European Management Review, (2020)
DOI: 10.1111/emre.12442

Cognition in Organisations: What it Is and how it Works

DAVIDE SECCHI and STEPHEN J. COWLEY
Research Centre for Computational & Organizational Cognition, Department of Language and Communication, University of Southern Denmark–Slagelse, Denmark

Drawing on contemporary work that traces cognition to embodiment, we present a model of cognition in organisations. In so doing, we add a middle ground to previous models: far from opposing macro to micro, we focus on how the meso influences complex adaptive dynamics. Taking peer-review as an exemplar, we show that organisational needs can be fulfilled by orchestrated coordination. Constrained by brains and bodies (the micro domain) that attune to structural constraints (the macro domain), human beings use material culture – artefacts, language, practices, etc. – to animate what we call social organising in the meso domain. The resulting coordination can anticipate organisational goals such that, as demonstrated in the case of peer-review, social organising regulates epistemic practice. Flexible, embodied activity enables reviewers and to meet the aims of organised science by pooling the expertise of those involved. They use multi-scalar dynamics that are mediated by material, temporal and spatial resources that, when concerted, constrain and enable organisational cognition.

Keywords: organisational cognition; e-cognition; distributed cognition; social organising; meso domain; micro–macro gap; peer-review case study

Introduction

In recent decades many have linked cognition with organisational research (e.g., Cannon-Bowers and Salas, 2001; Ilgen *et al*., 1994; Schneckenberg *et al*., 2019; Walsh, 1995) and/or reconsidered aspects of organisational life in relation to cognition (Hodgkinson and Healey, 2008). Meanwhile cognitive science has transformed its theoretical core: this appears in contrasting how 'cognition' is used in the organisational literature (Secchi and Adamsen, 2017) with how it is viewed in the now dominant *embodied* perspective (Robbins and Aydede, 2009; Shapiro, 2010). In approaching cognition-in-organisations, decision making and action are usually traced to the workings of a brain. Yet, human embodiment is now the focus of contemporary cognitive science (e.g., Clark, 1997; Chemero, 2009). Resources external to cerebral computations are seen to act as constitutive parts of cognitive processes in living systems (for a foundational text, see Varela *et al*., 1992). Using this new theoretical focus on cognition 'beyond the brain' (Hutchins, 1995a; 2014; Clark, 1997; Cowley and Vallée-Tourangeau, 2017) the paper offers a simple model of how cognition contributes to organisational activity and human organising.

We show that cognition is embedded in multiple aspects of organisational needs and concerns that connect communicational dynamics with what people actually do. In describing the ongoing dynamics as *social organising*, we treat human action as more than behavioural and behaviour as less than fully organised action. Our approach thus offers an alternative to opposing the macro to the micro. More precisely, we add a middle ground and focus on micro-meso-macro interconnected dynamics as multi-scalar activity that allows people to use what we call *organisational cognition*.[1] There are at least two main reasons for undertaking this conceptual endeavour. One is that without any conception of *social organising*, theory overplays how hidden structures allegedly influence what people do and think in organisations. Instead of taking multi-scalarity seriously, many seek structural and/or individual-based 'causes'. The second reason is that, by

Correspondence: Davide Secchi, Research Centre for Computational & Organizational Cognition, Department of Language and Communication, University of Southern Denmark–Slagelse, Sdr. Stationsvej 28 4200 Slagelse — Denmark. E-mail secchi@sdu.dk

[1]When we refer to 'cognition in organisations' we are referring to a wider set of literature to which 'organisational cognition' is one way of dealing with it that is typical of management. Our aim is that of using the first as an umbrella term for the second.

unveiling the forces that construct and sustain the changing meso domain of social organising, the researcher is naturally nudged into thinking of organisational cognition as a complex system. The focus on complexity is not *per se* new, since many management scholars have argued along these lines for decades (e.g., Burnes, 2005). However, what is unique to the model is its emphasis on dynamics that undermine the dichotomy individual vs system by emphasizing what used to be a black box, that is, the actional or meso domain. This means that our model can unite fine grained video ethnographic work with a perspective framed by agent-based simulations. As a result, it becomes relatively straightforward to isolate both macro and micro mechanisms and also determine how they co-function. With an agent-based simulation perspective, researchers can create fairly complex simulations that can account for describing (or *illustrating*, as Edmonds *et al*., 2019 would put it) organisational cognition. In turn, the results of this work can be pursued 'in the wild' by using what the models show together with a range of ethnographic and qualitative methods that include fine-grained video analysis. In considering cognition as the co-functioning of micro-meso-macro domains, we frame modes of action that are plastic (i.e., adaptive and flexible). Hence, this interpretation of cognition becomes important to the understanding of organisations.

To illustrate the model we use peer-review as a case study of how embodied cognitive science can be used to rethink many organisational phenomena. The example is apposite in that, while organisation studies traditionally focus on formal organisations (as traditionally defined by Blau and Scott, 1962; Scott, 2003) peer-review is both highly dependent on the informal and also dedicated to the control of innovation or knowledge creation – it incorporates a bundle of activities facilitated by a publishing company. Indeed, precisely because the creative process is only loosely organisational, the example is especially telling. Not only does peer-review exhibit what we term *social organising*, but its innovative outcomes connect loosely defined practices with both personal idiosyncrasies and well-defined organisational contexts (e.g., publishing companies). In this paper, we leave aside debate about what an organisation is to take a pragmatic approach. This is to say that any situation in which an organisation serves as a macro-structure of reference (i.e., the 'context' in one of the previous sentences) gives the opportunity for *social organising* to be studied. Further, it is argued that a mix of 'softer' and more traditional modes of organising is increasingly important to contemporary businesses (Nohria, 1994; Fioretti, 2012; Herath, 2019). Finally, since peer-reviewing is put in place (and managed, even if remotely) by a publishing company, the example is easily connected with traditional organisational concepts (redescribed here in terms of the *macro* or the 'supra-structural').

In an attempt to deal with the complexity of actual phenomena, bounded rationality (Simon, 1997[1947]; Cyert and March, 1963), on the one hand, and sensemaking (Weick, 1993) as well as streams in social psychology (e.g., Brewer and Gardner, 1996), on the other, have addressed organisational issues with an individual-centred focus, with different degrees of intensity. Whereas the link between *macro* (e.g., culture, structure, hierarchy, power) and *micro* (e.g., skills, abilities, professionalism, self-efficacy) is often seen as 'psychological' (e.g., Barling and Cooper, 2008) or 'interactional' (Turner and Turner, 1978; Ten Have, 2016), such views cease to apply when one adopts an *embodied* perspective to cognition. Rather than strive to 'fill' a micro–macro gap, we trace complex projects to how professional and social persons cooperate while using devices and routines. Their activity constitutes a *meso* domain whose concerns are central to management and thus aptly labelled as involving *social organising*. Using action relevant to the organisation, the *meso* domain binds like a glue that connects the various elements together. This unique aspect of cognition in organisations is entirely lost where the focus falls on the individual and their brain activities (e.g., Hodgkinson and Healey, 2008) or 'shared' cognition (e.g., Cannon-Bowers and Salas, 2001) as a (*de facto*) average of individual cognitions. By highlighting the meso-domain, we open the 'black box' of thinking, practices and happenings between individuals by focusing on how actions are enhanced or constrained by micro and macro-structural elements.

In the next section we offer a model of organisational cognition that, we claim, can resolve many tensions in contemporary research (e.g., a mismatch between the tools used in organisational cognition research and observed organisational phenomena). We then use the case of peer-review to illustrate our model and we conclude with a few remarks.

