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Tradition and invention: The bifocal stance theory of cultural evolution

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Abstract

Cultural evolution depends on both innovation (the creation of new cultural variants by accident or design) and high-fidelity transmission (which preserves our accumulated knowledge and allows the storage of normative conventions). What is required is an overarching theory encompassing both dimensions, specifying the psychological motivations and mechanisms involved. The bifocal stance theory (BST) of cultural evolution proposes that the co-existence of innovative change and stable tradition results from our ability to adopt different motivational stances flexibly during social learning and transmission. We argue that the ways in which instrumental and ritual stances are adopted in cultural transmission influence the nature and degree of copying fidelity and thus also patterns of cultural spread and stability at a population level over time. BST creates a unifying framework for interpreting the findings of otherwise seemingly disparate areas of enquiry, including social learning, cumulative culture, overimitation, and ritual performance. We discuss the implications of BST for competing by-product accounts which assume that faithful copying is merely a side-effect of instrumental learning and action parsing. We also set out a novel "cultural action framework" bringing to light aspects of social learning that have been relatively neglected by behavioural ecologists and evolutionary psychologists and establishing a roadmap for future research on this topic. The BST framework sheds new light on the cognitive underpinnings of cumulative cultural change, selection, and spread within an encompassing evolutionary framework.

1. Introduction

Scholars have long marvelled at the human capacity for creative invention, enabling our species to conquer new habitats and solve increasingly challenging problems through cumulative cultural evolution (Cavalli-Sforza & Feldman, 1981; Mesoudi & Thornton, 2018; Richerson & Boyd, 2005; Tennie, Call, & Tomasello, 2009). The effectiveness of tools and technologies often depends on the ability to respond flexibly to changing conditions, to *innovate* during the process of transmitting information, thus resulting in sequential improvements of tools, acts, and artefacts – a phenomenon that has been researched extensively (e.g., Caldwell, Renner, & Atkinson, 2018). This emphasis on technological innovation, however, has tended to pay less attention to the evolutionary consequentiality of *non-instrumental* learning in the transmission of culture. For most of human history, cultural evolution has not only been innovative, but also characterized by slavish reproduction of rituals, traditions, and conventions, resulting in the remarkable longevity of some of these cultural traits in the form of *cultural traditions* (Box 1). High-fidelity preservation of non-instrumental culture is just as much of a hallmark feature of our species as is technological invention through sequential change (Whitehouse, 2021). But what are the mechanisms that cause some traits to change within a few generations while others retain their form and stability for millennia? What are the respective functions of tradition and innovation in the evolution of culture and what are the mechanisms through which these are expressed?

Past research has shown the adaptiveness of certain biases in social learning, most notably regarding social cues such as skill, age, and similarity to the learner (Mesoudi, 2011). For instance, the tendency to preferentially copy actions from individuals who display markers of success typically leads to improved propagation of optimally efficient technologies like arrowheads that maximize caloric returns during hunting (Atkisson, O'Brien, & Mesoudi, 2012). Such research is typically concerned with questions about *whom* and *what* are copied during the process of acquiring knowledge socially but seldom addresses factors that impact the fidelity of intergenerational transmission, or the extent to which the content changes as a result of being propagated. Here, we build on previous research distinguishing ritual and instrumental stances in cultural evolution, which we refer to as "bifocal stance theory"

(BST). During learning, ritual and instrumental stances are like bifocal spectacles, where "the upper half of the lens is used naturally when gazing at more distant objects (one might think of this as analogous to an instrumental perspective focusing on the bigger picture, oriented to end goals), whereas the lower part of the lens is better for examining things in close up (analogous to the ritual perspective focusing on detailed action parsing, oriented to the gestural level)" (Whitehouse, 2021, p. 35). Such a bifocal arrangement allows us to shift the focus back and forth when attending to different aspects of the learning environment.

