

TITLE : From copying to coordination: an alternative framework for understanding cultural learning mechanisms

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ABSTRACT

Copying has been a productive paradigm for the study cultural learning. Copying is about information transmission, the success of which is measured by the similarity of knowledge between models and learners. In this paper, we identify some shortcomings in the use of copying mechanisms (e.g., imitation, emulation) as explanations of cultural learning, emphasizing their focus on the flow of information (from expert to novice) instead of on the specific interactions involved during episodes of learning. We argue that the micro-interactions between models and learners and how they coordinate with one another better explain how knowledge is passed on between individuals. We propose to understand cultural learning as a form of interpersonal coordination, i.e., as the result of dynamic interactions involving mutual behavioral alignment between two interacting agents. We sketch how a coordination framework provides a richer picture of cultural learning, with more explanatory power than the copying paradigm.

Keywords: cultural learning; copying; coordination; imitation; emulation; cognitive mechanisms; interactions

1. Introduction

The study of cultural learning—how individuals acquire knowledge, practices, and norms from one another—is fundamental to identifying and characterizing the individual and inter-individual capacities that permit the propagation and evolution of human cultures and technologies. Much of the theoretical and experimental work on cultural transmission adopts copying as its paradigmatic case. Learning from others amounts to copying what they do and know, with the resulting differences in what is learned understood as ‘copying-errors’. The remarkable fidelity by which humans can copy the actions and goals of others—far more faithfully than our nearest phylogenetic relatives can—is taken as support that our ability to extract rich information through observation of expert others plays a key role in cultural learning. This way of understanding cultural learning has become so ubiquitous in the field of cultural transmission and evolution that it often appears more as an implicit background assumption guiding theoretical and experimental interpretation than as a special hypothetical claim heralded by a specific group of researchers.

Building plausible and coherent models of the cognition involved in cultural learning and studying cultural learning experimentally is important for understanding which specific individual capacities can and do play a role in cultural evolution. We argue that focusing on the content of cultural transmission leads the copying paradigm to confuse explanations of the causal processes involved in cultural learning with descriptions of the very informational patterns that demand explaining. An explanation in terms of causal mechanisms needs to account not just for which informational patterns obtain (i.e., which learning inputs map onto which behavioral outputs), but also *how* these mappings obtain (i.e., in terms of the cognitive and behavioral mechanisms involved during the learning process).

In this paper, we provide an *explicit* account of what we take the copying paradigm to be (section 2) and detail its constituent learning mechanisms, specifically imitation and emulation in humans (section 3). We then identify two epistemological challenges facing the copying paradigm preventing the development of psychologically plausible explanatory models of cultural learning (section 4). Finally, we present an alternative framework that centers on interpersonal coordination—rather than copying—as a base model for cultural learning (section 5). We show how this framework overcomes the explanatory challenges associated with the copying paradigm, contextualizes a growing body of literature that challenges its assumptions, and how this offers a richer explanatory scope for understanding the psychological and behavioral foundations of human culture.

But first, a caveat. We argue below that understanding copying as a paradigmatic case of cultural transmission has led researchers in the field of cultural evolution, especially experimentalists (e.g., Hoehl et al., 2019; Mesoudi, 2023), to adopt ontological assumptions and inferential strategies that we see as problematic *when addressing the cognitive processes of cultural learning*¹. We set to identify the issues linking these strategies and assumptions—which we jointly refer to as the ‘copying paradigm’ (for short)—, and explain why they are problematic. Therefore, we refrain from pointing to specific people employing the copying paradigm or listing existing slips in research papers. For one, we believe that it is more

¹ We are not addressing the research focusing on the population-level, evolutionary effects of cultural transmission, for which modelling cultural learning as a form of copying is a useful simplification (but see (Acerbi et al., 2021)). Discussions of copying as a mechanism explaining long-term evolutionary patterns are beyond the scope of this paper.

productive to highlight the shortcomings of the assumptions and strategies employed by the copying paradigm than engaging in a nitty gritty exegesis of who says what and where. As mentioned above, the use of what we identify as the ‘copying paradigm’ is too widespread, making such a listing unproductive. Secondly, as the copying paradigm is expressed in specific explanatory inferences, research papers and researchers often use it for some arguments, but not for others. Therefore, it is the validity of the conclusions reached when the copying paradigm is used that we criticize rather than any researcher or research paper. We thus leave it to the reader to determine in good faith where and when it is being used, hoping that our contribution serves to see extant and future research in a new and more productive light.