A model for the study of organisational cognition

Figure 1 draws a model of organisational cognition. Its *micro*, *meso*, and *macro* areas are defined as follows. The first (*micro*) area identifies *neurophysiological* processes that draw on the subjectivity of a biological individual (the 'individual sphere' in Figure 1) who may act alone or together with others. Second, the *macro* domain applies to well-known aspects of organisational life that include culture (Cameron and Quinn, 2011), power structures (Pfeffer, 1992), policies and regulations (Powell and DiMaggio, 1991), routines (Feldman and Pentland, 2003) or, broadly, the *supra-structural* domain

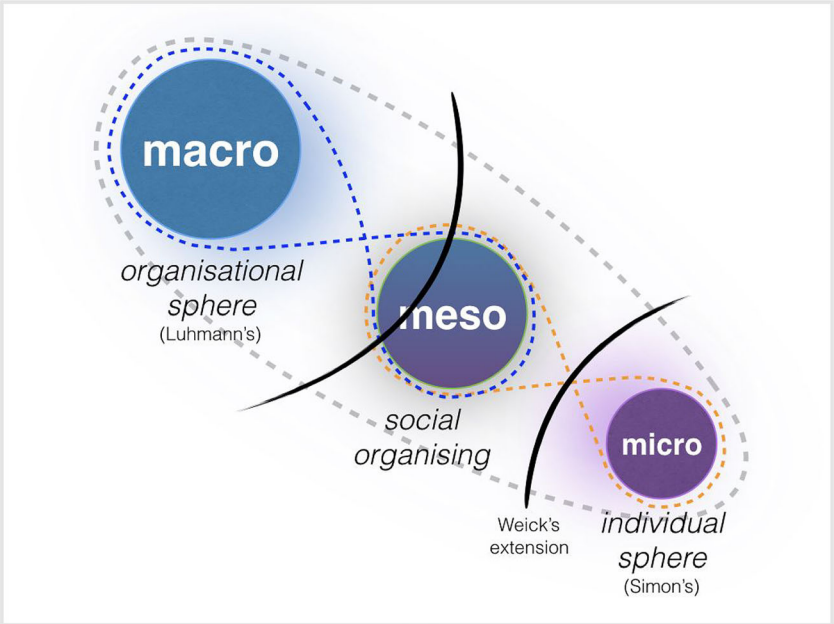

Figure 1 A simplified model for organisational cognition

of slowly changing social and history-bound constructs (Neumann and Cowley, 2016). Crucially, these transcend activities by individual participants in organisations. Accordingly, organisations also rely on people who, both alone and together, enact a *meso* domain. As they do so, they sustain (and, gradually, alter) supra-structural patterns and dynamics. While most readily grasped in relation to activity by several parties, the *meso* domain enables individuals to use equipment, make solo decisions or perform communicative activities. Social organising thus connects what we call 'intelligence' (e.g., Simon, 1997[1947]; Clark, 2003) with both team and group work and also various sporadic or accidental social interactions.

In this paper, the approach to human collaboration contrasts with views that ascribe cognition to brain-centred individual capacities. The individual focus fits with both traditional psychology and the philosophical view that the individual mind or brain is the seat of human reason (as in Simon, 1997[1947]). In adopting this view, many cognitive approaches to organisations overlook either *social organising* and/or the functions of the supra-structural (Lant and Shapira, 2000; Hodgkinson and Healey, 2008; Secchi and Adamsen, 2017). In contrast, in the proposed framework, the hub of organisational life is traced to the social aspect of organising. Given its complex adaptive nature, human activity can be regulated to ensure that collaborative projects (and outcomes) arise as people make sense of tasks, goals and the doings of others (Baber *et al*., 2006; Perry, 2013; but also Weick, 1993, see below). It is because such forms of social action are irreducible to subjectively controlled behaviour that the organisation as a whole (the total system which includes the *macro* in Figure 1) can be distinguished from its constitutive subsystems. In meeting goals and objectives, these sub-systems integrate and complement each other as both individual and team performance contribute to outcomes that an organisation values. Cognition in organisations can thus be traced to changing relations between the domains that appear in Figure 1. In treating cognition as connecting the domains – giving rise to modes of action that are both adaptive and flexible – the concept of cognition becomes central to the study of human organisations. In unveiling the intertwined connections between these three domains, the framework provides a useful bridge between qualitative work and the modelling of complex adaptive systems. Indeed, the model allows agent-based computational simulation to be seen as an especially valuable tool in the study of cognition and organisational behaviour (e.g., Secchi and Neumann, 2016). In our view, action arises from how living systems draw on *simplexity* (Gahrn-Andersen, 2019; Berthoz, 2012) and, in humans, much depends on epistemic phenomena based on an evolutionary history of how living bodies engage with the world. Accordingly, we emphasise human experience in a meso domain of coordinated social organising. In peer-review, for example, one deals both with broad questions of method and nuances of meaning – delicate ways of construing texts – that demand an approach that builds on human use of coordination that is mediated by bodies, language and documents.

The central tenet of this paper is that cognition is not to be identified with either the workings of the total system

or with that of individual sub-systems. Rather, as for distributed cognition (e.g., Hutchins, 1995a, 1995b), cognitive processes connect the doings of individuals with each other, with a highly structured cultural environment, and with the workings of brains, equipment and bodies. For this reason, circumstances affect all cognitive processes or, in other terms, cognition is always situated (as Hutchins explains in describing how to land a plane; Hutchins, 1995b). It is, we suggest, a biological fact that cognition demands embodied interaction between internal (i.e., individual or brain-related) and external (i.e., environmental) parts of larger systems (e.g., a niche). On this view, the cognitive process involved in, say, the act of drawing a timeline of events on a board is irreducible to an agent's mental (hence internal) processing. Rather, the processes are distributed over the board, the marker, the drawing, the context of the meeting, those to whom the drawing is directed to, and some of the agent's mental abilities. It involves *material relationality* – how one adds to experience by engaging with people and things.[2] Thus to take any of the elements – including mental processing – out of cognition is to describe a quite different cognitive process (Clark and Chalmers, 1998; Menary, 2010b). However, before defending this *systemic* view, we contrast it with one that is often used in organisation and management research. We then outline the three components of Figure 1, specifying the *micro* or individual and the *macro* or supra-structural domains. The section ends with the presentation of the *meso* domain, or *social organising*.

A look at cognition from bounded rationality

For Herbert Simon and most working in classic cognitive science, including up to recent and very recent work in management (e.g., Grandori, 2007; Sturm, 2012; Schneckenberg *et al*., 2019), cognition links two sets of resources. Simon (1990) uses the metaphor of a pair of scissors to make an epistemic cut between what he calls the 'internal' and the 'external'. This enabled him to overlook the body by attributing intelligence to a brain (the internal) that depends on information about the outside world (the external). As the metaphor suggests, the cutting edges are separable and yet, if the scissors are to work, they must be brought together. In other words, if one is to make a cognitive cut by, for example, deciding whom to hire or whether to seek a patent, a manager must link resources 'in the head' with information from the world. From Simon's perspective, the concept of *environment* serves, first, in defining the dynamic relation between a cognitive system 'internal' to a human being and information about outer resources (Vera and Simon, 1993). Second, the concept of the environment delineates the bounds of the system (Cooper, 1986). Further, if the brain is identified with a human individual, its disembodied workings can sustain the generic intelligence that serves an organisation (i.e., whether employees, managers, executives, or other stakeholders). By the same token, all cognitive value is determined by how the brain 'processes' information (Petracca, 2017). Unlike those adopting methodological solipsism, moreover, Simon grants considerable importance to the outside world. Yet, rather than distinguish between the *macro* and the *meso*, his computational lens reduce the world to what information processing systems can access and represent. Comparable brain-centred views of cognition are, of course, widely used in cognitive psychology and, thus, fields such as leadership studies (e.g., Lord *et al*., 2001) or organisational culture (e.g., Harris, 1994).

To widen the perspective, many link cognition to the study of organisational behaviour (Simon, 1997[1947]; Gavetti *et al*., 2007). Since organisations value human intelligence, this is important. However, one can also build on Simon's discovery that individual intelligence is bounded. Indeed, this insight is independent of belief in brain bound cognition. In the last 30 years, 'internalist' views have been complemented – and challenged – by a wide range of work on *embodiment* (see, Brooks, 1991; Clark, 1997; Chemero, 2009; Shapiro, 2010; Stewart *et al*., 2010). While Simon's 'information processing' overlooks the body, we focus on embodied perception, action and decision making. In giving emphasis to the *meso*, we stress that the study of organisational behaviour can gain much from attending to factors overlooked by Simon. Much depends on coordinated activity in the world beyond the brain.

