Social intelligence: how to integrate research? A mechanistic perspective

Marcin Miłkowski

Institute of Philosophy and Sociology, Polish Academy of Sciences,
ul. Nowy Świat 72, Warsaw, Poland
marcin.milkowski@obf.edu.pl

Abstract. Is there a field of social intelligence? Many various disciplines approach the subject and it may only seem natural to suppose that different fields of study aim at explaining different phenomena; in other words, there is no special field of study of social intelligence. In this paper, I argue for an opposite claim. Namely, there is a way to integrate research on social intelligence, as long as one accepts the mechanistic account to explanation. Mechanistic integration of different explanations, however, comes at a cost: mechanism requires explanatory models to be fairly complete and realistic, and this does not seem to be the case for many models concerning social intelligence, especially models of economical behavior. Such models need either be made more realistic, or they would not count as contributing to the same field. I stress that the focus on integration does not lead to ruthless reductionism; on the contrary, mechanistic explanations are best understood as explanatorily pluralistic.

Keywords: integration; unification; mechanism; integrated models

1 From disunity of science to unified models

Social sciences, and in particular, research on social intelligence, is today highly fragmented and different disciplines are sometimes highly disconnected from each other. Although some theorists of social sciences find this situation commendable, I do not. For one, there is a danger of duplicating effort in different sciences. For another, high-level abstract explanations in social sciences, when not properly constrained, or deepened [1], remain superficial and explanatorily weak. In particular, they run a danger of positing entities that play no causal role, if descriptions are not at all constrained by lower-level evidence.

To this, one may reply that such deepening is desired in physical or biological sciences, as these are mostly observable, while social sciences are "constructed."[1] I disagree. All sciences, and in particular, cognitive sciences, are highly theoretical [2], positing multiple non-observable entities for explanatory purposes. Mere observation is rarely ever explanatory. Similar point applies to "social construction": even if one agrees that some social sciences are busy with normative questions, their job is not

[1] I owe this observation to one of the reviewers of this paper.

merely do describe the social norms but also to explain why there are social norms to at all, why they are considered binding by members of social institutions, and so on. Prescriptions, or normative guidance – such as the one offered by normative views on human rationality – are not explanatory in themselves, at least not obviously so. Moreover, contemporary cognitive sciences are very sensitive to social aspects of cognition, and that fact makes them relevant for any student of social intelligence, radically constructivist or not.

Even if the traditional question of unity of science seems to be answered today mostly in the negative [3, 4], there is a related important question: What unifies a field of research? Why various studies are considered contributions to the same topic? An obvious answer, namely that it deals with the same entity or set of entities, seems to open a can of worms, especially in the light of various criticisms of the traditional unity of science. For example, one could say that one unifies cognitive sciences is the notion of cognition. Similarly, the field of social intelligence could be said to be unified because it deals, well, with social intelligence, not surprisingly.

However, John Dupré [4] has argued that such inter-theoretic identifications of entities are not straightforward. As he stresses, different biological disciplines idealize their entities in various ways. A lynx for ecological biology is an extremely idealized entity, especially when it comes to mathematical predator-prey models such as the Lotka and Volterra equation (for an analysis of the model, see [5]). There is no role for genes, for example, in this equation, so as far as this model is concerned, lynx might have no genes. It just has to play the predator role. But for molecular biology, predation might have no importance at all, whereas genetic structure is crucial. And so on. Hence, different fields of study may focus simply on a different entity when they talk of social intelligence.

However, Dupré's conclusion that the lynx under study is a different entity in different fields is too quick. Even if particular models consider only some of properties of an entity, the very applicability of the Lotka-Volterra model to a lynx presupposes a larger body of knowledge about the animal. For example, we have to know that it's a species of wild cats, so it will be predatory. This knowledge is necessary for the application of the predator-prey models but not contained therein. In other words, Dupré's argument fails, even if he is right that we may idealize lynx differently for different explanatory answers. Still, those different idealizations may be so disparate that they do not constitute a consistent field of research. Physics and theology can study the same entity, such as an ancient scripture; but they do not constitute the same field of research. In other words, there is little reason to think that the mention of the same entity, even if it is the same natural kind, makes different disciplines unified.