Previous research on the BST framework has produced evidence that distinctive social cues, as well as certain features of action representation (e.g., the salience of end goals) trigger different motivational states in the minds of cultural learners, in turn influencing copying fidelity and rates of innovation (for early formulations of the BST framework drawing on anthropological and developmental research, see Whitehouse, 2011, 2012b; for subsequent theoretical overviews, see Legare, 2019; Legare & Nielsen, 2015, 2020; Watson-Jones, Whitehouse & Legare, 2016; Whitehouse, 2021, Ch. 1). BST prompts many questions with far reaching implications for cultural evolution theory that remain unaddressed, however. Here, we seek to systematically discuss the cognitive underpinnings of social learning and the distinctive motivations that drive different modes of cultural transmission. We also consider underlying cognitive architecture, such as the level of deliberateness and domain-specificity with which individuals preferentially copy. This allows us to explore viable alternatives to popular assumptions in the current literature on convention learning – including, for instance, the possibility that our psychological capacity for high-fidelity ritual transmission is a culturally inherited "gadget" (Heyes, 2018a, 2019) – contrasting with past research that entertains innate learner motivations (e.g., Whitehouse, 2021) or even a Chomskean "universal ritual grammar" (Legare & Nielsen, 2020). Moreover, our approach sheds light on magical practices, which combine conventional actions with high goal salience. We also place BST into a wider research context by outlining its use and, clarifying its relevance to competing by-product accounts of overimitation and action parsing. We present a novel cultural action framework, which allows us to generate a series of testable predictions for consideration in future research, potentially bridging various sub-

Box 1. Key terms and their definitions

Convention, tradition: Actions that regulate and maintain social life in groups through various affiliative functions, e.g., by serving as group identity markers or coordination devices. Such actions are typically reproduced over long periods of time through faithful intergenerational transmission.
Innovation: Actions that deviate from modelled forms either through transmission error or purposeful modification aimed at achieving goals in better ways.
Quasi-instrumental rituals: Actions that signal conventionality but also promise the attainment of a particular end state.
Social learning: Information acquisition through interaction with- and observation of other individuals and their products (Heyes, 2012).
Social learning bias: A learning strategy that prioritizes some types of information over others (content biases) or which leads to preferential learning from models based on their attributes, such as displayed competence (model biases; Atkisson et al., 2012; Mesoudi, 2008).
Overimitation: Imitation of causally irrelevant steps in an action sequence (Lyons, Young, & Keil, 2007; Over & Carpenter, 2009).
Causal opacity: An action sequence is causally opaque when causal relations among its components are not apparent to an observer (e.g., when a step is seemingly physically inconsequential to the one that follows) (Kapitány & Nielsen, 2019; Legare, Wen, Herrmann, & Whitehouse, 2015; Whitehouse, 2011).
Goal demotion: Absence of a salient goal in an observed action sequence (Nielsen, Tomaselli, & Kapitány, 2018).
Ritual stance: A detail-focused mode of processing observed behaviour activated by cues indicating that the action is irresolvably causally opaque and/or goal-demoted. The ritual stance promotes social learning that has an affiliative function (Whitehouse, 2012b). It has also been described as the "normative stance" (Whitehouse, 2011, 2012b).
Instrumental stance: A goal-oriented mode of processing observed behaviour activated by cues indicating that each step contributes in a knowable way to the outcome (see Opacity resolvability). The instrumental stance promotes social learning of technical skills (Whitehouse, 2011).
Bifocal stance theory (BST): The framework in which cultural transmission is guided by both ritual and instrumental stances.
Opacity resolvability/causal knowability: The distinction between actions that are causally opaque and those that only appear to be causally opaque because of a lack of physical knowledge (resolvable opacity) (Whitehouse, 2011, 2012b). Thus the causal structure of an action sequence can be viewed as either knowable or not.
Domain-specificity: A cognitive mechanism is domain-specific when it is specialized for the performance of distinctive tasks (Cosmides & Tooby, 1994).
Domain-generality: A cognitive mechanism is domain-general when it uses the same computations to perform a range of different tasks.
Cognitive gadget: A distinctively human cognitive mechanism specialized predominantly by cultural rather than genetic evolution (Heyes, 2018a, 2018b).
Molecular view: A fine-grained, detail-focused way of observing behaviour, sensitive to its constituent parts (e.g., the discrete steps that make up the action sequence).
Molar view: A coarse-grained, goal-orientated way of observing behaviour, sensitive to the action sequence as a whole and its endpoint.