Extending the micro: the sensemaking approach

In organisational studies, the work of Weick has gained much attention (Weick and Roberts, 1993; Walsh, 1995). Although Weick does not make Simon's neat distinction between the internal and the external, his *sensemaking* approach nonetheless reduces environmental (either *macro* or *meso*) elements to how they appear from a psycho-cognitive perspective. On this view, embodied individuals construct (make sense) of their perception of reality (Weick, 1979). Yet, in bringing subjectivity to the centre, the individual becomes, not an information processor, but an 'experiencer'. Thus, like Simon, Weick attributes cognition to neural core. Since this is not the place to challenge this view (we have variously covered this aspect in previous work; e.g., Secchi, 2011, 2016; Secchi and Cowley, 2018), we emphasise only that, while Weick's work is of importance, it takes an old-fashioned

[2]This point can be read as both paying homage to and correcting how Latour and Woolgar (1986) highlight material relations.

view of 'minds' (Weick and Sutcliffe, 2006). It appeals to, not functionality (Clark and Chalmers, 1998), but an intuitive sense of *experience* (Thompson and Stapleton, 2009). In terms of Figure 1, the *sensemaking* perspective severs the biological individual from both *meso* and the *macro* domains or, in other terms, what lies beyond the body. Indeed, for Weick, this is necessarily so because making sense of the perceived is treated as 'subjective'. Given this kind of individualism, one can ignore action, bodies, sources, interactivity and dynamics (Thompson and Stapleton, 2009). As one of us argues elsewhere (Secchi, 2011; Secchi and Adamsen, 2017) Weick omits key elements of socially or organisationally oriented cognition even in challenging the narrowness of much work on decision making (Weick and Sutcliffe, 2006). In Figure 1, therefore, we place Weick's approach beyond the *micro* domain while stressing its failure to capture the power of material culture and the activity that arises in what we define as the *meso*.

We claim that difficulties arise from how the sensemaking approach understands the external environment and this is not dissimilar from what Simon calls the 'the environment'. This is because, while individual intelligence is bounded, humans use the world in extending the bounds (Secchi, 2011) of their own understanding: they use material culture that includes tools, language, organisations and institutions. Accordingly, views of *extended* mind (e.g., Clark, 2003) and *embodied* cognition connect with ecological psychology (Gibson, 1977), and, emphasising embodied dynamics, the paradigm of *enaction* (see, Stewart *et al*., 2010). By giving up the scissors metaphor, one can allow that embodiment changes as living human beings, persons, sensitise to both material and supra-structural factors (e.g., cultural niches – the *macro* domain). In looking beyond information, body and world contribute to understanding, action, and interaction. In the work on distributed cognition (Hutchins, 2014), for example, problem solving and decision making are traced to how people perform roles in the organisational setting – they draw on, not just behaviour, but also concerted activity and equipment. Hutchins (2014) therefore makes the cultural ecosystem central to organisational cognition. However, our concern reaches beyond organisational routines, practices and procedures (e.g., Miller *et al*., 2012) in that it extends to instances where people operate in less constrained ways (as in chance seeking behaviour; Bardone, 2011) or under cognitive uncertainty (Michel, 2007). Rather than focus on how activity is constrained by the slow processes of a cultural ecosystem, we stress how people harness bodily resources as they undertake cooperative activity. For the same reason, we focus on the activity of *social organising* and not mere description of ecosystems.

Tackling the supra-structural

Supra-structures transcend individuals because they self-sustain in time scales that are slower than those of lived human action. For example, if one employee does not show up at work, the overall organisational dynamics are unlikely to show much change. Although there may be shifts in how particular procedures, practices, or routines are conducted, a single person's absence rarely obliterates either a practice or the organisation (e.g., Pentland and Feldman, 2005). Of course, the phenomenon varies in that absence of a key individual – a manager or someone with expert knowledge of some kind – may lead to increased disruption. Nonetheless, as those at work adapt, the dynamics change as the supra-systemic domain exerts *some* autonomy (as subjective changes also appear). The general view applies to all the supra-structures of an organisation and, strikingly, it does so as they change and adapt in ways that rarely depend on what the employees and managers actually do (Michel, 2007). Further, these dynamics support individual (and group) cognition in that they constitute external routines and practices (Magnani, 2007). A codified procedure, for example, serves an individual worker in performing a range of tasks that may or may not involve other colleagues.

Since living humans are necessary to the development and maintenance of supra-structures, their autonomy is necessarily limited. Our systemic model is thus usefully distinguished from Luhmann's 'systems view'. At the risk of oversimplification, Luhmann's (1995) work can also be contrasted with that of Weick. While the latter traces cognition to subjective sense-making, Luhmann unites the *meso* and *macro* domains by appeal to autonomous social systems (based on a putative autopoietic status). As a sociologist, Luhmann (1995) leaves aside issues concerning human agency by emphasising 'communication'. By so doing, he treats social systems as program-like and thus independent of psychology and behaviour (for critique, see Fuchs and Hofkirchner, 2009). In the model offered here (Figure 1), we point to how Weick overplays the subjective and, by contrast, how Luhmann underestimates the importance of concerting their activity between people. While Luhmann's conception of 'communication' escapes from views where people send messages from head to head (or what Harris, 1981, ridicules as *telementation*), he overplays the disembodied or, simply, *what is said*. In reducing embodiment to 'psychology', he leaves aside how organisations, teams, groups and persons-in-role solve problems and make decisions. In short, while sharing Luhmann's positive view of systems theory, we clarify systemic functions by appeal to how material and institutional resources grant considerable flexibility to human action. As with Chemero's (2009) *radical*

embodied cognitive science – a view centred on agent-world interaction (not mental states) – our systemic perspective attributes *social organising* to living persons who achieve results while drawing on supra-individual and organisational domains. Consistently with Chemero's work, our systemic perspective takes a "radical" view of embodiment.

Social organising or the 'missing link'

Cognition can be defined in terms of the enabling conditions for behaviour (Wheeler, 2005; Secchi and Cowley, 2018). Indeed, appeal to such conditions makes it possible to better understand the power of human organisations and, in so doing, helps clarify the uniqueness of human social activity. To fully explore this area, it is of value to begin with how the super-structural organisational *macro* domain, on the one hand, and the individual *micro* domain, on the other, influence the social dynamics of organising. It is the binding role of the various *meso* domains that allow individuals to cognise within wider socio-economic systems. These can be compared to the convergence between the *emergent* (e.g., Cunningham, 2001) and *immergent* dynamics (e.g., Andrighetto *et al*., 2007) that characterise complex systems. The results can be pursued in both agent-based simulation models (Baker, 2010) and, by using video ethnographic methods (e.g., language research, see Cowley, 2014), human interactivity (Steffensen *et al*., 2016). In the following, we pursue how the *meso* domain works and why we regard it as the core component of all kinds of organisational cognition.

First, since persons live in cultures and develop by learning to use linguistic and other resources, cultural products shape human consciousness and thus *all* human action (Donald, 2001). As argued by Hutchins (1995a, 2014), a distributed perspective can be applied to human practices in general – this is the *ecological* aspect of cognition. Where organisations achieve outcomes, they depend on people who act in cognitive ecosystems that establish physical and cultural constraints (e.g., organisational learning, leader-member exchange, organisational justice, prosocial and extra-role behaviour). Even something as easy as writing an e-mail is deeply social in drawing on who we are as persons (*enacted* cognition). Indeed, it links writers with voices and expertise as they anticipate a receiver's hopes and expectations: people bring systemic knowledge and cognitive powers in ways that they could not achieve alone. Writing is thus a form of co-action – it is directed at someone. While originally explored in experiments on co-action (Wenger and Sparrow, 2007), it is emblematic of *social organising*. Above all, this is because understanding, planning and cooperation draw on cultural products – whether tools, institutions, talk or text – in so many ways. While *social organising* may involve more than one person, the meso domain often depends on individual activity (as in writing an e-mail). Indeed, one of us argues elsewhere that a principle of 'cognitive separation' underpins human use of tools, institutions and language (Cowley and Vallée-Tourangeau, 2013), that is, the *extended* aspect of cognition. By treating objects as independent of persons (even as we work with them), human agents gain from linking history to bodies in anticipating what they – and others – are likely to say, feel and achieve (Donald, 1991) – this is the *embodied* aspect of cognition.

In broad terms, the classic mind-centred view of cognition has been supplemented with ecological, enacted, extended and embodied additions. In other traditions, similar issues start from how social behaviour grants 'psychological' and 'experiential' ways of getting things done. Among the more influential of such approaches are social identity theory (Tajfel, 1978), ways of conceptualising collective self (Brewer and Gardner, 1996) collective intentionality (Zahavi, 2018), tracing teamwork to cross-functional activity (Parker, 2011) and seeking to clarify 'experiential, behavioural and brain dynamics' (Laroche *et al*., 2014). Thus, social identity invokes individual cognitive and coping activity (Scheepers and Ellemers (2019) that can be associated with phenomenology, self or even real-time functionality. While not the place to critique such theories, *social organising* does not focus on psychology or experience any more than it does on particular ways of adding to brain-based powers.