A disintegration of interdisciplinary research and a focus on very limited explanatory models has been one of the worries of Allen Newell and Herbert Simon, founding father of artificial intelligence and cognitive science. They both saw psychology as offering micro-theories, or theories of very limited scope, that did not contribute to a common view of the human mind [6]. Newell, as an alternative, proposed to unify the research program in cognitive science with a notion of a cognitive architecture [7]. In his opinion, a cognitive architecture can be used for creating multiple micro-theories and offers a unifying perspective on how the mind works. In a more contem-

porary context, researchers from the field of cognitive robotics suggested that unified cognitive-robotic architectures could be used to unify research efforts [8].

However, unified theories of cognition are not ways to unify *fields* of research. They may broaden the scope of theories but need not cross-fertilize the field as such, and, as Herbert Simon has stressed already in 1998 [9], they stress the systems as a whole instead of mechanisms in the systems that make cognition possible. To theoretically integrate the whole field, there must be stress on such mechanisms. That is the lesson we take from this effort for the research on social intelligence.

In this paper, I develop a mechanistic account of unification and integration of the field of social intelligence, close in spirit to Simon's view. In section 2, I introduce the mechanistic framework as related to the question of integration different models and theories. Then, in section 3, I tentatively sketch the mechanisms that can be studied to gain insight into social intelligence. I conclude by stressing that the mechanistic perspective supports explanatory pluralism.

2 Mechanistic unification of research

According to the received view on the unity of science, the goal of the unification is to create a single, universal theory. Hence, in this view, the most important relationships are inter-theoretical, reduction being the most prominent. However, it is neither realistic nor desirable to build a single theory in fields dealing with complex phenomena [10–13]: Building multiple independent, usually highly idealized, models of phenomena may be much more useful than replacing them prematurely with a single theory. The core of the argument is that more robust results can be expected when they are produced independently by multiple statistically independent models than when they are generated with just one of them, as long as they draw from the same evidence base. Moreover, by testing how multiple theories or models match available evidence, researchers can compensate their confirmation bias, which makes all people prone to making a mistake of premature discarding alternative hypotheses [14]. Additionally, for special sciences, it is simply neither realistic nor practical to reduce them to a fundamental physical theory, such as quantum mechanics. In brief, there are genuine advantages in having multiple theories dealing with the same phenomena to be explained.

This consideration means that integrating the discipline is not to be confused with replacing all other theories with a single one, as long as alternative sound theories can be found. For our purposes, it means that the account of mechanistic unification and integration will not aim at disposing with multiple models or theories. So how should such integration proceed?

Just because social intelligence relies on multiple mechanisms, one could appeal to a notion of "vertical integration":

> The natural sciences are already mutually consistent: the laws of chemistry are compatible with the laws of physics, even though they are not reducible to them. Similarly, the theory of natural selection cannot, even in princi-

> ple, be expressed solely in terms of the laws of physics and chemistry, yet it is compatible with those laws. A conceptually integrated theory is one framed so that it is compatible with data and theory from other relevant fields. Chemists do not propose theories that violate the elementary physics principle of the conservation of energy: Instead, they use the principle to make sound inferences about chemical processes. A compatibility principle is so taken for granted in the natural sciences that it is rarely articulated, although generally applied; the natural sciences are understood to be continuous [15].

Barkow et al. complain that in behavioral and social sciences such is not the case. These fields proceed in splendid mutual isolation. But how can one exactly understand this vertical integration, or compatibility of sciences?

One recent proposal of a general account of inter-theoretic and inter-model relationship is to use the notion of a constraint [16]. The weakest kind of constraint is a truth-constraint: two bodies of knowledge satisfy a truth-constraint just in case they can be both true at the same time. The notion of truth-constraint can be then used to precisely spell out the notion of vertical integration: namely, two bodies of knowledge are vertically integrated iff one body of knowledge truth-constraints the other and the first body cannot (in some weak sense) be false. (Notice that this definition accounts for *vertical integration* in a somewhat deflationary manner. The relationship is asymmetric in such a case, when normally, truth-constraining is horizontal, i.e., no body of knowledge is presupposed to be definitely true or more reliable than the other). However, truth-constraining is a weak relation of logical coherence. The wave theory of light does not exclude the particle theory of light, so they satisfy the (horizontal) truth-constraint, even if they propose a completely different account of the basic nature of light. One stronger constraint concerns the nature of entities and processes (activities) presupposed by both theories. Both theories of light no longer satisfy such a constraint, unless a unifying theory is proposed: one that holds that light has both the nature of a particle and wave at the same time.

