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Social Meta-Learning: Learning How to Make Use of Others as a Resource for Learning

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Abstract. While there is general consensus that robust forms of social learning enable the possibility of human cultural evolution, the specific nature, origins, and development of such learning mechanisms remains an open issue. The current paper offers an action-based approach to the study of social learning in general and imitation learning in particular. From this action-based perspective, imitation itself undergoes learning and development and is modeled as an instance of social meta-learning – children learning how to use others as a resource for further learning. This social meta-learning perspective is then applied empirically to an ongoing debate about the reason children imitate causally unnecessary actions while learning about a new artifact (i.e., over-imitate). Results suggest that children over-imitate because it is the nature of learning about social realities in which cultural artifacts are a central aspect.

Keywords. Social ontology, action-based framework, learning to learn, social learning, over-imitation

Introduction

Neither humans nor robots can be preprogrammed to competently operate in real world environments: there is too much *complexity* and it cannot be anticipated beforehand what will be *relevan*t for successful interaction [1]. Instead, both humans and robots must be capable of learning. In the realm of social engagements, the issue of preprogramming is even more pronounced because the "objects" involved are ontologically emergent from the co-constituted activity of the participants [2]. Accordingly, participation in a socio-cultural world requires that humans and robots be equipped with the ability to learn from others (social learning), and, for human-like competence, to learn and develop their ability to learn from others (social meta-learning).

There is general consensus that participation in human culture and advances through cultural evolution have depended on the possibility of robust forms of social learning. Imitation is widely thought to be one of these robust forms of social learning but the specific nature, origins, and development of this form of learning garners far less agreement [3,4,5,6,7]. Further, the dominant theoretical frameworks in both animal and developmental research do not motivate a perspective in which imitation itself involves learning and development. In general, humans are not only capable of learning, but also,

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they are capable of learning to learn (meta-learning) [8]. With respect to social forms of meta-learning children are learning how to use others as a resource for subsequent (social/individual) learning and development. This perspective on imitation as a form of social meta-learning is motivated from within an alternative action-based framework for modeling development more broadly [9,10].

1. An Action-Based Framework: Interactivism

Theoretical models and assumptions about the nature and origins of representation, learning, and development involve sets of mutually constraining relations. Using an action-based framework for modeling learning and development means being committed to (inter)action as the epistemic ground for the emergence of mind [11,12]. From an action-based perspective, knowledge is *constituted* by interactive competence and representation is a matter of learning about relevant interactive possibilities.

Interactivism is a well-developed action-based framework that models the origins and ontology of representation, learning, and development for both the physical and social world [13,10,14,15]. The interactivist model of physical object representation borrows from the work Piaget [12]. For both models, physical object representation is constituted by an invariant web of interactive possibilities. Any point in the web is reachable from any other point and the web remains invariant under a large class of other possible transformations (e.g., visible or invisible displacement).

1.1. Social Agent Representation

In contrast to physical objects, the interactive possibilities afforded by social agents are, largely, not perceptually available. Instead, the interactive characterization of a social agent depends, in large part, on that other agent's interactive characterization of you. Consequently, an accurate interactive characterization of a social agent is going to require knowing about the broader type of situation of which the two agents are major aspects. Accordingly, successful interaction and coordination between social agents is made possible through the creation, invocation, and maintenance of mutually held interactive characterizations of the type of situation – i.e., social realities. In turn, social realities provide the basic ontology for learning about and navigating social life [2].

1.2. Learning and development

From an action-based perspective, knowledge is constituted by interactive competence and, is therefore, inherently active, relational, and necessarily constructed through a variation and selection process [10]. In contrast to nativism and empiricism, knowledge is not assumed to come from somewhere (genes or environment), nor is it assumed to be constituted by some sort of correspondence relationship between mind and world [16]. Instead, knowledge is actively constructed through the creation of new internal organizations for the organism's possible functioning and internal organizations that enable successful interaction with the environment will be selected for. In short,

learning is modeled as a variation and selection emergent constructivist process [11].