Challenging cognitivist focus on perceiving and monitoring ('situation awareness'), emphasis falls on what Lambros Malafouris (2019) calls 'thinging' or, as we prefer, material relationality. In a classic case, Fioratou *et al*. (2010) show how those working with anaesthetists use *distributed situation awareness*. Parties act in concert as they integrate 'situational cues from multiple, dynamically changing data streams' (Fioratou *et al*., 2010, p. 83). Far from relying on interaction or complex selves, bodies and equipment co-perceive, adapt and display to create 'an evolving situation' (Fioratou *et al*., 2010, p. 83) where each party tracks activity by using "relevant expertise". Material relationality thus supplements and, to a large extent, replaces language in allowing parties to integrate experiential, brain and body dynamics in epistemic action. In pursuing how the unit achieves the goal of giving a patient the right amount of the correct drug at a suitable moment (Fioratou *et al*., 2010), we claim what matters is, not real-time activity, but continuous actions in the meso scale of *social organising*. In modelling behaviour like that associated with distributed situation awareness, one can pursue the dynamics of relational systems to simulate how the team bring forth outcomes that depend on material relationality. The

process is not to be traced to self, identity or mind-centred cognition: in pursuing its intrinsically organisational nature, we later draw parallels with the case of a manuscript that is subjected to critical peer-review.

Social organising has been studied in many domains. In what we see as a classic case of organisational cognition, Perry (2013) traces how road construction depends on temporary works (e.g., building tracks) and how parties use ad hoc resources (e.g., deducing if someone has been on site by looking at the state of their Wellington boots). In another case, Pedersen (2012) traces the low frequency of medical errors to the fluid organising of emergency medical teams. While their goals are defined by patient diagnosis and well-being, in emergency medicine, however, problems are messy, ill-defined and urgent – teams act as they concert expertise in lived time. Medical procedures are redundant, demand improvisation and, surprisingly perhaps, successful outcomes often draw less on talk than on unnoticed, fine adjustments in bodily activity. As people perform in teams, they manage social organising by acting in a particular role. By so doing, they unthinkingly draw on contingencies as they link up individual knowledge, organisational structures, culture, stakeholder expectations, and more besides. Cognitive outcomes link rapid processes to lived experience of action (roughly *sensemaking*; Weick, 1995) and how macro processes are enabled and constrained by ongoing activity. In summary, organisational cognition unfolds in *self-regulating systems* that, at a given moment, may be an individual with (or without) support, or a dyad or group who address a larger project. The summary precisely characterises the model's *meso* domain. Although self-regulating mechanisms are a typical feature of system dynamics it is, once again, within more complex systems (as modelled in agent-based simulations) that the above dynamics are most satisfactorily represented. This appears in, for example, computational simulation studies of opinion dynamics in teams (Mäs *et al*., 2013), or of memory in the context of organisational routines (Miller *et al*., 2012).

As people bind individual resources (including culturally derived skills) together with the demands of longer lasting or supra-structural factors, they undertake social organising that aids in the success of larger projects. In so doing, of course, they sustain many social and cultural systems. Organisational cognition thus characterises enabling conditions for behaviour that takes place in – and is valued by – people in social groups. It occurs in the actual world and depends, to a large extent, on how cooperative action links formal structures with material supports that function in both *emergent* and *immergent* ways (Conte *et al*., 2014; Cowley, 2016). As a result, people can undertake *meso* scale activity alone or, more typically, in dyads, groups and across wider networks.

The case of peer-review

Although many readers will be familiar with editorial peer-review, some will regard it as a social practice based, above all, on clear and efficient communication. Indeed, something along these lines is accepted in the literature (e.g., Bornmann, 2011; Huutoniemi, 2015). However, given current concerns about the quality of science, much work in the field is overshadowed by Merton's (1942) normative vision of the practice. Peer-review is often conceptualised and studied as, not part of science, but as an individual performance of quality assurance (e.g., Bornmann, 2011). In the current climate, this leads to negativity in that, when studied empirically, peer-review is found to be neither reliable, bias-free nor able to predict success (Bornmann, 2011). Elsewhere one of us argues that such findings can be placed in perspective only by emphasising the cognitive status of peer-review (Cowley, 2015). From this angle, peer-review serves as, not only quality control but, we argue, as a mode of explaining how *social organising* contributes to science. Ultimately, it is an organisational means of regulation that establishes what counts as knowledge in a given field (Cowley, 2015; Huutoniemi, 2015; Squazzoni *et al*., 2013).

From an institutional perspective, editorial peer-review arises in regulating activities between submitting a paper to a journal and subsequent rejection or publication. Where a manuscript successfully becomes a publication, reviewers play a role in persuading editors that it is worthy of this status. Indeed, it is this goal which drives decision making around initial acceptance for review, assigning and managing reviewers, reporting back to the author, evaluation, revision, and so on. In what follows, we regard such integrated activities as constituting an organisational 'project'. In completing the tasks and sub-tasks of a project, those concerned strive to address the editor's needs and, by extension, those of a larger community (of both scientists and other stakeholders). Peer-review is thus extended over time, occurs in definite places, relies on material cultural products and connects authors, an editor (often more than one) and reviewers. At all times, parties use the publishing company's support and, above all, online resources. These resources – among which the most popular seem to be ScholarOne, Manuscriptcentral – provide online forms that reviewers typically fill in when uploading reviews and, at once, support editors with templates for emails, reviewer selections, and other operational features. These are constitutive of what we have called supra or macro structure. Indeed, the case for describing peer-review as *social organising* is precisely that it depends on material relationality that serves in pooling the expertise of many thinking people. Further, during review and decision, the persons often work, not as a team, but as

complementary – and often agonistic – partners (Cowley, 2015).

From what is written above, it is apparent that peer-review is characterised by high levels of ambiguity. While uncertainty allows the calculation of probabilities associated with the likelihood that something may occur, on our grasp of ambiguity, such calculations are either extremely difficult or impossible (see Rosenkopf & Abrahamson, 1999). This is due to scarcity of information, information overload, inability or lack of willingness to make sense of it, or because of data/experience pointing at contradictory evidence. All of the above can be easily related to peer-review. In line with Cohen and March (1974), and in order to streamline our presentation, we distinguish between ambiguity of *purpose*, *power*, *experience*, and *success*. All it takes for the first type to surface is for the different actors involved, for example, editors, reviewers, authors, to have different perspectives on the purpose of their actions. And this is, of course, very likely, given that there is no clear code (for example) nor any set of formal standards for review. On the power involved in the process, there is perhaps less ambiguity, since the roles are set by both practice and disciplinary bounds. However, as with any tacit norm, interpretation can differ from case to case. Another important source of ambiguity is learning, since it may be very different what one gains from the experience. It may vary widely from person to person. We believe this to be connected to purpose, yet different because actually conducting the review (i.e., experience) may transform one's beliefs around what peer-review is actually for. Finally, there are also different levels of 'investments' in the process, that, almost certainly, the author and editor care more than do others about what is finally published. Yet, success is ambiguous. Is a higher impact factor a sure mark of success? Or are higher numbers of citations or inclusion in national assessment lists? And, even if there is a measure of success or a personal feeling of satisfaction for the work of an editor, what about the roles of associate editors, the publisher, or the reviewers? Conflicting perceptions of success in reviewing may even tear the process apart.

Is peer-review cognitive?

Our reasons for choosing peer-review to illustrate the *systemic* perspective is, above all, the process. The practice needs to be flexible to meet the needs of various disciplines, journals, reviewers and, of course, different contexts.