2. The copying paradigm of cultural learning

Cultural transmission is inherently an asymmetrical process. A model possesses some knowledge that a learner lacks—e.g., knowing how to chop down and then buck trees for lumber—, and the transmission of this knowledge is the result of interactions between the model and the learner, enabling the learner to acquire the knowledge they previously lacked. For this knowledge to be transmitted and the asymmetry broken, the model must express it in the form of actions (e.g., physical actions, utterances) that carry information about the knowledge, such that the learner can acquire that knowledge.

The copying paradigm takes as an explanatory target the *content* of cultural transmission, i.e., the information that is constitutive of the item under transmission (e.g., the form of an action, a goal). More specifically, it aims to explain what knowledge is transmitted from model to learner, and what patterns of variation result from episodes of cultural transmission. It asks questions such as “why is the learner’s behavior similar/dissimilar (in relevant respects) to that of

the model?” and “what kind of information are learners capable of acquiring?”. It offers answers of the kind “because it was faithfully copied” and “children of the age of four can copy both instrumental and causally opaque actions”.

The use of the term copying fluctuates between two meanings, one narrow, one broad. In the narrow sense, a learner copies a model by learning to reenact behaviors in a way similar to those displayed by the model (e.g., copying a specific way to handle an axe), or by reproducing an end-product or goal that is similar to the one produced by the model (e.g., copying by bucking logs of the same length as by the model). Expressions of the form “a learner copied a behavior or goal from a model” emphasize the similarity in the token behaviors or goals exhibited by both models and learners, with the learners having successfully copied the model when they (re)produce behaviors or goals similar enough to those displayed by the model (Charbonneau, 2020).

In a broader sense, ‘copying’ is understood as the transmission of information between model and learner, with a successful learning episode leading the learner to hold (in their brains) a copy of some knowledge that was possessed only by the model to begin with (Boyd & Richerson, 1985; Heyes, 1994). This notion of copying is broader in that it also comprises cases where the behaviors of the model and learner differ, but for which we nevertheless want to say that cultural learning has successfully occurred. For instance, one may learn from a model to avoid eating some plant without ever reenacting the exact same behavior that the model displayed when the learner was taught (e.g., slapping the plant out of the learner’s hands). So while the *expression* of the information may differ between model and learner, the transmission would still be due to a copying process if the information leading to these differently expressed

behaviors is (similarly enough) the same in the minds of the model and of the learner². This broader understanding covers the narrower sense, where the similar (copied) behaviors and/or goals are the expression of similar information (Charbonneau, 2015). It is this broader meaning of copying that we understand the copying paradigm to be committed to, and when not ambiguous, we will characterize the relevant units of comparison simply as ‘traits’ (whether they be information, behaviors, artefacts, etc.).

By focusing on the content of cultural learning, the copying paradigm adopts a specific understanding of learning episodes. A learning episode is construed as the transition between two states of affair: the first where a model is knowledgeable and a learner is not, and the second where both the model and learner are knowledgeable. From this perspective, learning episodes are understood to be discrete events of unidirectional information transmission as relevant information is transmitted by the model and received by the learner.

Under the copying paradigm, learning episodes are understood as unidirectional since the transmission of knowledge operates in only one direction—from the expert model to the naïve learner. Cultural transmission is asymmetric as the relevant information flows from model to learner, and never the other way around (otherwise the roles would simply be reversed). This does not mean learners are strictly passive, as they can choose what to learn, from whom and

² While the information transmitted is being copied, its material implementation in the brains of the models and the learners (i.e., its neural substrate) may vary substantially. Most students of cultural learning are not committed to any specific views on just how the same (or similar enough) information may be realized in different people’s brains (e.g., Richerson & Boyd, 2005).

when. However, they are not understood to contribute anything substantive (informationally) to the learning episode.