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fields of cultural evolution research which, in the past, have tended to overemphasize either technological learning or normative conformism rather than both together. The extent to which BST is able to stimulate collaborative efforts between the disciplines lies in its ability to bring a more cognitively focused treatment of social learning into the ambit of anthropological and evolutionary theorizing. Conversely, it is also bringing ideas grounded in anthropology and evolutionary sciences to bear on various fields of cognitive science, such as developmental psychology which has long been posing pertinent questions about the different functions of social learning and imitation (Keupp, Behne, & Rakoczy, 2013; Schmidt, Butler, Heinz, & Tomasello, 2016; Uzgiris, 1981). We argue that transdisciplinary integration is essential to appreciate the flexibility with which humans alternate between varying degrees of high-fidelity copying and innovation, in order to solve both physical and social challenges – the main hurdles in the evolution of sociocultural complexity.

2. Bifocal stance theory

BST proposes a distinction between ritual and instrumental stances on observed behaviour which tap into distinct motivational systems, sensitive to different social cues, giving rise to different patterns of cultural transmission (Whitehouse, 2011, 2021). Adopting an instrumental stance, we expect observed behaviour to be directed towards the accomplishment of specifiable end goals via potentially knowable causal pathways. In a ritual stance, we do not necessarily expect observed behaviour to be directed towards the accomplishment of specifiable end goals and, even if we do, we assume (implicitly or explicitly) that at least some of the actions required to perform the behaviour correctly do not contribute to those end goals in ways that are potentially knowable. In other words, the instrumentality or conventionality of an action often lies in the eye of the beholder and the more the salience of causal pathways to an end goal is degraded, the more the observer's behaviour becomes oriented to social and affiliative outcomes, rather than to physical and technical ones. Participation in collective rituals signals membership of a cultural group and willingness to participate is at least partly motivated by the rewards of belonging.

Examples of behaviour that strongly activate the ritual stance range from relatively elaborate ceremonies such as weddings, funerals, baptisms, initiations, puberty rites, coronations, carnivals, and liturgies through to simpler behavioural conventions such as greetings, dining etiquette, codes of conduct, proper attire, and ceremonial precedence. All these forms of conventional behaviour comprise innumerable action clusters that lack specifiable end goals or, even if they have goals, stipulate the observance of behavioural scripts that lack a fully knowable causal structure. The *puja* rituals performed by Jains in India, which involve various worshipful actions directed towards idols, illustrate this quite well (Humphrey & Laidlaw, 1994; Whitehouse, 2004, pp. 95–97). Different variants of the *puja* range from bathing an idol (*prakshal puja*) to placing a flower on it (*pushpa puja*). When asking different practitioners about why they engage in this practice, Humphrey and Laidlaw documented a multitude of different meanings, ranging from symbolic and expressive motivations (e.g., to enable one's spiritual knowledge to blossom or become purified like a flower), to more decidedly instrumental interpretations (such as that the scent of the flower makes the process of worship more pleasant). Interestingly however, some informants maintained that the placing of flowers did not mean anything at all and needed to be carried out simply because that is what Jain worshippers do (Humphrey & Laidlaw, 1994, p. 35).

Anthropologists have long debated what makes ritual behaviour distinct from any other and have focused on variants of the idea that rituals are governed by "rules without meaning" (Staal, 1989) or that intentional meaning is not intrinsic to the actions performed (Humphrey & Laidlaw, 1994). They note that certain procedures must be carried out in stipulated ways (e.g., the bride and groom must dress a certain way, the person to be knighted must kneel in order to be tapped on the shoulder by a sword, etc.) and the reasons for those actions cannot be derived from the intentional states of the actor and seem instead to come from some other sources (tradition, the ancestors, a divinity, etc.). BST proposes that a rationale for following the ritual script is inessential for successful and high-fidelity ritual transmission and may be entirely lacking in some cultural traditions. For instance, when a Catholic first learns to cross herself upon entering a church, this likely constitutes the type of automated and unquestioned behaviour that precedes fully established and explicit knowledge of the wider religious belief system the act is embedded in (Whitehouse, 2002). In other words, even though the congregant may or may not acquire a goal-oriented rationale later on, the initial instances of behaviour acquisition are imitative and driven by the motivation of simply wanting to fit in with the other church goers. Thus, ritual participants may carry out the required procedures without at first being able to say why. They may not know what the actions "mean" and may not see them as linked to any kind of specifiable origin or future end goal.