The entity and process constraints can be easily applied to a mechanistic account of explanation, which is particularly sensitive to issues of interfield research [17, 18]. Before I go to elucidate how that applies to the study of social intelligence, the notion of mechanistic explanation has to be made clear. According to new mechanism, to explain a phenomenon φ is to elucidate the causal structure of the mechanism that gives rise to φ. While mechanisms are defined variously, the core idea is that they are organized systems, comprising causally relevant component parts and operations (or activities) thereof (for a recent review, see, e.g., [19]). Component parts of the mechanism interact, and their organized operation contributes to the capacity of the mechanism to exhibit φ.

Another important notion to be elucidated is the one of the *interfield theory*. The interfield theories are ones that relate at least two fields of study. By a *field* of study, Darden understands for example cytology or genetics rather than biology; in other words, it has a more restricted scope than a theory or a discipline. Two fields may appeal to the same spatiotemporal locations, entities or activities, and one of them

may provide a better understanding of the spatiotemporal relationships, causal relationships, physical nature, structure or function thereof. In the case of social intelligence, it is quite clear that social relationships may be elucidated in various ways by various disciplines, from evolutionary and ecological biology [20] to cultural studies.

There are at least three ways fields may become integrated mechanistically: by *simple integration*, when the models of mechanisms can be considered pieces of puzzle that fit together; by *interlevel relationship*, when another level of organization is added to make explanation more complete; and by *intertemporal integration* [18]. In the case of simple integration, two fields may simply study social intelligence in a similar way but with a slightly different stress. For example, sociology of science studies researchers in a lab, and so does cultural anthropology, while the first field may use more quantitative analyses and historical evidence than the other to study similar phenomena.

The interlevel relationship is much more complex, as it may be confused with reduction. The need to introduce multiple levels of explanation is related to the nature of the mechanism under study. As Herbert Simon [21] argued, on theoretical grounds, complex systems are likely to be *near-decomposable*, or composed of subsystems whose interactions are weak but not negligible. One facet of near-decomposability is hierarchical organization, in which different levels can be discerned, with interactions at a different order of magnitude. Such systems, as long as their capacities to be explained are identified, can be subject to mechanistic constitutive explanation, in which lower levels of organization explain higher levels. Levels are understood spatiotemporally; and the relationship between them is proper part-whole relationship [22] (for a longer account, see [13]; for a more deflationary one, [23]). Note that the existence of a lower level explanation does not make the higher level disposable in this framework: the higher level is explained by the interaction of the components and activities on the lower level, and the lower level contributes to the capacity of the higher level. In such a case, one could say that our knowledge of the higher level has been deepened, which also leads more empirical credentials to our previous beliefs about the higher level [24].

As long as explanations are integrated in an interlevel fashion, they are not only truth-constrained. The model of the lower level of a mechanism elucidates the activities and entities of the mechanism on the higher level. Such mechanistic explanations, called *constitutive*, cover at least three levels of organization: the *bottom* (-1) level, which is the lowest level in the given analysis and describes the internals of mechanism parts and their interactions; an *isolated* (0) level, at which the parts of the mechanism are specified along with their interactions (activities or operations); and the *contextual* (+1) level, at which the function of the mechanism is seen in a broader context. Depending on the shared scientific practice, the bottom level in the explanation will vary [25], as well as the upper levels. Note that one can easily introduce a further level if needed. Let's take an explanation that accounts for reproduction of bacteria. The reproduction of bacteria in a given environment (contextual level) is explained in terms of division (isolated level that ignores the environment), and division in terms of cellular mechanisms (the bottom level). The cellular-level mechanism

can be further explained by its molecular parts, which would introduce a fourth level in this explanation.