Episodes of cultural transmission are also construed as events, specifically the learner's transition from a state of unlearned (naïve) learner to that of a learned learner. As the explanatory emphasis is set on the relation between the informational start and end state of the transmission episode—i.e., which aspects of knowledge are transmitted to the learner and the variations (if any) in that information—, the details of the specific interactions (e.g., between models and learners) occurring during the transmission episode are of lesser importance. The copying paradigm does not deny that transmission episodes can be more complex or involve interactions over varying periods of time. But these “micro-interactions” (occurring within/during the learning episode) are idealized away as it is the transition in the informational state resulting from cultural learning that is of explanatory interest.

3. Learning mechanisms under the copying paradigm

The copying paradigm's explanatory target are the patterns in the variation or lack of variation in the content of the knowledge transmitted from a model to learner. What requires explanation are not the specific interactions involved in the informational transactions, but instead the degree to which the learner's acquired knowledge maps onto that of the model. A proper explanation (the *explanans*), then, must be capable of identifying the causes of why some content is faithfully transmitted, and why some variations in content occur (the *explanandum*).

The standard strategy is to explain these patterns as the effects of copying mechanisms, such as imitation and emulation. Imitation is typically understood as action and goal copying, i.e., the reproduction of the course of an observed action or action sequence, together with the

specific goal the actions are used to attain. For example, to learn an axe-based bucking technique, it may be necessary to copy exactly the actions of the model. In contrast, emulation is understood as end-result or goal copying, i.e., the reproduction of the outcome of an observed action or action sequence without copying the specific actions used to attain this goal. For example, one may copy the shape and length of the logs made by another lumberjack without using that lumberjack's specific bucking technique (e.g., using an axe) but instead using one's own (e.g., using a saw).³

When the learner's and the model's traits are highly similar, the similarity can be explained by a high-fidelity mechanism that ensures the accurate transmission of the relevant information⁴. For instance, children of the age of four, when observing both instrumental and non-instrumental actions used to achieve a certain goal, tend to copy both types of actions. Even though the non-instrumental actions have no clear function in bringing about the outcome, children tend to copy those in specifically social contexts, a phenomenon called 'over-imitation' (Lyons et al., 2007). Over-imitation is better explained by the children imitating their models—learning their specific actions and goals—rather than emulation—copying only the goals—since had they learned through emulation, they would have dropped the non-instrumental actions as these are irrelevant to attaining the goals.

³ Emulation and imitation come in many forms. Finer typologies are not consequential to our discussion. For discussion of these, see Hoppitt & Laland (2013).

⁴ Copying does not require the perfect replication of information, but that the copying is generally faithful enough or of sufficient high-fidelity. Put differently, it admits for better and poorer copying and does not entail assuming that cultural transmission is a replicative process.

When the learner's and the model's traits differ, the differences can be explained by either transmission errors (e.g., random copying-errors (Henrich, 2016; Mesoudi, 2011)), directional biases in learning some kind of content (e.g., convergent transformations (Claidière et al., 2018)), or by the use of some cultural learning mechanism that is sensitive to specific kinds of information but not others. For instance, if we observe that a learner copies only the goals displayed by a model but not the specifics of the actions used to achieve those goals (the specifics are lost in transmission), we can explain the transmission as being driven by emulative learning. Should we have observed, instead, that the specific actions were also copied we would have explained the episode as being driven by imitative learning.

In sum, the copying paradigm is interested in explaining what content cultural learning can transmit from model to learner, and why such content—and variation in that content—is transmitted.

4. Explanatory challenges to the copying paradigm

4.1—Copying as *virtus dormitiva*

In Molière's play *The Imaginary Invalid*, a group of physicians explain the soporific effect of opium as the result of its dormitive-inducing virtue, effectively offering a restatement of the capacity in need of explanation. Here, we argue that understanding emulation and imitation as causal mechanisms providing explanations of the cognitive workings of cultural learning leads to tautological explanations of this *virtus dormitiva* kind.