Indeed, the hallmark of its cognitive role lies in its epistemic nature: not only is a published paper meaningful but, just as importantly, the author and reviewers focus on formatting, presentation, style, and *what* the data, evidence and argument claim to show. In that this may generate hypotheses and models while disclosing new possibilities and facts, this epistemic activity shapes what philosophers call *content* (e.g., Devitt and Sterelny, 1999) in ways that demand action. Hence, drawing on the *meso* domain, a good reviewer will attend to both claims that can be associated with what is read and how they relate to both the text and supra-structural factors (hence connecting subjective experience with the macro domain). Content is evaluated against a reviewer's grasp of a field, judgements of the paper's scientific and social relevance, evaluation of the appropriacy and application and methods chosen, the presentation of data, and the general argument. Far from being reducible to the subjective or a 'mind' (or a brain; i.e., the micro), content must be evaluated as part of science. Like many aspects of style and structure, it must be shaped to fit a community's epistemic traditions. Especially in science, meso domain action draws on 'symbolisations' (written language, tables, statistical images, pixelated images etc.; see Kravchenko, 2007) that have been carefully assembled through coordinated mindful activity. The reviewer deals with symbolisations in ways that are partly rigid and partly flexible. As is typical of *social organising*, it demands both conformity to a field's norms and expectations and a reviewer's ability to use her/his own individual expertise. The reviewer's co-action is directed at authorial decisions about 'content'. In reviewing one typically places oneself in the role of a 'reader' of the journal in question. Then, using both material resources and expertise, one not only reads with care but, in so doing, interrogates the coherency of the work described. At times, a reviewer will notice a gap in the literature or, perhaps, appeal to a yes/no indicator when one might demand a probabilistic logic. This is highly skilled decision making in a meso domain that can be triggered by some kind of hunch (a micro response) or a shift of attention to aspects of a macro-domain associated with a method or an accepted view. This is triggered by several aspects of the distributed e-cognitive framework we have referred to in the previous section. Reviewing is a kind of epistemic action that unites expertise, one's sense of a projected reader and personal use of *material relationality.* Peer-review requires skills in meshing both focal and non-focal awareness.

Similar kinds of carefully calibrated decision making, problem identification and problem creating are characteristic of all modes of innovation (Salge and Vera, 2012). Evidently enough, while often less creative than in science, many organisational projects are based on a capacity to innovate – including many whose main concern is with services, procedures, and manufacture. In peer-review, however, decisions are not to be seen as ends. The parties involved are required to display reasons for particular dispositions towards recommendations, suggestions, and advice through so called social channels,

namely, the others involved in the process. Simon (1993) labels this 'docility' and, seen as *social organising*, the disposition (or its lack) becomes central to the strategic use of social resources (Secchi and Bardone, 2009). The concept of 'docility' has been called in as a behavioural feature of distributed cognition because of its focus on exchanges between individuals whose products (i.e., reports, e-mails, revised documents) arise from actions in the meso-domain. Further, strategies are highly variable – for example, an author can challenge a reviewer. Moreover, as shown elsewhere (Secchi, 2011, 2016), docility demands conformity to a *macro* framework that may include, for example, the disciplinary of a publishing company that hosts a journal. Not only do publishing companies set the ground for standards with which journals need to comply, but the pre-set online templates and forms affect how cognition is performed through doing (Magnani, 2007). Along these lines, (good) reviewers check each others' work after submission, a (responsible) editor engages in conversations with both reviewers and authors, and the (conscientious) author can also accept/reject comments in reports, send comments, etc. It is plain that 'docile' individuals can only be effective because the cognitive process is, among other things, a socially-oriented contribution to a larger project (science). Given its organisation, the socially-bound cognitive mechanism has a tradition of being used to model social systems where agents interact with supra-ordinated conformity norms while bound by their own position, skills, attitudes and other characteristics (e.g., Miller and Lin, 2010; Secchi and Gullekson, 2016).

Table 1 exemplifies the three micro-meso-macro domains, by offering succinct definitions (second column), then providing sample elements for each of them (third column) and, finally, concluding by outlining organisational cognitive aspects together with samples from the case of peer-review (last column on the right). The bold type font in Table 1 identifies aspects of *e-cognition* (Menary, 2010a; Secchi and Cowley, 2018) that are relevant when addressing both organisational cognition and peer-review while the text in italics is used for the examples. The following pages present an overview of e-cognition processes by referring directly to Table 1's classification.

Organisational cognition as change

The total peer-review system uses causal processes that enable people to use intelligence in connecting the *macro* (or supra-structural) with the *micro* (or subjective and neurophysiological human workings). For example, a reviewer may decide to clarify what she/he thinks the community of scholars in her/his field would consider appropriate while also drawing on individual experience, skills, knowledge, purpose, identity. This would identify an *ecological* aspect, necessary for cognitive activity to navigate the ambiguities of the norms, values or rules available in the macro supra-structure (see Table 1). This aspect works as a connector, by bridging various elements of action as a working system (Hutchins, 2014). As a result, community 'rules' contribute to the cognitive task of, for example, writing the report (Table 1) such that the action opens possibilities and, at once, enables cognising. This is what Magnani (2007) would call cognition 'through doing' and constitutes the *enacted* aspect of e-cognition (see Table 1) that lies at the heart of the meso domain. Peer-review is organised informally and relies very much on the actors' interpretation of professional standards to be performed. By operationalising this macro element into the here-and-now, social organising contributes to decrease the related ambiguity of power and experience because it forces each actor to anticipate other actors' behaviour. For example, an editor may have expectations for a reviewer's report/recommendation and/or an author's response and email them accordingly. However, it should not be thought that the total system is intrinsically cognitive: just as itching and scratching accompanies thinking, most subjective and neurophysiological activity that shapes writing, sending e-mails or reviewing has no part in the results of *social organising*. In relation to a published paper (if there is one), the editor is primarily concerned with the report that draws on *social organising* or the meso domain. Further, the same goes for the rule and internet platforms, the structure and reputation of the publishing organisation and, indeed, a history that led to the selection of an editor. When one considers the intelligent exploitation of these external resources (Table 1), the reference is then on the so-called *extended* aspect of e-cognition (e.g., Clark and Chalmers, 1998). Of course, this 'extension' is dynamic and thus grants an epistemic dimension of meaning and cognition to action (e.g., Clark, 2003). Accordingly, the *meso* domain of *social organising* is intrinsically cognitive in that it enables many parties (author, editors, reviewers, etc.) to transform and freeze scientific content. The crucial process of textual revision and change is regulated by how peer-review mediates the concerns of a community. An author's final decisions about how a paper will appear depend on a complex interplay of incentives and constraints. It is thus no more to be explained by a 'micro' or 'individual' domain than well-defined scientific protocols (of the 'macro' domain) can determine reviewing. Rather, the complexity of peer-review arises as each domain feeds the other and, in this sense, offers a paradigm case of organisational cognition (consistently with Magnani, 2007; Bardone, 2011; Secchi, 2011). Content develops through to problem identification and decision making that occur as people draw on material resources to make and evaluate (a small subset of) the relevant symbolisations (Kravchenko, 2009;

Table 1 Organisational cognition and peer-reviewing

Domain	*Definition*	*Elements involved (examples)*	*Social organising (meso) as cognitive connector*
Micro (individual sphere)	*Neurophysiological processes associated with a biological individual*	Authors, editors, reviewers, publisher, proofreaders, proof editors, …	• **Embodied** aspects linking action to perception (emotions, feelings, moods, other bodily reactions) – *may be gut feelings on a topic, method, structural defects of a manuscript* • **Embrained** individuals have always to be considered in any human cognitive process (of course, this brain is a social brain!) – *the extent to which a reviewers recalls quotes and/or references out of memory*
Meso (social organising)	*People act as parts of organisations and connect 'intelligence' with various social dynamics*	Reading the submission, writing a report, author who writes a cover letter to the editor, a reviewer writing a note to the editor accompanying their report, authors engaging with reviewer reports, …	• **Enacted** mechanisms allowing agents to understand, interpret, "think" *through action – writing is typical of such doings* • Actions are always situated, meaning that the elements that specify them are **embedded** in the making of cognition – *the assessment that the editor sends to the author depends on balancing the needs of the publisher, the standards (as interpreted) from the academic community, evaluation of the reviewers' reports, specific journal needs, and more*. • Cognition is **extended** in the sense that all resources exploited by agents are considered functional to its workings – *the word processing software (LaTeX, MS Word, pages, or else) used to write the paper, a cover letter, anything, is not neutral to the way agents act*
Macro (organisational sphere)	*Supra-structural aspects of organisational life*	Cultural norms of the respective academic communities, principles and values of the publishing company, aim and scope of the journal, …	• **Ecological** cognitive mechanisms are necessary for anyone to cope with the ambiguity of organisations – *the understanding of one's role in the process (author, editor, reviewer, publisher) requires a sense of identity, commitment, engagement, and responsibility, without which organisational cognition loses part of its functionality*

Note: bold text in the last column on the right represents a cognitive mechanism at play in the organisation; text in italics in the last column on the right indicates an example on peer-review.

