual mind-body life." [Structuralism] "may be a pure science, but is surely purity bought at a great price – i.e. truth to life" (1907, p. 79).

However, the strengths of functional psychology, stemming from its truth to life principle, became its weaknesses from another lens: appreciation for value and context and ecological features translated into a failure to generate testable hypotheses, or hypotheses that did not lend themselves to forms of control sufficient to make causal claims. Heidbreder noted that functionalism "encountered the criticism, sometimes merely a vague imputation, that it somehow falls short of the strictly scientific" (1933, p. 228). Titchener (1898) clearly regarded a static, reducing, isolating approach to psychology as scientific, attaining a degree of scientific rigor that a system level approach could never reach.[4] Underlying this line of critique is the view that Functional Psychology can never offer more than elaborate descriptions, intricately contextualized descriptions that do not lend themselves to generalization and thus transfer of

[4] Although historical and conceptual links between functionalism and behaviorism are well documented (e.g. Green, 2009), Watson confessed in his autobiography that as Dewey's student at the University of Chicago, he "never knew what he (Dewey) was talking about then, and unfortunately for me, I still don't know" (quoted in Fancher and Rutherford, 2012, p. 361).

findings to new settings. Although the distinction between explanation and description is a fuzzy one, concerns about the generalizability of insights gained from inquiry situated "in the wild" remain relevant to D-cog. Any practice based account of cognition is subject to the standard critiques levied against their reliance on a relatively higher degree of interpretive analysis. Practice lends itself only to qualified, contextualized description, and always with a reference to created meanings specific to the context in which the practices occur, and always with the caveat that these meanings are in negotiation and transformation. Multiple studies can lead to transferable insights, but not to generalizable accounts, at least as the results of laboratory studies are purported to be generalizable. Practices, even cognitive practices are not amenable to discovery in the same way that natural powers or law-like regularities are discovered through systematic isolation and experimental control, at least in the way these have been historically constructed as necessary to scientific discovery and has been incorporated into conceptions of "good" psychological science, despite the questionable ecological validity of such science (e.g. Skinner, 1938; Titchener, 1898). Meanings (of, for example, charts, graphs, or symbols) cannot be neutrally described by the researcher but are always actively interpreted (as has been argued to be the case for any act of observation, but that is another discussion); multiple meanings and divergent interpretations of meanings are always possible.

D-cog does have the tradition of anthropology and ethnography behind it. However, even without the robust ethnographic methods which D-cog enjoys, the proponents of Functional Psychology considered description to be an important aim in its own right. Indeed, they regarded a detailed and accurate description of the subject matter to be necessary to practical aims. Good description fosters application. The benefit to be gained by a description of processes as they

occur in the wild is generally missed in criticisms of descriptive accounts, which typically focus on the inability of descriptive accounts to offer predictions.

But description itself, the "exact portrayal" has benefits that include eventual application of findings. Angell was less interested in the possibilities that a new world view engenders for its own sake than in the benefits of accurate depiction of psychic life: "With the fruits of this general survey at our disposal we shall be in a position to secure the intelligent application of our psychological facts and principles to the needs of practical life, just as the scientific facts and theories of electricity have been fitted to the needs of telegraphy" (Angell, 1915, p. 5). If the ability to isolate explanatory factors was compromised by functionalist assumptions and methods, as was the substance of the structuralist critique against them, functionalists tended to view this as a necessary consequence of the effort to get the correct viewpoint of the subject matter: "If his method tempts him now and then to sacrifice something of petty exactitude, he is under no obligation to yield, and in any case he has for his compensation the power which comes from breadth and sweep of outlook" (Angell, 1907, p. 90).

Moreover, the criticism that Functionalism (or D-Cog) offers principally or merely a new world view fails to capture what is most beneficial about just such a new view. Functionalism's promise was publically heralded by APA president Jastrow (1901), whose praise focused on Functionalism's potential to "raise questions which might otherwise remain unasked" (p. 8). Functionalism offers not only new interpretations of existing facts but leads to the creation of new facts and more importantly, raises questions not formerly asked or conceived (1901). The Chicago school of Functionalism was, although always controversial, fully embraced by the American Psychological Association as exemplary of "good science." This point is strongly

emphasized in Carleton's excellent analysis (2001). It is underscored by the election of Dewey in 1899 and Angell in 1906 as presidents of APA.

The creation of new facts, new concepts, and the ability to raise new questions is one of the principal affordances of D-cog for understanding many forms of practice, including science.

