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Comment

Language as a means to reduce uncertainty  
Comment on “An active inference model of hierarchical action  
understanding, learning and imitation” by R. Proietti, G. Pezzulo,  
A. Tessari

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The paper “An active inference model of hierarchical action understanding, learning and imitation” [1] provides an interesting and comprehensive overview and a compelling model of how action understanding, learning, and imitation might occur. Rather than focusing on the approach, with which we are fully sympathetic, or the model’s detail, in the following, we will highlight some points that the authors might want to incorporate or address.

One aspect not addressed in the model is the role language might play in this framework. The authors mention language only tangentially when they say “prior information can come from different sources: it can be provided exogenously (for example, via verbal or contextual cues) or be generated endogenously, on the basis of the learner’s own motor knowledge.” (pag. 98). We agree that language can be a cue conveying previous information like context does, but we think that it can be more than a cue. Language not only helps grounding in the environment through simulation of sensorimotor (exteroceptive, proprioceptive, and interoceptive) experiences, a mechanism the authors mention (p. 101), but it also extensively contributes to action preparation and implementation. Language can help construct predictions in relation to which sensory signals can be evaluated [2]. Language can be a powerful tool to reduce uncertainty in action selection (on the role of language overall, see [3]).

Once a label is used, for example, to name an action, the action representation becomes more compact, its differentiation from similar actions increases, and its boundaries from other actions become less fuzzy [4]. Providing new labels for new tools facilitates their use [5]. Providing a new label to a novel action might help strengthen its

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saliency and memorability, enhance its recognition, make its execution smoother, and facilitate its imitation. Notably, previous studies have shown that potentiating language abilities, for example, syntactic ones, might impact the ability to perform sequential, hierarchical actions [6,7]. The role of language in the context of action learning might not be limited to overt language. During action learning, a special role is played by inner language or self-talk: it can help maintain action-related information in working memory, it can motivate and even support action endurance [8,9].

Aside from tangentially mentioning “verbal cues”, the authors extensively discuss the distinction between a direct and a semantic route to action. Importantly, however, semantic knowledge does not necessarily involve language – we might form a concept without a corresponding label. Labels represent an additional layer that might further facilitate action planning, recognition, and execution. This is related to affordances, and particularly how language encodes and reflects them. While distinguishing between the direct and semantic routes, the authors mention different affordances, e.g., functional and structural ones. Similarly, studies on stable and variable affordances [10,11] have shown that the processing of variable affordances, like the current orientation of objects, activates a direct, automatic vision-to-action route implemented in dorso-dorsal circuits. By contrast, a more ventral representation (dorso-ventral circuit) concerns actions evoked by stable affordances, like size, and texture. Importantly, actions prompted by stable affordances are also those encoded linguistically.

Another aspect that the authors might want to discuss further and eventually implement in the model is the distinction between different kinds of actions and the relative mechanisms of motor resonance when imitating. We might learn novel actions that we have previously recurrently observed but not executed. For example, one could be an eager spectator of tennis matches without having ever played tennis. Also, we might learn novel actions after having previously executed some chunks or components of them. The motor resonance mechanisms elicited in the two cases might differ consistently. In addition, although the focus of the model is on imitation, we wonder why the authors do not mention the fact that, in some cases, observing actions might lead to activate not a similar but a complementary action to the one we observe. Notably, the mirror neuron system is activated also in the second case [12], and the authors themselves have provided important contributions both on imitation and joint action.

One further point concerns the role of visual attention in relation to body parts. In the first simulation, the authors claim: “The learner can only make saccades to one body part at a time but can integrate this information over time to infer the current movement segment of the teacher.” Our impression is that visual attention might be more diffuse and less focused on single body parts and that the visuospatial expertise of the observer might modulate its role. For example, an expert player might more easily connect single body parts with global bodily movements, weighting differently each step’s solution in the hierarchical model.

A final remark concerns the choice of tennis as a paradigmatic example. While we appreciate that the authors investigated a sports activity and do not question the example’s generalizability, we believe there could be clearer examples. Consider, for example, the intention of preparing coffee and the proximal scopes related to the single actions that compose it – opening the coffee pot, pouring water, inserting coffee, etc. In the case of tennis, the distinction between intentions and proximal goals, although present, is sometimes blurred and not clearly distinguishable as in the case of other actions.

### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### **References**

- [1] Proietti R, Pezzulo G, Tessari A. An active inference model of hierarchical action understanding, learning and imitation. *Phys Life Rev* 2023;46:92–118. <https://doi.org/10.1016/j.plrev.2023.05.012>.
- [2] Lupyan G, Clark A. Words and the World: predictive coding and the language-perception-cognition interface. *Curr Dir Psychol Sci* 2015;24(4):279–84. <https://doi.org/10.1177/0963721415570732>.

- [3] Borghi AM. The freedom of words: abstractness and the power of language. Cambridge University Press; 2023.
- [4] Cangelosi A, Parisi D. The emergence of a 'language' in an evolving population of neural networks. *Connect Sci* 1998;10(2):83–97.
- [5] Foerster FR, Borghi AM, Goslin J. Labels strengthen motor learning of new tools. *Cortex* 2020;129:1–10.
- [6] Brozzoli C, Roy AC, Lidborg LH, Lövdén M. Language as a tool: motor proficiency using a tool predicts individual linguistic abilities. *Front Psychol* 2019;10:1639.
- [7] Thibault S, Py R, Gervasi AM, Salemme R, Koun E, Lövdén M, et al. Tool use and language share syntactic processes and neural patterns in the basal ganglia. *Science* 2021;374(6569):eabe0874.
- [8] Latinjak AT, Morin A, Brinthaup TM, Hardy J, Hatzigeorgiadis A, Kendall PC, et al. Self-Talk: an interdisciplinary review and transdisciplinary model. *Rev Gen Psychol* 2023. <https://doi.org/10.1177/10892680231170263>.
- [9] Nedergaard JS, Wallentin M, Lupyan G. Verbal interference paradigms: a systematic review investigating the role of language in cognition. *Psychon Bull Rev* 2023;30(2):464–88.
- [10] Borghi AM, Riggio L. Stable and variable affordances are both automatic and flexible. *Front Human Neurosci* 2015;9:351.
- [11] Sakreida K, Effmert I, Thill S, Menz MM, Jirak D, Eickhoff CR, et al. Affordance processing in segregated parieto-frontal dorsal stream sub-pathways. *Neurosci Biobehav Rev* 2016;69:89–112.
- [12] Newman-Norlund RD, van Schie HT, van Zuijlen AM, Bekkering H. The mirror neuron system is more active during complementary compared with imitative action. *Nat Neurosci* 2007;10(7):817–8.