Cowley, 2015). As aggregations of written signs, these too are wholly material (see, Harris, 1981; Kravchenko, 2009): it is only in the context of *social organising* that they contribute to a cognitive process. As this happens, a reviewer is moved to make suggestions, demands and offer critical comments that (in the best of cases) are aimed at inviting an author to revise and alter the presentation of the text, digits, tables and statistical results. Peer-review anticipates future activity – judgements that link a biological individual with a socially derived ability to perform in a set of cognitive ecosystems. In the terms of distributed cognition, Hollan *et al*. (2000) regard any cognitive process in that it is distributed either (1) socially, (2) on external artefacts, and/or (3) over time. This perspective is radical and, as discussed elsewhere (Secchi, 2011), it undermines the self-centred traditions in cognition (especially that of Simon and the Carnegie School; Gavetti *et al*., 2007). Emphasis on the meso domain has importance for the study of human cognition in general. Within the domain of distributed cognition, it traces much of what humans say and do (action) to *social organising*. While its theoretical implications extend beyond management, recognition of how the different domains work together is central to the study of organisations. By extending Hollan *et al*.'s (2000) perspective, we aim at (a) framing organisational cognition (and peer-review within it) as distributed cognition, and (b) indicate that, in focusing on the *social* aspects of organising – that is, the 'meso' domain – organisational cognition prefers this particular kind of distribution over the other two (i.e., artefacts and time). Hence, the peculiar aspects we are highlighting are

inherent to the role of the social. In organisational cognition and in peer-review, most (if not all) action is channelled through social interactions, perceptions, anticipations, and idealisations. In this context, peer-review is an exemplar of what may happen in some organisational cognitive processes. In performing as a reviewer, as in many cases, one must integrate expertise, explicit knowledge and ways of acting while imagining/judging symbolisations that constitute a document (see Table 1). When bodily reactions are associated with action, an *embodied* perspective can be called in (Varela *et al*., 1992) while more neurophysiological aspects can be exemplified by *embrained* aspects of e-cognition (Secchi and Cowley, 2018).

In peer-review the leading figure is often the editor. Typically at least, he or she is responsible for selecting reviewers, persuading them to work in a committed way and making judgements about their reports and resubmissions. This too is irreducible to procedure, habit, routine or simple communication. Rather, they depend on integrating micro and macro factors in decision making under expert influence. Importantly, *social organising* makes peer-review intrinsically creative and, thus, part of what Ziman (2000) terms 'real science'. If reviewers, editors and authors are to generate valuable insights, it is crucial that competitive social relations (Cowley, 2015) grant the activity agonistic and emotional components. Indeed, while the empirical work remains to be done, the 'quality' of peer-review seems likely to be best assessed in epistemic terms (Cowley, 2015): even generating new 'discipline relevant' facts is thus irreducible to individual search. Under a different angle, and specifically for the reasons just mentioned, ambiguity of purpose is among the factors that contribute to this creative process. In fact, it is the flexibility and adaptability of the process (due to its inherent ambiguity) that allows for reviewers and editors to break the schemes, if necessary or, more simply, if deemed better for the field. This 'free' space finds its boundaries in the working of the meso domain. Not only the interaction but its very prospect allows the various agents involved to conflate both macro (e.g., professional standards, reputation issues) and micro perspectives (e.g., the neurophysiological).

Peer-review is akin to classic cases of distributed cognition in that, over time, it integrates external resources and cultural products (Hollan *et al*., 2000). Further, just as in other carefully managed cultural ecosystems (e.g., cockpits, hospitals), peer-review relies on recursive processes that connect a wide range of stakeholders with material devices. As institutionally defined *social organising*, it contrasts with widely studied and highly structured cases in that, above all, it widens scientific enterprise. For this reason, a publication's epistemic value can emerge in slow time-scales. Peer-review thus depends on multi-scalar dynamics based on how evidence-based science is assessed and managed by overlapping communities. The core of knowledge creation (more conventionally, discovery) thus lies in making and construing symbolisations that a community deems valuable. In presenting peer-review as epistemic we stress how social organising unites institutional and other supra-structural (*macro*) factors with an individual's idiosyncratic knowledge (Cowley, 2015). As with all expertise, it uses anticipation, ideas about what and how things can be done and, above all, a sensitivity to symbolisations (i.e., data, graphics and written signs). A reviewer must use supra-structural norms while sensitising to contingencies and the materials to hand (see Baber *et al*., 2014). Peer-review is adaptive and flexible. While its basis is cognitive, it is crucial that the final products will be scrutinised, assessed and, from various perspectives, appreciated, allowed to pass and, very often, also disparaged.

On a separate, but connected angle, since change is central to *social organising*, it can be usefully pursued by detailed ethnographic and qualitative analysis. For the same reason, this is consonant with associating peer-review with many features of a complex adaptive system. In fact, one can argue that agent-based simulations are a good approximation of complexity and adaptability of agents over time (e.g., Fioretti, 2013). In fact, change is exactly one of the reasons that makes this class of models relevant to organisational cognition, with specific ties to peer-review (see Secchi and Cowley, 2019).

Concluding remarks

Our fundamental claim is that the study of organisational cognition can be focused on attention to *social relations*, their *dynamics* and *relationships*. These define how cognition manifests itself in organisational settings and, at the same time, open up a new perspective on phenomena as diverse as identity, roles, and positions. Through the lenses of cognition, these cease to appear fixed but, rather, become highly adaptive. On a systemic view, *micro* and *macro* aspects of organisational life thus co-function as persons use artefacts as they act, alone or together, in the *meso* domain. Results prompt them to shift between identities, roles, positions and the like. They lead, above all, to the decision making that shapes various organisational outcomes. Much depends on how material relationality is embedded and manifest in the social organising of activity in *meso* domains.

Taking a *radical systemic perspective* to cognition brings adaptation and change to the core of organisational life. In fact, social and non-social resources, timescales, and spatial multi-levels are all attributable to the dynamics

of adaptation. For this reason, approaches concerned with complex adaptive systems such as agent-based computational simulations (Edmonds and Meyer, 2017) as well as hybrid methodologies that merge simulation with conceptual, qualitative, and/or quantitative approaches are often more appropriate. In opening up ways of combining the ethnographic, video analysis and agent-based simulations, the radical systemic perspective holds much promise. Indeed, shifting the emphasis to social organising promises to bring new life to the framework of organisational cognition.

References

Andrighetto, G., R., Conte, P. Turrini and M. Paolucci, 2007, "Emergence in the loop: Simulating the two way dynamics of norm innovation". In G. Boella, L. van der Torre and H. Verhagen (eds.), "*Normative multi-agent systems*". Dagstuhl seminar proceedings. Dagstuhl, Germany: Internationales Begegnungs- und Forschungszentrum für Informatik (IBFI), Schloss Dagstuhl, Germany. http://drops.dagstuhl.de/opus/volltexte/2007/907

Baber, C., M. Parekh and T. G. Cengiz, 2014, "Tool use as distributed cognition: How tools help, hinder and define manual skill". *Frontiers in Psychology*, **5**: 116.

Baber, C., P. Smith, J. Cross, J. E. Hunter and R. McMaster, 2006, "Crime scene investigation as distributed cognition". *Pragmatics & Cognition*, **14**(2): 357–385.

Baker, Alan, 2010, "Simulation-based definitions of emergence". *Journal of Artificial Societies and Social Simulation*, **13**(1). https://doi.org/10.18564/jasss.1531

Bardone, E., 2011. *Seeking chances. From biased rationality to distributed cognition*. New York: Springer.

Barling, J. and C. L. Cooper, 2008. *The Sage handbook of organizational behavior*, Micro Perspectives Vol. **1**. Thousand Oaks, CA: Sage.

Berthoz, A., 2012. *Simplexity: Simplifying principles for a complex world*. New Haven, CT: Yale University Press.

Blau, P. M. and W. R. Scott, 1962. *Formal organisations: A comparative approach*. Stanford, CA: Stanford University Press.

Bornmann, L., 2011, "Scientific peer review". *Annual Review of Information Science and Technology*, **45**: 197–245.

Brewer, M. B. and W. Gardner, 1996, "Who is this 'we'? Levels of collective identity and self representations". *Journal of Personality and Social Psychology*, **71**(1): 83–93.

Brooks, R. A., 1991, "Intelligence without representation". *Artificial Intelligence*, **47**(1): 139–159.

Burnes, B., 2005, "Complexity theories and organizational change". *International Journal of Management Reviews*, **7**(2): 73–90.

Cameron, K. S. and R. E. Quinn, 2011. *Diagnosing and changing organizational culture: Based on the competing values framework*. London: Wiley.