Functional Psychology and Pragmatism: Implications for Distributed Cognition

Overlap between the functional, dynamical, utility-focused "point of view" in psychology with American pragmatism in philosophy is obvious. Conceptually and historically, the lines between Functional Psychology and pragmatist philosophy are indistinct. Angell, although wary of promoting Functional Psychology as "mere philosophy," conceded that " the two movements spring from similar logical motivation and rely for their vitality and propagation upon forces closely germane to one another" (1907, p. 68). For Mary Whiton Calkins (1906), commenting on her contemporaries, the connections are obvious from the very reliance on function as the focus of analysis: Function, she notes, is "defined as 'part played with reference to reaching or maintaining an end.' This doctrine of the functional psychologists -- a symptom or an application of the modern movement in philosophy known as pragmatism -- hardly needs, to be illustrated" (Calkins, 1906, p. 74).

But the instrumental (utility) focus of pragmatism is not its most interesting feature. There are implications of the system level emphasis on problem solving that lead us quite naturally to pragmatist conclusions. The assumptions of and the conceptual and methodological problems with functional psychology lead naturally to pragmatism as a philosophical stance. We conclude that D-Cog would be well served by more openly embracing an explicitly pragmatist philosophical framework; that such a framework has implications that are not

expressed in the mere identification of cognition as a variety of practice (e.g. see Engel, Maye, Kurthen, and König, 2013). We will focus here on two of pragmatism's features.

First, one problem facing both Functional Psychology and D-cog is that in the realm of human interaction, the boundaries of any system are never clear. Hutchins focuses upon the cockpit and the ship. We have focused on the "lab-as-problem-space" (Nersessian et al. 2003).These are systems to be sure, but they are embedded within larger systems, long traditions, and almost impossibly complex nexuses of practice. Hutchins does not deny this embedded status and does not present his ship or cockpit as a cleanly bounded system. But neither does he deal philosophically with the implications of the "system boundary problem" as it might be called (Giere 2002). Boundaries of systems, if not clear, if not corresponding to divisions in nature, must therefore be determined by the inquirer. This is not to say that they do not reflect real patterns of organization. But there are decisions to be made about where to draw the lines. Thus the boundaries of systems are imposed at least to some extent artificially, for the sake of inquiry. They are imposed to reflect the interests, goals, and questions of the inquirer. They are, in other words, a matter of perspective, a central assumption of pragmatism (e.g., James, 1907).

Secondly, the functionalist assumption that meanings are interactions between organism and environment leads to the pragmatist emphasis on the centrality of *value* in problem solving, including the forms of problem solving that constitute science. Indeed, the suspicion that functionalism is "tinged with teleologies" since it deals in utilities, is among the recorded criticisms of functionalism levied by its contemporaries (Heidbreder, 1933, p. 228). Titchener was most disturbed by this problem (reviewed in Carr, 1930). Value is intertwined with function, or rather, function implicates value. There are no neutral functional descriptions: "The fact is that stimulus and response are not distinctions of existence, but teleological distinctions, that is

distinctions of function, or part played, with reference to reaching or maintaining an end" (Dewey, 1896, p. 365). A 1904 review of Angell's (1903) discussion of the philosophical implications of a functional psychology summarizes the connection succinctly, quoting from Angell's paper where indicated: "Now if consciousness is really an efficient agent in the furtherance of the life activities of the organism, its value obviously lies in its cognitive and volitional and even in its emotional functions. So a functional psychology must canvass the general processes at present termed cognitive, affective, conative. In this canvass the questions treated by the normative philosophical sciences under head of value [logic dealing with value of the knowledge process, ethics with value in conduct, and aesthetics with value in feeling] must arise because they are synonymous with the problems of effective functioning" (Kellogg, 1904, p. 164).

The idea that teleologies, values, are to be avoided at all costs continues to haunt a good deal of scientific inquiry, to what is ultimately its detriment (Douglas, 2009; Longino, 2004). To elevate the place of values in science is to challenge the fact-value dichotomy (Putnam, 2002), leading some to regard the inquiry in question as lacking in rigor and integrity. Yet the dichotomy is mistaken and unsustainable, as is the point of Putnam's essay and as is well recognized by pragmatists. Indeed, Putnam notes that he follows Peirce and other "classical pragmatists," among whom James and Dewey would be first in line, in arguing that "science itself presupposes values – that epistemic values (coherence, simplicity, and the like) are values too" (Putnam, 2002 p. 4).