Note that emulation and imitation are defined in terms of the informational content effectively transmitted during a learning episode (Charbonneau & Bourrat, 2021). In other words, these copying mechanisms are defined by their input-output mapping, i.e., between what

a learner observes in the model (e.g., actions and end-states) and what a learner in turn reproduces (e.g., goals only for emulation, goals and actions for imitation). This is also true for more sophisticated typologies of imitative and emulative learning, where the definitions may also include contextual information about when, where, and with whom the trait is deployed (Hoppitt & Laland, 2013).

By defining learning mechanisms in terms of the content they transmit, the copying paradigm leads to tautological explanations of cultural learning, where the observation of some class of input-output transmission mapping is said to be the causal result of a mechanism defined as ‘that mechanism which produces that kind of observed mapping’. So, for instance, to the question, “What cognitive mechanism did the child use to copy both the actions and the goal of the model?”, the answer provided is “imitation, that mechanism which copies both the actions and the goal of a model.” For the question, “Why did the child copy causally opaque, conventional actions in addition to instrumentally transparent ones?”, the copying paradigm answers, for instance: “Because they adopted the ritual stance, that stance where one imitates causally opaque, conventional actions in addition to instrumental ones.” (Jagiello et al., 2022)

To serve an explanatory role, a mechanism must explain *how* the mappings are obtained, i.e., not just which input-output mappings are produced (what content is transmitted), but *how* the inputs (the model’s trait) are computed into their outputs (the learner’s trait). Emulation and imitation do not tell us how one partitions an observed complex action sequence into sub-actions and sub-goals, nor how the causal relations between actions and goals are recognized, etc. Instead, we are told that learners are sensitive to or recognize some actions and goals as being instrumental or conventional, causally transparent or opaque, etc., which leads them to copy some actions and goals but not others. This, in effect, is merely restating that some aspects of the

model's behavior (e.g., those actions that are causally opaque) were copied (or not) in the learner's behavior, the very pattern one seeks to explain.

It is thus more adequate to understand 'social learning mechanisms' such as emulation and imitation not as mechanisms, but instead as capacities or forms of cultural learning, i.e., as descriptions of recurrent informational patterns of human cultural transmission, the very patterns in need of explanation. In other words, when one's goal is to understand how cultural learning works, emulation and imitation specify *explananda*, not *explanantia*.

4.2—Micro-interactions matter

By focusing on the informational states of models and learners, the copying paradigm approaches learning episodes as events, i.e., as the learners transitioning from unlearned to knowledgeable individuals (see above). This is perhaps best illustrated by experimental work on cultural learning where learning episodes are often reduced to a single interaction of a learner observing a model, and asked or expected to reproduce some observed behavior (e.g., activating a lightbox with their forehead (Gergely et al., 2002)). While acquiring complex knowledge (such as skills, ritual practices, etc.) can often be complex stories stretching in time and space, the copying paradigm treats them as stories involving multiple events of cultural learning (e.g., first one imitates how to hold an axe, then one imitates how to swing it, then one emulates where to chop the log). Within the copying paradigm, however, learning episodes seem to be understood as baseline, atomic events.

Construing learning episodes as copying events by which some content is transmitted, the specifics of how that content is transmitted are lost, and the copying paradigm fails to provide explanations of *how* cultural learning is deployed in any specific, local scenario. In other words, focusing on input-output mappings between models and learners—i.e., transmission *after* the

fact—, and treating transmission episodes as discrete copying events (of emulation, of imitation, etc.), the copying paradigm fails to account for the causal pathways by which some content is transmitted from model to learner—i.e., it overlooks the details of the interactions *during* the learning episodes.