Cannon-Bowers, J. A. and E. Salas, 2001, "Reflections on shared cognition". *Journal of Organizational Behavior*, **22**(2): 195–202. https://doi.org/10.1002/job.82

Chemero, A., 2009. *Radical embodied cognitive science*. Cambridge, MA: MIT Press.

Clark, A., 1997. *Being there: Putting brain, body, and world together again*. Cambridge, MA: MIT Press.

Clark, A., 2003. "Natural-born cyborgs". In *Minds, technologies, and the future of human intelligence*. Oxford: Oxford University Press.

Clark, A. and D. J. Chalmers, 1998, "The extended mind". *Analysis*, **58**: 7–19.

Cohen, M. D. and J. G. March, 1974, *leadership and ambiguity. The American college president*. New York: McGraw-Hill.

Conte, R., G. Andrighetto and M. Campennì, 2014. *Minding norms. Mechanisms and dynamics of social order in agent societies*. Oxford: Oxford University Press.

Cooper, R., 1986, "Organisation/disorganisation". *Social Science Information*, **25**(2): 229–335.

Cowley, S. J., 2014, "Linguistic embodiment and verbal constraints: Human cognition and the scales of time". *Frontiers in Psychology*, **5**: 1085.

Cowley, S. J., 2015, "How peer review constrains cognition: On the frontline in the knowledge sector". *Frontiers in Psychology*, **6**: 1706.

Cowley, S. J., 2016. "Cognition beyond the body: Using ABM to explore cultural ecosystems". In Secchi D. and M. Neumann (eds.), *Agent-based simulation of organizational behavior*. Cham: Springer, pp. 43–60.

Cowley, S. J. and F. Vallée-Tourangeau, 2013. "Systemic cognition: Human artifice in life and language". In Cowley S. J. and F. Vallee-Tourangeau (eds.), *Cognition beyond the brain*. London: Springer, pp. 255–273.

Cowley, S. J. and F. Vallée-Tourangeau (Eds), 2017. *Cognition beyond the brain. Computation, interactivity and human artifice*, 2nd ed. London: Springer.

Cunningham, B., 2001, "The Reemergence of 'Emergence'". *Philosophy of Science*, **68**(S3): S62–S75. https://doi.org/10.1086/392898

Cyert, R. M. and J. G. March, 1963. *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice-Hall.

Devitt, M. and K. Sterelny, 1999. *Language and reality: An introduction to the philosophy of language*. Cambridge MA: MIT Press.

Donald, M., 1991. *Origins of the modern mind: Three stages in the evolution of culture and cognition*. Cambridge, MA: Harvard University Press.

Donald, M., 2001. *A mind so rare: The evolution of human consciousness*. New York: WW Norton & Company.

Edmonds, B., C. Le Page, M. Bithell, E. Chattoe-Brown, V. Grimm, R. Meyer, C. Montañola-Sales, P. Ormerod, H. Root, F. Squazzoni, 2019, "Different modelling purposes". *Journal of Artificial Societies and Social Simulation*, 22(3). https://doi.org/10.18564/jasss.3993

Edmonds, B. and R. Meyer (eds), 2017, *Simulating social complexity. A Handbook*. Understanding Complex Systems. Springer International Publishing. https://www.springer.com/gp/book/9783319669472

Feldman, M. S. and B. T. Pentland, 2003, "Reconceptualizing organizational routines as a source of flexibility and change". *Administrative Science Quarterly*, **48**(1): 94–118.

Fioratou, E., R. Flin, R. Glavin and R. Patey, 2010, "Beyond monitoring: Distributed situation awareness in anaesthesia". *British Journal of Anaesthesia*, **105**(1): 83–90.

Fioretti, G., 2012, "Two measures of organizational flexibility". *Journal of Evolutionary Economics*, **22**(5): 957–979.

Fioretti, G., 2013, "Agent-based simulation models in organization science". *Organizational Research Methods*, **16** (2): 227–242.

Fuchs, C. and W. Hofkirchner, 2009. "Autopoiesis and critical social systems theory". In Magalhães R. and R. Sanchez (eds.), *Autopoiesis in organization: Theory and practice*. Bingley: Emerald, pp. 111–129.

Gahrn-Andersen, R., 2019, "Biological simplexity and cognitive heteronomy". *Language Sciences*, **71**: 38–48.

Gavetti, G., D. Levinthal and W. Ocasio, 2007, "Perspective—neo-Carnegie: The Carnegie school's past, present, and reconstructing for the future". *Organization Science*, **18**(3): 523–536. https://doi.org/10.1287/orsc.1070.0277

Gibson, J. J., 1977, "The theory of affordances". In R. E. Shaw and J. Bransford (eds.), *Perceiving, acting, and knowing: Toward an ecological psychology*. Hillsdale, NJ: Lawrence Erlbaum, pp. 67–82.

Grandori, A., 2007, "Discovery in natural selection and knowledge processes: A commentary on 'an agent-based model of exaptive processes'". *European Management Review*, **4**(3): 153–156.

Harris, R., 1981. *The language myth*. London: Duckworth.

Harris, S. G., 1994, "Organizational culture and individual sensemaking: A schema-based perspective". *Organization Science*, **5**(3): 309–321.

Herath, D. B., 2019. *Business plasticity through disorganization*. Bingley, UK: Emerald.

Hodgkinson, G. P. and M. P. Healey, 2008, "Cognition in organisations". *Annual Review of Sociology*, **59**: 387–417.

Hollan, J., E. Hutchins and D. Kirsh, 2000. "Distributed cognition: Toward a new foundation for human-computer interaction research". In *Proceedings of the ACM transactions on computer-human interaction (TOCHI)* Vol. **7**. New York: ACM Digital Library, pp. 174–196.

Hutchins, E., 1995a. *Cognition in the wild*. Cambridge, MA: MIT Press.

Hutchins, E., 1995b, "How a cockpit remembers its speeds". *Cognitive Science*, **19**(3): 265–288.

Hutchins, E., 2014, "The cultural ecosystem of human cognition". *Philosophical Psychology*, **27**(1): 34–49.

Huutoniemi, K., 2015. "Peer review: Organized skepticism". In Wright J. (ed.), *International encyclopedia of the social and Behavioural sciences*, 2nd ed. Oxford: Elsevier, pp. 685–689.

Ilgen, D. R., D. A. Major and L. Spencer, 1994. "The cognitive revolution in organisational behavior". In Greenberg J. (ed.), *Organisational behavior: The state of the science*. Mahwah, NJ: Lawrence Erlbaum, pp. 1–22.

Kravchenko, A. V., 2007, "Essential properties of language, or, why language is not a code". *Language Sciences*, **29**: 650–671.

Kravchenko, A. V., 2009, "The experiential basis of speech and writing as different cognitive domains". *Pragmatics & Cognition*, **17**: 527–548.

Lant, T. K. and Z. Shapira, 2000. *Organizational cognition: Computation and interpretation*. London: Psychology Press.

Laroche, J., A. M. Berardi and E. Brangier, 2014, "Embodiment of intersubjective time: Relational dynamics as attractors in the temporal coordination of interpersonal behaviors and experiences". *Frontiers in Psychology*, **5**: 1180.

Latour, B. and E. Woolgar, 1986. *Laboratory life: The construction of scientific facts*, 2nd ed. Princeton, NJ: Princeton University Press.

Lord, R. G., D. J. Brown, J. L. Harvey and R. J. Hall, 2001, "Contextual constraints on prototype generation and their multilevel consequences for leadership perceptions". *The Leadership Quarterly*, **12**: 311–338.

Luhmann, N., 1995. *Social systems*. Stanford, CA: Stanford University Press.

Magnani, L., 2007. *Morality in a technological world. Knowledge as a duty*. New York: Cambridge University Press.

Malafouris, L., 2019, "Thinking as 'thinging': Psychology with things". *Current Directions in Psychological Science*, **29**(1): 3–8.

Mäs, M., A. Flache, K. Takács and K. A. Jehn, 2013, "In the short term we divide, in the long term we unite: Demographic crisscrossing and the effects of faultlines on subgroup polarization". *Organization Science*, **24**(3): 716–736.

Menary, R., 2010a, "Introduction to the special issue on 4e cognition". *Phenomenological Cognitive Science*, **9**: 459–463.

Menary, R., 2010b. "Introduction: The extended mind in focus". In Menary R. (ed.), *The extended mind*. Cambridge, MA: MIT Press, pp. 1–25.