We see a failure to confront the role of values in distributed cognitive systems and creating conceptual difficulties for D-cog. Representations and representational states are described in what appear to be value neutral terms. Even as D-cog radically rejects the

individualist framework that has historically characterized cognitive science, it retains traditional concepts of cognitive science, including the notion that cognitive processes are computational processes and the notion that computations take place over representations. Hutchins describes computations as taking place via "representational states…within the given cognitive system that includes both the embodied human agents, their patterns of communication and traditions of practice, as well as the material artifacts, devices, and instruments they use" (Hutchins, 1995, p. 373). An important feature of representational theories has been their ability to provide an explanation for our power to recombine and rearrange elements of perceptual experience central to innovation and theoretical advance, particularly important in the context of science practice.

But there questions begged about the very divisions between "inner" and "outer" that D-Cog and similar perspectives seek to avoid. Hutchins notes that representational media "may be inside as well as outside the individuals involved" (Hutchins, 1995a, p. 373). We have discussed this problem in more detail elsewhere (Osbeck & Nersessian, 2006). Briefly. the traditional notion of internal representation is problematic when understood as structures or other entities "in the head" (whether mind or brain) that disconnect cognition from our social and material environments and erect a barrier between knowledge and action. For D-cog, an account of the nature of the representations in the brain component of the system that feasibly can couple with external representations remains to be developed (see Nersessian 2009 for an effort in that direction). More importantly for the present discussion, the notion of representation in distributed cognitive systems is saturated with unrecognized implications of value. It has long been recognized that "external representations" in the form of drawings, pictures, paintings, diagrams, graphs, charts, and statistical formulae are loci of symbolic meaning and vehicles of communication that may be understood as representational, though the form of representation is

socially shared rather than internal (see, e.g. Goodman 1976). Given these concerns, we have in another paper attempted to outline a variety of ways representation itself might be considered to be distributed in a distributed cognitive system (Osbeck & Nersessian, 2006). Similarly, in attempt to provide a more adequate account of representation, Ed Reed introduced the notion of representational systems, emphasizing that the representational power of artifacts, whether pictures, measurements, maps, money, or alphabets, stems from its part in a cultural meaning system; an artifact's use is given meaning and thus representational significance within the constraints of such an institution. (Reed, 1991). The ecological concept of "affordance" (Gibson, 1979; Greeno, 1998) is really directed at values, the value of objects for perceiving organisms in an environmental niche. A variety of non-representational approaches to problem solving and learning have emerged in recent decades. In aligning with ecological theories and extending their implications to the cognitive and social realm, these approaches at least implicitly and sometimes explicitly invoke the saturation and permeation of psychological processes with value considerations, teleologies, and meanings (e.g., Chemero, 2009; Good, 2007; see also Anderson, 2003).

Values are notoriously difficult to define and overlap with many other things, but among the things with which they overlap are emotional states - affective experience, as Angell understands: "From the very beginning of this process of adjustment to the world of physical nature and to the presence of other human beings, there is operative the strong and persistent influence of feeling, emotion, and desire" (1915, p. 35).

The central place of value and affect, then, a consequence of socially distributed account of representation, is not emphasized in D-Cog, to what we regard as a disadvantage. We are able to say this on empirical as well as conceptual grounds, having found in our efforts to advance the

framework of D-cog that values - epistemic, social, cultural, and personal - infiltrate every level of science practice, most obviously and consistently in the collaborative spaces of interdisciplinary and transdiscipinary science (Osbeck, Nersessian, Malone, and Newstetter, 2010). Thus a significant affordance of a renewed look at Functional Psychology in relation to Distributed Cognition is the reminder of the place of value in any distributed system, not to mention on the part of any cognitive scientist conducting research within and on that system.

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References

Adams, F., & Aizawa, K. (2008). *The bounds of cognition.* Oxford: Blackwell.

Angell, J.R. (1903). The relations of structural and functional psychology to philosophy. The *Philosophical Review*, vol 12 (3), 243-271.

Anderson, M. (2003). Embodied cognition: A field guide. *Artificial Intelligence*, 149 (1), 91-130.

Angell, J.R. (1907). The province of functional psychology. *Psychological Review*, 14, 61-91.

Angell, J.R. (1908). *Psychology: An introductory study of the structure and function of human consciousness.* New York: Henry Holt.