Compare, for instance, two scenarios where a learner learns how chop, buck, and limb a tree by emulation. While such techniques can be emulated by a learner reverse-engineering a logged tree left behind by a model, it can also be learned by observing a model logging the tree. In the first case, reverse-engineering the technique on the basis of the logs left behind by an absent model, the learner will have to reconstruct the means used to produce the specific logs while relying on mental simulation and trial-and-error hypothesis testing, supported by interactive inspection and manipulation of the chopped logs. In this scenario, technical reasoning and folk physics may play a central role in learning how to reproduce the end-goal logs. In contrast, should the model be present, the learner could observe them inspecting, chopping, bucking, and limbing the tree. Examining where the lumberjack positions themselves relative to the tree and following the gaze of the model and adopting their visuospatial perspective as they limb down the trunk, the learner could reconstruct the skill in her own way, identifying through the model's behavior which parts of the tree are targets in the chopping and bucking processes, and which are not, even if the learner does not directly imitate this behavior when she comes to practice herself. While both cases are examples of emulating the very same informational content—i.e., the goal (the resulting logs), not the specific technique (sequence of actions) is copied—, they involve different interactions and different cognitive mechanisms. Indeed, the two learners faced fundamentally different problems in term of learning: the first faced a problem of reconstruction and bootstrapping of motor solutions from the observed end-state, while the

second faced a problem of translating observed actions into a relevant goal plan, predicting from the contingent actions a more flexible, hierarchically structured goal plan.

What this example illustrates is that a strict focus on the outcomes of learning episodes, taken as discrete copying events, is insufficient for identifying the causal mechanisms involved in cultural learning: the very same output can be reached by different causal pathways. This is because emulation and imitation, as descriptions of transmission events, do not specify which mechanisms are actually involved during a specific transmission episode. Neither do they specify what kind of interactions are involved nor how these contribute to the observed learning outcome. Going back to the above example, stating that learning was in both scenarios emulative informs us only about the output of the learning episodes (both learned to emulate a logging technique). However, it does not tell us about how the different interactions and causal mechanisms, cognitive and behavioral, were effectively employed by the learners to acquire the logging skill. The detail of the interactions shaping the learning episodes is where the causal action takes place. Forms of copying, such as emulation and imitation, effectively gloss over the often-complex interactions involved in the transmission episodes of which they characterize the outcome.

With its strictly informational ontology, both in defining what learning mechanisms are (copying ones) and what learning episodes consists of (events of knowledge transition), the copying paradigm fails to produce an explanatory framework for the causal study of mechanisms of cultural learning. To get to a causal, mechanistic explanation of cultural learning, learning episodes must be dissected as interactive processes rather than taken as atomic events. An explanatory program for cultural learning must thus investigate what happens *during* and *within* a learning episode rather than focus exclusively on what has been transmitted faithfully, and

what has not. In other words, rather than approaching learning episodes as (copying) events, we should approach them as complex interactional processes, i.e., as interactions extended and structured in time and space (see below). There is a growing literature that understands cultural learning as a complex, interactional processes, research that is not captured by the copying paradigm (see e.g., Gweon, 2021; Moll, 2020). However, because there is a lack of an alternative to the copying paradigm, the distinctiveness of such research is often lost. In the next section, we suggest that understanding cultural learning as a form of interpersonal coordination, rather than as a form of copying, better captures the contributions such work and can better serve as a guiding framework for a more productive and explanatorily stronger research program.

5. A coordination framework for cultural learning

As an alternative to the copying paradigm, we propose an interactionist framework that models cultural learning as a form of coordination. Coordination is a term with several meanings. These include intrapersonal coordination (where one is coordinating one's own limbs with each other, such as clapping one's hands), coordination with the environment (involving interaction with dynamic/moving objects, such as the hand-eye coordination required in catching a ball), and interpersonal coordination (modifying or adapting to the presence and/or behavior of another person). We use the term to refer to the latter: interpersonal coordination. We propose to define cultural learning as *the process(es) by which learners modulate their behavior contingently on the behavior or behavioral products of a model, which result in the learner acquiring some knowledge that they previous lacked*. We construe cultural learning as a form of coordination in that the interactions between the model and the learner during a given learning episode, together with the computational work of sub-personal cognitive processes involved in such interactions,

are causally responsible for the learner acquiring (or failing to acquire) some relevant knowledge. Note that we are not saying that cultural learning is a coordination mechanism *per se*, but rather that instances of cultural learning are instances of interpersonal coordination from which learning results (for which coordination mechanisms may but need not be involved).