For organisms that are capable of minimal forms of development, the constructive processes can be recursive in that current constructive processes can make use of prior constructive processes. In more complex organism, like humans, the constructive processes can themselves undergo learning. Such organisms will be capable of meta-recursive constructive processes – they will be cable of learning to learn [8,14]. From this perspective learning and development involve the same underlying dynamics but at different times scales. Accordingly, development will be constituted as the properties and constraint manifested by the historicities of learning – the ways in which prior learning influences future learning [17]. For developmental research this will mean designing studies and interpreting results in the developmental context of what children have previously learned about the affordances of objects and social agents in different types of situations.

2. Social Meta-Learning

With respect to social forms of meta-learning children are learning how to use others as a resource for subsequent (social/individual) learning and development. In general, forms of social meta-learning are going to involve issues of the competence and reliability of those others [14]. An early example of social meta-learning is when children develop attachment relationships that are adapted to specific people in their care-giving environment. Different attachment relationships develop to maximize using the adult as an emotional resource. Securely attached children are able to consistently use the adult caregiver to help make *global* evaluations about situations and in that sense use the adult as a secure base from which to explore their environments. A later emerging form of social meta-learning is social referencing. Social referencing involves using an adult's emotional reaction to a particular object or event within a specific situation. This emotional reaction provides the child with a *more specific* evaluation about whether to proceed or withdraw from their ongoing activity.

Imitation is a powerful form of social meta-learning that remains particularly useful throughout the first 3-4 years of life. For imitation, children are learning about how to use adults as a resource for specific engagements with the physical, social, and cultural world. However, children must not only learn *how* to imitate another persons' actions (solving the correspondence problem [18]), but also: *who* to imitate, *what* to imitate, and *when* to imitate. Further, children must develop the ability to use imitation for different functions: learning, play, affiliation, trust, commitment, etc. Finally, social meta-learning has renewed importance once children develop sufficient language capabilities. "Trust" research has focused on the various cues that children learn to use as indicating the reliability of information coming from conflicting sources [19]. In general, many of these cues are learned and reconciled with other cues at around age 4. For example, a person's past accuracy is recognized as a more relevant cue for predicting their future reliability over an affiliation cue like familiarity [20].

Having outlined an action-based approach to the representation of social realities and the development of social meta-learning, this approach will be

applied to the empirical study of imitation learning. This application has two aspects: first, in contrast to the current conceptual focus on imitation fidelity, this approach presupposes a theoretical perspective in which all imitation is selective and based on cognitive, motivational, and social-cognitive processes. Second, this approach will be used to propose an alternative account for an ongoing empirical debate within contemporary imitation research about the nature of over-imitation. The paper concludes by suggesting that the current action-based framework is adequate to the task of grounding empirical research on imitation in a way that more closely resembles the richness of human culture.

3. The Current Study

A current debate amongst imitation researchers concerns the underlying reason why children copy the causally unnecessary actions of an adult model when learning about novel artifacts. For example, children will replicate tapping on the top of a box as part of a sequence along with other causally necessary steps in their effort to open it. This phenomenon has been termed 'over-imitation'. The current study will use the above social meta-learning perspective to propose an alternative account for why children over-imitate?

3.1. The Debate

Explanations for why children over-imitate have generally fallen into two camps. In the one camp, researchers have argued for a cognitive-learning explanation: that over-imitation manifests as a side-effect of a learning strategy in which copying all of an adult's intentional actions is typically adaptive [21,22,23]. That is, children are thought to copy the causally unnecessary actions because they believe (mistakenly) that those actions are necessary to open the box. In the other camp, researchers have argued for a social-motivational explanation: that children understand the adult's demonstration of the unnecessary actions to be an opportunity for social engagement [24,25,26]. That, is, children copy the unnecessary actions because they want to interact with the adult.

The current perspective agrees with the social-motivational approach that children are motivated to interact socially with the adult; however, success at such an interaction requires learning. That is, in order to successfully interact with the adult, children must learn about this particular social situation of which the relatively novel artifact is a central aspect. Consequently, children's over-imitation responses will have less to do with their causal understanding of the object and more to do with the *culturally relevant* object affordances that they presume are necessary for successful interaction. From the perspective being advocated in the current study, all imitation activity is selective and that selectivity always involves both cognitive-learning and social-motivational aspects that are themselves relative to the child's understanding of the broader type of situation (social-cognitive aspects). Thus, we propose that learning about social realities is the more general phenomenon that is captured by standard over-imitation studies.