Angell, J.A. (1915). *Chapters from Modern Psychology*. New York: Longmans, Green, & Co.

Angell, J.R. and Moore, A.W. (1896). Reaction time: A study in attention and habit. *Psychological Review*, 3, 245-258.

Baldwin, J.M. (1896). The type-theory of reaction, *Mind* (5), 81-90.

Baldwin, J.M. (1902). Development and evolution.

Barke, A. (2001). John Dewey and early Chicago Functionalism. *History of Psychology*, 2001 4, 323-340.

Benjamin, L. (2007). A brief history of modern psychology. Oxford: Blackwell.

Boring, E.G. (1957). *A history of experimental psychology*. New York: Appleton Century Crofts. (Original work published 1929)

Carleton, L. R. (2001). The rise of Chicago Functionalism. In J. Shook (Ed.), *Functionalist psychology*, pp. 370-390. Originally published 1982.

Calkins, M. W. (1906). A reconciliation between structural and functional psychology. *Psychological Review*, 13(2), 61-81.

Carr, H. (1910). Studies from the psychological laboratory of the University of Chicago: The autokinetic sensation. *Psychological Review*,17(1), 42-75.

Carr, H. (1930). Functionalism. In C. Murchison (Ed.*). Psychologies of 1930* pp. 59-78. Worcester, MA: Clark University Press,.

Carr, H. & Watson, J. (1908). Orientation in the white rat. *Journal of Comparative Neurology and Psychology*, 18 (1), 27-44.

Chemero, A. (2011). Radical embodied cognitive science. Cambridge, MA: MIT Press.

Clark, A. (2003). *Natural born cyborgs: Minds, technologies, and the future of human intelligence*. Oxford, UK: Oxford University Press.

Clark, A. (2008). *Supersizing the mind: Embodiment, action, and cognitive extension*. New York: Oxford University Press.

Darwin, C. (1859). *The origin of species*. London: John Murray.

Dewey, J. (1896). The reflex arc concept in psychology. *Psychological Review,* 3, 357-370.

Dewey, J. (1916). *Democracy and education*. New York: Simon & Schuster.

Dewey, J. (1970). The need for a recovery of philosophy. In Dewey, J., Moore, A., Brown, H., Mead, G.H., Bode, B., Stuart, H., Tufts, J. & Kallan, H. *Creative intelligence: Essays in the pragmatic attitude.* New York: Henry Holt. Originally published 1917.

Dewey, J. (1922). *Human nature and conduct. An introduction to social psychology*. New York: Henry Holt.

Dewey, (1925). *Experience and nature*. London: George Allen & Unwin.

Dewey, J. (1938). *Logic: The Theory of Inquiry*. New York: Henry Holt.

Dewey, J. (1970). The need for a recovery of philosophy. In J. Dewey, A. Moore, H. Brown, G.H. Mead, B. Bode, H. Stuart, J. Tufts, and H. Kallan. *Creative intelligence: Essays in the pragmatic attitude*, pp. 3-69. New York: Octagon Books. Originally published 1917.

Dewey J. & Bentley, A. (1949). *Knowing and the known*. Boston: Beacon.

Dilley, R. (1999). Introduction. *The problem of context*, pp. 1-46. New York: Berghahn Books.

Douglas, H. (2009). Science, policy, and the value-free ideal. Pittsburgh, PA: University of Pittsburgh Press.

Engel, A., Maye, A., Kurthen, M., and König, P. (2013). Where's the action? The pragmatic turn in cognitive science. *Trends in Cognitive Sciences*, 17(5), 202-209.

Gibson, J.J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.

Giere, R.N. (2002). "Scientific cognition as distributed cognition," in P. Carruthers, S. Stitch, & M. Segal (Eds.), *The Cognitive Basis of Science*, pp. 285-299. Cambridge: Cambridge University Press.

Good, J.M.M. (2007). The affordances for social psychology of the ecological approach to social knowing. *Theory & Psychology*, 17 (2), 265-295.

Goodman, N. (1976). Languages of art. New York: Hackett.

Green, C. D. (2009). Darwinian theory, functionalism, and the first American psychological revolution. *American Psychologist*, 64(2), 75.

Greeno, J. (1998). The situativity of knowing, learning, and research. *American Psychologist*, 5(1), 5-26.

Greenwood, J. (2009). *A conceptual history of psychology*. New York: McGraw-Hill.