By reframing cultural learning from a coordination perspective, causal explanations of how cultural knowledge is transmitted emphasize two levels of explanation: (1) the micro-interactions and (mutual) adjustments between a model and a learner occurring during a learning episode, and (2) the underlying cognitive mechanisms supporting these micro-interactions.

At the micro-interaction level, a learning episode can be explained in terms of the actions and reactions of the learner and model involved during the learning episode, together with the spatiotemporal structure of these interactions and the (apparent) intentions of the individuals involved. Returning to the example of the novice lumberjack, an explanation might focus on how the learner allocates her attention while observing the model in response to their behaviors, or her information-seeking behaviors as she inspects the scene, manipulates the logs, and asks questions. These interactions are also temporally structured—the learner may silently observe earlier in the learning process but start asking questions only once she already has a foundational understanding of the task. The model's behaviors during the learning episode are also key to explaining the transmission of knowledge. For instance, the model may behave differently whether they are willing to participate in the learning episode or whether they merely tolerate observation by the learner. Their interactions with the learner will also vary depending on whether they actively communicate during the learning episode, whether they modulate their own behaviors to demonstrate, etc. How the model structures their interactions also serve as explanation at this level. For instance, whether the model favors a turn-taking approach to the

learning interaction or a dynamical, online strategy, etc. All in all, these interaction parameters matter when transmitting knowledge from one person to another, and differences in these interactions can change what gets transmitted.

These interactions and their spatiotemporal structure can be further deconstructed by describing the causal role of the specific cognitive mechanisms that learners exploit in bringing about cultural learning, and those that involve both the model and the learner. Coordination is associated with a suite of cognitive and behavioral mechanisms that permit a wide range of complex, dynamic social interactions (Vesper et al., 2017). For instance, seeing where a model is looking as they perform a task can be used to construct the learner's action sequence representation and beliefs about upcoming actions. In such interactions, mechanisms of gaze-following, visuospatial perspective taking, action prediction, action monitoring and task co-representation can take a leading role in the learning (Charbonneau et al., 2022). Instead, learning by reverse-engineering some end-product (e.g., left-over logs) in the absence of a model would rely on mental simulation and trial-and-error hypothesis testing. In the latter scenario, technical reasoning would play a more important role than social cognition (Osiurak & Reynaud, 2020).

A coordination framework opposes the copying paradigm by focusing on *how* knowledge is transmitted from model to learner rather than merely on *what* content is transmitted. It does so by (1) describing learning episodes as dynamic, extended interactions where (2) the specific micro-interactions shaping the learning episode may be supported by different cognitive mechanisms, and where (3) these micro-interactions and cognitive mechanisms will vary depending on the local circumstances and relative involvement of the learner and model. In other

words, the coordination framework adopts a finer grain of analysis when seeking explanation for the transmission of some knowledge (Charbonneau & Bourrat, 2021).

While the coordination framework prioritizes interaction over content when explaining cultural learning, this does not mean that all learning involves close coordination, just as the copying paradigm does not argue that all learning involves perfect (no-error) copying. Indeed, just as content can be copied faithfully or imperfectly, a lack of coordination can be as relevant to understanding learning outcomes as a highly social, engaged interaction. However, whereas evaluating learning based on content is only possible once learning has occurred—making judgements of fidelity and copying post-hoc—features of the interaction structure are wholly separate from learning outcomes. Such a separation is preferable for experimentalists as it means that the interaction structure can be a manipulated rather than a measured variable.