Even where end goals of ritual and tradition are made salient early on during learning, they do not explain "recurrent fidelity" (Heyes, 2018a, 2018b), the longevity of these practices from an evolutionary point of view. In a hypothetical world where only the instrumental stance exists (where cultural transmission is goal-oriented at all times), selection should favour accurate copying to prevent technologies from regressing to more primitive states but also goal emulation, which eliminates the steps of a sequence that are inconsequential in reaching a goal. Over time, this should have led to the gradual disappearance of practices that have a weak action–outcome link (practices that do not surpass chance levels in achieving a desired end state). BST proposes that the ongoing and stable presence of practices that are ineffective in producing environmental outcomes, result from a non-instrumental, affiliative motivation, helping to regulate social life in groups (such as hierarchy maintenance or improved coordination). Viewed in this light, participating in a collective ritual is very different psychologically from the experience of working together on an instrumental task, such as fixing a vehicle or building a fence.

It is important to emphasize, however, that BST does not attempt to categorize socially learned behaviour into either ritual or instrumental actions. We argue, on the contrary, that most social learning involves a complex mixture of both ritual and instrumental stances, activated flexibly, often in rapid succession. Action sequences may exhibit properties that make them more likely to activate either a ritual or instrumental stance, for example, if the start and end points of a sequence turn out to be the same, learners are more inclined to interpret the action as *causally opaque* (Box 1) and thus conventional (Watson-Jones et al., 2016). But whether such start–end-state equivalence activates a ritual stance also likely depends on the presence of other contextual cues.

Box 1 summarizes the key concepts required to grasp this framework. When observing behaviour through the lens of the ritual stance, the focus of attention is not on acquiring a causal

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rationale for the procedures. Social etiquette, clothing fashions, tea ceremonies, and even the rules of childhood games *may* be ascribed a purpose (whether in the process of teaching and learning or in reflecting later on why our habits take the form that they do) but often their purposes remain mysterious, and the actions are simply copied without question. Whether or not rituals are attributed purpose, it would make little sense to try to formulate in rational causal terms how that purpose is realized (Whitehouse, 2011, 2012b, 2021). Interpreting an action sequence through the lens of the instrumental stance on the other hand (either via cues provided by the model or properties of the action itself) prompts an expectation of learning something technically useful, thus directing attention to the causal structure of behaviour and its endpoint.

As we will discuss in section 2.3, some cultural practices are likely to activate both ritual and instrumental stances. These are goal-directed rituals, ranging from magical spells to sporting contests. They incorporate cues that signal instrumentality (a salient goal) as well as cues that signal conventionality (e.g., irresolvable opacity), which make the adoption of either stance more likely than in other cases that can be viewed as more decidedly conventional or technological.