Heidbreder, E. (1933). *Seven psychologies*. Englewood Cliffs, N.J.: Prentice-Hall.

Hutchins, E. (1995a). How a cockpit remembers its speeds. *Cognitive Science*, 19, 265-288.

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

James, W. (1890). *The principles of psychology* (Vols 1-2). New York: Henry Holt.

James, W. (1907). *Pragmatism: A new name for some old ways of thinking*. New York: Longmans, Green, & Co.

Jastrow, J. (1901). Some currents and undercurrents in psychology. *Psychological Review* 8, 1-26.

Kellogg, A.L. (1904). Review of 'The Relation of Structural and Functional Psychology to Philosophy.' *Psychological Bulletin*, v,1(5), 163-165.

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. New York: Cambridge University Press.

Longino, H. (2004). How Values Can Be Good for Science. In P. Machamer & G. Wolters (Eds), S*cience, values, and objectivity,* pp. 127-142. Pittsburgh, PA: University of Pittsburgh Press.

Nersessian, N. J. (2005). Interpreting scientific and engineering practices: Integrating the cognitive, social, and cultural dimensions. In M. Gorman, R. D. Tweney, D. Gooding & A. Kincannon (Eds.), *Scientific and technological thinking* (pp. 17-56). Hillsdale, N. J.: Lawrence Erlbaum.

Nersessian, N. J. (2009). How do engineering scientists think? Model-based simulation in biomedical engineering research laboratories. *Topics in Cognitive Science*, 1, 730-757.

Nersessian, N. J. (2012). Engineering Concepts: The Interplay between Concept Formation and Modeling Practices in Bioengineering Sciences. *Mind, Culture, and Activity*, 19(3), 222-239.

Nersessian, N. J., Kurz-Milcke, E., Newstetter, W., & Davies, J. (2003). Research laboratories as evolving distributed cognitive systems. In D. Alterman & D. Kirsch (Eds.), *Proceedings of the Cognitive Science Society*, 25,pp. 857-862. Hillsdale, NJ: Lawrence Erlbaum Associates.

Newell, A., & Simon, H. A. (1972). *Human Problem Solving*. Englewood Cliffs, NJ. Prentice-Hall.

Osbeck, L. M., & Nersessian, N. J. (2006). The distribution of representation. *Journal for the Theory of Social Behaviour*, 36(2), 141-160.

Osbeck, L. M., Nersessian, N. J., Malone, K. R., & Newstetter, W. C. (2010). *Science as psychology: Sense-making and identity in science practice.* New York: Cambridge University Press..

Raphelson, A. (1973). The pre-Chicago association of the early functionalists. *Journal of the History of the Behavioral Sciences*, 9, 115-122

Ratner, J. (1963). Foreward to Dewey, J.: Philosophy, psychology, and social practice, pp. 9-15. New York: Capricorn.

Reed, E. S. (1991). Cognition as the cooperative appropriation of affordances. *Ecological Psychology*, 3(2), 135-158.

Reid, Thomas (2002). 1785/2002, *Essays on the intellectual powers of man*, Derek Brookes (ed.), University Park: Pennsylvania State University Press. Originally published 1785.

Segall, M. H., Campbell, D. T., & Herskovits, M. J. (1966). *The influence of culture on visual perception.* Oxford, England: Bobbs-Merrill.

Shook, J. (2001). Introduction. In J. Shook (Ed.), *Functionalist psychology*, pp xi-xxix, Bristol: Thoemmes Press.

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis.* Oxford, UK: Appleton-Century.

Smith, R. (2013). *Between mind and nature*. London: Reaktion Books.

Titchener, E.B. (1895). Simple reactions. *Mind*, 4, 74-81.

Titchener, E. B. (1898). The postulates of a structural psychology. *Philosophical Review*, 7, 449-465.

Titchener, E. B. (1899). Structural and functional psychology. *Philosophical Review*, 8, 290-299.

Vico, G. (1984). *The new science of Giambattista Vico*. Cornell University Press. Originally published 1725.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wheeler, M. (2010). In defense of extended functionalism. In R. Menary (Ed.), *The extended mind*. Cambridge, MA: MIT Press.

Wittgenstein, L. (1953) .*Philosophical Investigations*. Oxford:Blackwell.

Woodworth, R. (1948). *Contemporary schools of psychology* (2nd Ed.). New York: The Ronald Press Co.

Wundt, W. (1916). *Elements of folk-psychology*. E.L. Schaub, Trans. London: Allen