The main, though fallible, heuristics in such explanations are localization and decomposition [26]. For example, social capacities of a human being can be explained by a psychological model, the psychological capacities with a neuroscientific model, and many neuroscientific explanations proceed from neuroimaging studies (some of which are not reliable; see [27, 28]). Note that from the mechanistic point of view, the model of, say, economical behavior of people involved in forex exchange, is explanatory only if it is complete. This means that the model needs to cite all relevant causal factors and clearly identify the explanandum phenomenon. In more concrete terms, it will mean that most micro-economical models will fail to be explanatory, as they tend to abstract away from crucial individual causal factors, in contrast to social models of behavior [29]. Also, many models that try to explain economical behavior only in neurophysiological terms fail to cite relevant factors known from psychological studies; neuroeconomics has lost touch with the rest of neuroscience by failing to integrate behavioral studies combined with physiological, pharmacological, or anatomical techniques that rely on animal models [30].

The intertemporal integration applies to phenomena that can be analyzed, due to their hierarchical organization, on multiple temporal scales. For example, the behavior of a person interacting with a computer artifact may be explained by citing distal factors, relevant for explaining the history of computer artifacts that can be used by human beings. It can also be explained on a shorter time scale, by citing this person's skills and their acquisition. Also, it can be explained in a fine-grained fashion by using neuropsychological models of human-computer interaction. Different explanations of behavior will require researchers to appeal to mechanisms operating at different time scales.

The new mechanism frames the discovery of explanatorily relevant mechanisms for the mechanism under study in terms of looking up, down and around [31]. For example, Craver and Darden write:

> One can look up to the higher-level mechanism of which it is a component. One can look back to the mechanisms that came before it or by which it developed. One can look forward to what comes after it. One can look around to see the even wider context within which it operates. The adequate explanation of many biological phenomena requires describing a temporally extended and multilevel mechanism. This is why many fields, working at multiple levels, often must integrate their work in the discovery of mechanisms [18].

Let me summarize this section. By framing explanations of social intelligence in mechanistic terms, one can understand current scientific practice but also articulate certain norms of explanation, useful for integrating the field of social intelligence. In brief, the field will be unified as long as it will study the complex mechanisms underlying social intelligence, and use knowledge about mechanisms operating at different levels of organization and various time scales to constrain hypotheses about the overall structure of the mechanism.

3 Levels and time scales of the social mind

In this section, I will tentatively sketch the mechanisms underlying social intelligence and cite relevant disciplines (for another similar proposal, see [32]). Most abstractly, one can understand social intelligence as capacity for skillful social interaction. Such abilities can be described on various levels of abstraction, for example in agent-based models [33, 34]. Such models, however, usually only presuppose certain psychological capacities of agents, and for the new mechanism, they require integration with cognitive science. They can, however, describe multi-agent cooperation and coordination. Quite obviously, social organization, with all kinds of business, military, power, and informal hierarchies, can be analyzed in terms of near-decomposable systems, and hence, idealized as mechanisms or components of larger mechanisms. But we can also look down to deepen the explanation of social mechanisms, and cognitive science has growing interest in the social.

Traditional cognitive science was methodologically individualist, and framed intelligent behavior in terms of processing of internal representations of individuals. Embodied and grounded cognition, the extended and scaffolded mind, enactivism and distributed cognition all challenge the traditional approach in different ways. Social intelligence is accounted for in terms of embodied interactions supported and extended by actively built cognitive niches. Despite the variety of approaches, they may be jointly dubbed "wide cognition"; they offer a new coherent picture of cognition, as well make it possible to integrate and unify interdisciplinary research [35]. Below, I list how four approaches of wide cognition enable and require interfield integration.

The claim of the *embodied cognition* (EC) is that the physical body of an agent is constitutively relevant for cognition; in other words, cognitive processing involves more than the brain. Core cognition, which essentially involves perception and action, depends deeply on the features of the physical body. This, obviously, means that biological mechanisms of human beings can become easily integrated on lower levels of the explanation. These biological mechanisms may include the features of our sensory and motor systems relevant for skillful action, including neural mechanisms of embodied joint attention [36].

The *situated and embedded* approach to cognition holds that cognition should be cashed out in terms of the interaction of the agent and its immediate surroundings. The extra-bodily context constrains and enables cognition. For this reason, situated cognition needs to refer to behavioral studies as well as to basic biological and cognitive mechanisms of sociality, which includes such abilities as mindreading [37, 38]. Note that the mechanism of the social mind might not need to cite the controversial hypothesis of mirror neurons, sometimes assigned too many tasks without credible empirical evidence [39, 40].