3.2. The Study

In order to test this proposal, we sought to demonstrate how culturally relevant object affordances change depending on the type of social situation. Seventy-four, predominantly white, middle class children (47 male, 27 female) who were 3-5 years old participated in the study. A within-subjects design was used that that manipulated the type of social situation and measured children's over-imitation behavior. Specifically, children's actions during a canonical imitation situation were compared with their actions during a subsequent helping situation. In the helping situation, opening the box becomes decidedly instrumental relative to the ultimate goal of helping an adult. This provided children with an opportunity to use *whatever* they learned about the box (from the canonical imitation situation) to accomplish their ultimate goal of assisting the adult in the helping situation. It was hypothesized that children would be less likely to over-imitate in the helping situation relative to the canonical imitation situation.

3.3. Results and Discussion

Results indicated that nearly 80% of children in the imitation situation over-imitated, while this number dropped to less than 5% in the helping situation. This finding is in stark contrast to Lyons and colleagues' [22,27] efforts to demonstrate that over-imitation involves a distortion to the child's causal-belief structure about how the artifact "really" operates. From the current perspective, children are learning how to successfully interact in the situation. Consequently, learning with respect to the box per se is tied to what children are learning about the social interaction that, as a whole, defines the situation – i.e., the social reality.

In general, the culturally relevant interactive affordances of an artifact/object are going to change depending on the type of situation that is involved. In part, what is culturally relevant about an object depends on one's purposes and these will vary in different types of situations. Findings from the current study provided converging evidence that over-imitation in preschoolers is less about the causal structure of the box and more about the normative structure of the situation as a whole [28,29]. This normative structure (social-cognitive aspects) helps children to understand the purpose of the situation (motivational aspects) as well to define the meaning of the object in the situation (cognitive aspects). To put it simply, children are learning that "this is what you do to the artifact to participate in the social reality" rather than that "this is the necessary causal structure for how to open the box".

4. Conclusion

The current study sought to apply an action-based perspective on social realities and social meta-learning to the empirical study of imitation. This perspective presupposed an alternative characterization of imitation that recognizes the selective nature of all forms of imitation activity. Consequently, the current study proceeded to explore the psychological basis for that selectivity in a canonical over-imitation setting. In particular, how cognitive and motivational aspects were related to the broader type of social situation and

how they collectively guided children's imitation activity. The main conclusion is that children over-imitate because it is the nature of learning about social realities in which artifacts are a culture-relative aspect.

4.1. What is Special About Imitation Learning?

Imitation is widely assumed to be a particularly important form of social learning because of its contribution to human culture more broadly. However, understanding of *cultural* artifacts does not reduce to the causally necessary ways of using objects or even to their instrumental functioning. Instead, cultural artifacts are saturated with aesthetics and their functioning is tied to our social interests as much as to our "rational" needs. Cultural artifacts are constrained by their physical embodiment but attain socio-cultural meaning through their contribution to social agents co-constitutive participation in social realities (i.e., social ontology). Likewise, social ontology does not reduce to the *mere* presence or absence of social objects that are understood as more complex physical objects. Instead, social ontology is emergent from interactive systems grounded in the world. Thus, social realities are fundamentally constrained by the need for interactive coordination. Although such coordination will involve arbitrary aspects (e.g., it does not matter what side of the road we drive on), that does not mean that there are no normative constraints for understanding what one ought to do to participate in cultural activities. That is, rationality and causal necessity do not exhaust the normative ground for guiding imitation learning. Accordingly, imitation researchers can move beyond their view of artifacts as physical objects to one in which artifacts are viewed as culture-relative aspects of social ontology.

The current action-based perspective offers a robust theoretical framework for exploring some of the richness of learning to participate in human culture. This framework draws on a model of the basic content of culture in terms social ontology and provides a genuinely developmental perspective on those learning to participate in such culture. The current empirical work and theoretical integration constitute a first step for a promising avenue of research in the domain of social meta-learning. Finally, social meta-learning is something that roboticists will need to consider if they are to build social agents capable of participation in human socio-cultural activities.

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