Merton, R. K., 1942/1973. "The normative structure of science". In Storer N. W. (ed.), *The sociology of science*. Chicago, IL: University of Chicago Press.

Michel, A. A., 2007, "A distributed cognition perspective on newcomers' change processes: The management of cognitive uncertainty in two investment banks". *Administrative Science Quarterly*, **52**: 507–557.

Miller K. D. and S.-J. Lin, 2010, "Different truths in different worlds". *Organization Science*, **21**(1): 97–114. https://doi.org/10.1287/orsc.1080.0409

Miller, K. D., B. T. Pentland and S. Choi, 2012, "Dynamics of performing and remembering organizational routines". *Journal of Management Studies*, **49**(8): 1536–1558.

Neumann, M. and S. J. Cowley, 2016. "Modeling social agency using diachronic cognition: Learning from the mafia". In Secchi D. and M. Neumann (eds.), *Agent-based simulation of organizational behavior*. Cham: Springer, pp. 289–310.

Nohria, N., 1994. *Networks and organizations: Structure, form and action*. Boston, MA: Harvard Business School Press.

Parker, G. M., 2011. *Team players and teamwork: New strategies for developing successful collaboration*. London: John Wiley & Sons.

Pedersen, S. B., 2012, "Interactivity in health care: Bodies, values and dynamics". *Language Sciences*, **34**(5): 532–542.

Pentland, B. T. and M. S. Feldman, 2005, "Organizational routines as a unit of analysis". *Industrial and Corporate Change*, **14**: 793–815.

Perry, M., 2013. "Socially distributed cognition in loosely coupled systems". In Cowley S. J. and F. Vallée-Tourangeau (eds.), *Cognition beyond the brain: Interactivity, computation and human artifice*. London: Springer, pp. 147–169.

Petracca, E., 2017, "A cognition paradigm clash: Simon, situated cognition and the interpretation of bounded rationality". *Journal of Economic Methodology*, **24**(1): 20–40.

Pfeffer, J., 1992. *Managing with power: Politics and influence in organizations*. Boston, MA: Harvard Business Press.

Powell, W. W. and P. J. DiMaggio (Eds), 1991. *The new institutionalism in organizational analysis*. Chicago, IL: University of Chicago Press.

Robbins, P. and M. Aydede (Eds), 2009. *Cambridge handbook of situated cognition*. Cambridge: Cambridge University Press.

Rosenkopf, L. and E. Abrahamson, 1999, "Modeling reputational and informational influences in threshold models of bandwagon innovation diffusion". *Computational & Mathematical Organization Theory*, **5**(4): 361–384. https://doi.org/10.1023/a:1009620618662

Salge, T. O. and A. Vera, 2012, "Benefiting from public sector innovation: The moderating role of customer and learning orientation". *Public Administration Review*, **72**(4): 550–559.

Scheepers, D. and N. Ellemers, 2019. "Social identity theory". In Sassenberg K. and M. Vliek (eds.), *Social psychology in action*. Cham: Springer, pp. 129–143.

Schneckenberg, D., V. Velamuri and C. Comberg, 2019, "The design logic of new business models: Unveiling cognitive foundations of managerial reasoning". *European Management Review*, **16**: 427–447.

Scott, W. R., 2003. *Organisations. Rational, natural, and open systems*, 5th ed. Englewood Cliffs, NJ: Prentice-Hall.

Secchi, D., 2011. *Extendable rationality. Understanding decision making in organisations*. New York: Springer.

Secchi, D., 2016. "Boundary conditions for the emergence of "docility" in organizations: Agent-based model and simulation". In Secchi D. and M. Neumann (eds.), *Agent-based simulation of organizational behavior*. Cham: Springer, pp. 175–200.

Secchi, D. and B. Adamsen, 2017. "Organizational cognition: A critical per- spective on the theory in use". In Cowley S. J. and F. Vallee-Tourangeau (eds.), *Cognition beyond the brain: Computation, interactivity and human artifice*, 2nd ed. Heidelberg: Springer, pp. 305–331.

Secchi, D. and E. Bardone, 2009, "Super-docility in organisations. An evolutionary model". *International Journal of Organisation Theory and Behavior*, **12**(3): 339–379.

Secchi, D. and N. L. Gullekson, 2016, "Individual and organizational conditions for the emergence and evolution of bandwagons". *Computational and Mathematical Organization Theory*, **22**(1): 88–133. https://doi.org/10.1007/s10588-015-9199-4

Secchi, D. and S. J. Cowley, 2018, "Modeling organizational cognition: The case of impact factor". *Journal of Artificial Societies and Social Simulation*, **21**(1): 13

Secchi, D. and S. J. Cowley, 2019, "Improbable fairness: Reviewing under the lenses of impact factor". *RASK*, **50**: 191–209.

Secchi, D. and M. Neumann, 2016. *Agent-based simulation of organizational behavior*. New York: Springer.

Shapiro, L., 2010. *Embodied cognition*. London: Routledge.

Simon, H. A., 1990, "Invariants of human behavior". *Annual Review of Psychology*, **41**: 1–19.

Simon, H. A., 1993, "Altruism and economics". *American Economic Review*, **83**(2): 156–161.

Simon, H. A., 1997[1947]. *Administrative behavior*, 4th ed. New York: The Free Press.

Squazzoni, F., G. Bravo and K. Takács, 2013, "Does incentive provision increase the quality of peer review? An experimental study". *Research Policy*, **42**: 287–294.

Steffensen, S. V., F. Vallée-Tourangeau and G. Vallée-Tourangeau, 2016, "Cognitive events in a problem-solving task: A qualitative method for investigating interactivity in the 17 animals problem". *Journal of Cognitive Psychology*, **28**(1): 79–105.

Stewart, J. R., O. Gapenne and E. A. Di Paolo, 2010. *Enaction: Toward a new paradigm for cognitive science*. Cambridge MA: MIT Press.

Sturm, T., 2012, "The 'rationality wars' in psychology: Where they are and where they could go". *Inquiry*, **55**(1): 66–81.

Tajfel, H., 1978. "Social categorization, social identity and social comparisons". In Tajfel H. (ed.), *Differentiation between social groups*. London: Academic Press, pp. 61–76.

Ten Have, P., 2016. "Ethnomethodology". *The international encyclopedia of communication theory and philosophy*. Ashgate, U.K.: Wiley.

Thompson, E. and M. Stapleton, 2009, "Making sense of sense-making: Reflections on enactive and extended mind theories". *Topoi*, **28**(1): 23–30.

Turner, J. H. and P. R. Turner, 1978. *The structure of sociological theory*. Homewood, IL: Dorsey Press.

Varela, F. J., E. Thompson and E. Rosch, 1992. *The embodied mind*. Cambridge, MA: MIT Press.

Vera, A. H. and H. A. Simon, 1993, "Situated action: A symbolic interpretation". *Cognitive Science*, **17**: 7–48.

Walsh, J. P., 1995, "Managerial and organisational cognition: Notes from a trip down memory lane". *Organisation Science*, **6**(3): 280–321.

Weick, K. E., 1979. *The social psychology of organising*, 2nd ed. New York: McGraw-Hill.

Weick, K. E., 1993, "The collapse of sensemaking in organizations: The mann gulch disaster". *Administrative Science Quarterly*, **38**(4): 628. https://doi.org/10.2307/2393339

Weick, K. E., 1995. *Sensemaking in organisations*. Thousand Oaks, CA: Sage.

Weick, K. E. and K. H. Roberts, 1993, "Collective mind and organisational reliability: The case of flight operations on an aircraft carrier deck". *Administrative Science Quarterly*, **38**: 357–381.

Weick, K. E. and K. M. Sutcliffe, 2006, "Mindfulness and the Quality of Organizational Attention". *Organization Science*, **17**(4): 514–524. https://doi.org/10.1287/orsc.1060.0196

Wenger, D. and B. Sparrow, 2007, "The puzzle of coaction". In D. Ross, D. Spurrett, H. Kinkaid and L. G. Stephens (eds.), *Distributed cognition and the will*. Cambridge, MA: MIT Press, pp. 17–41.

Wheeler, M., 2005. *Reconstructing the cognitive world: The next step*. Cambridge, MA: MIT Press.

Zahavi, D., 2018, "Collective intentionality and plural pre-reflective self-awareness". *Journal of Social Philosophy*, **49**(1): 61–75.

Ziman, J., 2000. *Real science: What it is and what it means*. Cambridge, MA: Cambridge University Press.