The *extended mind* is the idea that cognitive processes are not necessarily brain-bound and can incorporate external resources such a tools, language, and external systems in order to enhance or augment cognitive processes. The difference of this approach from situated cognition is the emphasis that parts of what were traditionally considered the environment should properly be understood as part of the agent's mind. Even if the claim of the extended mind is exaggerated [41], this approach

stresses the importance of material bases of cognition [42]. Here, cognitive archeology [43] as well as the study of human-computer interactions [44] becomes important.

The *enactive* approach to cognitive science recognizes a crucial inter-dependency between an autonomous agent and the world it inhabits. Cognitive activity is wholly defined neither by the agents nor their environment, but it emerges from their interaction. Again, enactive approaches can be easily linked with some biological disciplines and fields, one of which is biosemiotics [45]. It is also very sensitive to temporal dimensions of human interactions on multiple scales [46].

These approaches in cognitive science are immediately relevant for the study of social intelligence, and they do not deny the importance of the brain or individual mechanisms. But wide cognition does caution against adopting an excessively narrow perspective that abstracts emotions away from the broader bodily, social, and cultural contexts that play a critical role in their development and functioning. Obviously, one factor critically important phenomenon for study of social intelligence is language, which is understood in current cognitive science not as mere realization of a formal grammar but also as involving multiple levels of cultural interaction and coordination, as well as internal mechanisms, also involving bodily interactions [47–49]. I suggest that different approaches of wide cognition offer multiple constraints on social theorizing; at least, these are truth-constraints, but ideally, we should strive at identifying common mechanisms that enable distributed, embodied and embedded cognitive processing.

At the same time, there are also competing explanations of various phenomena of social intelligence. Should one frame linguistic conventions in propositional and game-theoretic terms [50]? Or maybe it requires an evolutionary point of view [51]? Or a view that mentions institutional contexts [52], and temporal dynamics [53]? Not all these views can be true at the same time, and integration is not just a matter of conceptual investigation. One could also see these different approaches as competing idealizations; however, they cannot be treated easily as supporting multiple-model idealization [12] as they don't offer predictions or explanations for the same set of phenomena (if philosophical accounts of convention can offer any predictions for empirical phenomena, for that matter). However, one can see a set of common mechanisms for solving coordination problems in many of those approaches; sketching those is definitely beside the scope of this paper, whose aim is to defend a certain programmatic attitude to the study of social intelligence.

Another challenge remains to specify how to investigate cultural and social phenomena so as to include them all in a unified models of social and cultural cognition. For example, so called network goods have value to someone only if other interactive parties also have them. It makes no sense to own a fax machine if nobody else owns one. This phenomenon can be studied on different time scales, and it is an open question how to integrate economical analyses with the psychological research on joint action, and the ethnographical studies typical of distributed cognition with computational modeling in evolutionary game theory, as it is also an example of a co-adaptive behavior.

4 Conclusion

In this paper, I merely sketched a mechanistic perspective on the integration of the field of social intelligence. (A complete case study of examples how mechanistic explanations furnish researchers with multiple constraints in their theorizing would require much more space.) Instead of suggesting that there is a single, privileged theory of social intelligence, to which all other theories or models should be reduced, new mechanism stresses that understanding complex phenomena requires rich, multilevel models operating at multiple time scales. As such, it can help establish common research topics and identify the core submechanisms of social intelligence.

The interlevel nature of constitutive mechanistic explanations makes new mechanism a natural ally of explanatory pluralism [54, 55]. Instead of suggesting that there should be just a bottom-level causal explanation of all levels of organization of a given complex system, new mechanism insists that explanations at all levels are needed. These different explanations need not belong to the same discipline. They may be shared among various fields and disciplines. In other words, constitutive mechanistic explanations don't require different disciplines to become completely lumped together, as long as they can provide input for a common body of knowledge about a given mechanism.

This leads to a related issue. The assumption that the whole field of social intelligence is to be integrated may turn out premature. In principle, social intelligence may remain just a hub of interaction between different fields concerned with social and mental phenomena; it wouldn't constitute a separate field then. However, the same principles would apply then: as long as we're interested in discovery of real mechanisms of social interaction of cognitive agents, there is a need to avoid excessive fragmentation of research, which may only need to isolation of subfields and duplication of effort.

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