From a coordination point of view, learning episodes are complex, structured interactions the specifics of which best explain what knowledge is transmitted, how it is transmitted, and how well. By identifying explanatory interactions and mechanisms that differ from those patterns in need of explanation, the coordination framework allows us to move beyond descriptions of patterns in the variation (or lack of) of content transmission, thereby avoiding the *virtus dormitiva* issue. This is made possible by taking a closer look at what occurs *during* (rather than merely as a result of) a learning episode, how local circumstances play a causal role in learning, and how learners and models flexibly adapt to different contingencies to successfully transmit cultural knowledge. Moreover, adopting a coordination framework asks important questions that the copying paradigm cannot address, such as: “Why do we exploit some kinds of interactions and cognitive mechanisms in some circumstances rather than others?” and “What cognitive

capacities allows us to flexibly choose how we are to learn in any given scenario?”

(Charbonneau et al., 2022).

A further advantage of the coordination framework is in how it can accommodate a wide variety of cultural learning scenarios where learners flexibly acquire skills from models in richer interactional contexts (Charbonneau et al., unpublished). Indeed, forms of cultural learning such as active teaching with complex feedback loops (Okazaki et al., 2019) or learning through collaborative peer-play (e.g., Boyette, 2016) lend themselves more naturally to the coordination framework we propose than to an unidirectional, observational framework like copying, as learning models (teachers, more experienced peers, etc.) dynamically adapt their behavior to the actions of the learner in ways that maintain the ongoing interaction and scaffold the acquisition of complex skills (e.g., Flynn, this volume). For their part, learners are frequently active participants in such interactions (and may engage in active information seeking, such as by asking questions or testing out their own novel solutions while trusting their experienced partner to provide reliable feedback (Moll, 2020; this volume)). There is a growing literature implicitly moving away from the copying paradigm, a literature better captured by the coordination model we propose here.

Importantly, adopting a coordination framework does not deny that cultural learning can take the form of copying events. Observational learning—by which a learner observes a model produce some behavior and learns from this public representation how to reproduce a similar behavior with no other contribution from the model than their performance—fits well within the coordination framework. From our perspective, copying by observation with no other interactions serves as a limiting case of cultural learning, one with minimal interactions between model and learner. However, the coordination framework differs from the copying paradigm as it

does not take such instances as paradigmatic examples of cultural learning. Instead, it leaves open to empirical investigation just what sorts of coordinative interactions take place in any singular learning episode, and which cognitive mechanisms are recruited on the spot. This opens the door not only to develop more sophisticated experimental setups that can manipulate the micro-interactions involved in learning episodes, but also offers a more naturalistic, ecologically valid understanding of cultural learning in the wild, focusing on how we adapt to different interactional and environmental circumstances to learn from one another.

6. Conclusion

The copying paradigm has served as the leading framework in the experimental study of cultural learning. It is also used as the key bridge for the study of cultural transmission between the sub-population (interpersonal) and population-level research of cultural evolution. We have identified two key epistemological issues faced by the copying paradigm when addressing the project of understanding what cultural learning consists of at the sub-population level.

First, by explaining only what content (and its variation) is transmitted by cultural learning, the copying paradigm confuses detailed descriptions of informational pattern resulting from learning episodes with the causal explanation of these patterns. Emulation and imitation are not explanatory mechanisms (*explanans*), but merely re-descriptions of the informational patterns that need explanation (*explanandum*).

Second, by construing learning episodes as copying events explainable in terms of input-output mappings (as in emulation or imitation), the copying paradigm adopts an atomic view of learning episodes where finer-grained descriptions of the interactions involved are idealized away. Again, it is interested only in the learning outcomes, not how those are achieved. Such an

explanatory focus imposes severe and unnecessary limitations on providing plausible psychological explanations of the cognitive and behavioral mechanisms supporting cultural learning.

We sketch the foundations of an alternative account of cultural learning, whereby the explanatory focus is set on the micro-interactions between model and learner, and the cognitive mechanisms underlying those interactions. Our account offers a richer, non-tautological framework for explaining how we learn from one another and how the context of learning affects what and how we learn. Not only does the coordination framework solve the internal, explanatory issues of the copying paradigm, it better characterizes extant research that outreach the copying paradigm, thereby offering an epistemological framework for conducting more productive experimental research.

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