2.1 Stance selection

Any observed behaviour that is not obviously contributing in a causally transparent way to a readily identifiable end goal may be interpreted through the lens of either the ritual or the instrumental stance, guided by salient social cues, such as comportment, gait, gesture, ostensive cueing, social synchrony, coordination, confidence, experience, seniority, or verbal cues suggesting normativity or expectations of conformism. To illustrate how difficult it can be to select a ritual or instrumental stance on observed behaviour, it is instructive to consider the example of "Sylvia's recipe" (Gergely & Csibra, 2006; see also Whitehouse, 2011, 2021). Sylvia had a distinctive way of roasting ham. She cut off both ends of the joint before placing it in the oven. She had learned this technique at her mother's knee, never questioning it. Many years later she prepared this dish while her elderly mother was visiting. Observing Sylvia's technique in astonishment, the mother asked her what she was doing. It turned out that when Sylvia was a child the family roasting tin was too small to accommodate an average joint of ham and that is why her mother cut off the ends. The young Sylvia observing her mother's cooking methods never enquired as to the underlying rationale. She may have assumed that the removal of the ends of the joint had some instrumental explanation (e.g., to allow the juices of the meat to flow out) even if that purpose was not immediately obvious. One could equally imagine a cultural milieu in which Sylvia's recipe was accorded a supernatural function, for example to release the spirit of the animal that has given its flesh (quasi-instrumental – see sect. 2.4). But it is equally possible that Sylvia adopted a purely normative, non-instrumental understanding of the procedure, prioritizing its *social* meanings and functions. Accordingly, cutting off the ends could be a clue to the cook's ethnic origins, via traditions passed down by many generations of mothers before her. Moreover, whenever a normative perspective is activated there is also a further, if rather baffling, possibility: That nobody knows why meat should be prepared in this peculiar fashion, it simply *should*. Such a response to stipulated ritual procedures is particularly common when the procedures themselves have become familiar habits. In many such cases, scripts that are so familiar that they become sedimented in implicit procedural memory no longer require conscious effort to perform and are thus less likely to prompt conscious reflection on why we do them at all (Whitehouse, 2004). When we interpret behaviour in these ways – as a normative convention rather than as an instrumental technique – we adopt a ritual stance (McKay & Whitehouse, 2015; Whitehouse, 2012b).

The story of Sylvia's recipe is instructive because it shows clearly that many observed behaviours could activate either the ritual stance or an instrumental stance – social learning could potentially go either way. It might well be the case, that knowing *instrumentally* how best to release liquids from meat during the roasting process with the intention of maximizing the tenderness of the resulting dish, could confer prestige on the cook. Clearly, any prestige acquired in that way is a consequence of demonstrated competence at cooking rather than cooperative or affiliative commitment. Nevertheless, cutting off the ends of the meat could just as credibly be understood as a ritual action – that is, a convention that cannot be justified because it leads to an outcome via some knowable physical–causal chain. This would be the case if, for example, Sylvia's mother is thought to have removed the ends of the meat to make it recognizable as a dish associated with a particular cultural group. In some cases, the "done" or "proper" way of presenting food is also associated with an elite stratum in society (e.g., the serving of chilled oysters on the shell) and, because this is the "high class" or "posh" way of doing it, dutifully observing this aspect of the ritualized presentation of food may indeed confer prestige both on the person who has mastered the method and the discerning consumer of the dish.

BST proposes that when we learn or carry out a particular sequence of actions we "flexibly switch between the two based on relevant social cues" (Herrmann, Legare, Harris, & Whitehouse, 2013). But even though an action sequence may entail the activation of both ritual and instrumental stances at different moments, one or other of the two stances may tend to predominate in a particular action cluster, such that we are more inclined to view it through the lens of the ritual stance (e.g., when kneeling to pray in church, in conformity with the congregation) or the instrumental stance (e.g., when kneeling to fix a bicycle, to facilitate access to a low-lying sprocket). Nevertheless, there are also many action clusters that activate both stances in such rapid succession that it may be hard to decide whether to class them overall as ritual or instrumental. The noted anthropologist Edmund Leach, for example, describes the process of gardening among the Kachin of highland Burma as continually oscillating between practical instrumental elements necessary to ensure plant growth and "aesthetic frills" that are technically unnecessary but conventional aspects of horticulture, identifying the gardener as a *bona fide* member of the Kachin cultural group (Leach, 1954). Much the same may be said of spectator sports such as football (Newson et al., 2020), which have many very ritualistic aspects (from "Mexican waves" to the wearing of special scarves) but also very causally transparent procedures for achieving end goals (such as the placement of a ball at the back of a net). We return briefly to this point in section 2.4.1. when discussing the affiliative aspects of ritual participation and also in connection with quasi-instrumental rituals.

The use of a "stance" metaphor for ritual and instrumental social learning differs from Dennett's (1987) notion of an "intentional stance," which suggests a mindset cognizant of the view that the actions of others are governed by beliefs and desires. As discussed in the next section, we do not assume that ritual and instrumental stances operate only in ways that are deliberative

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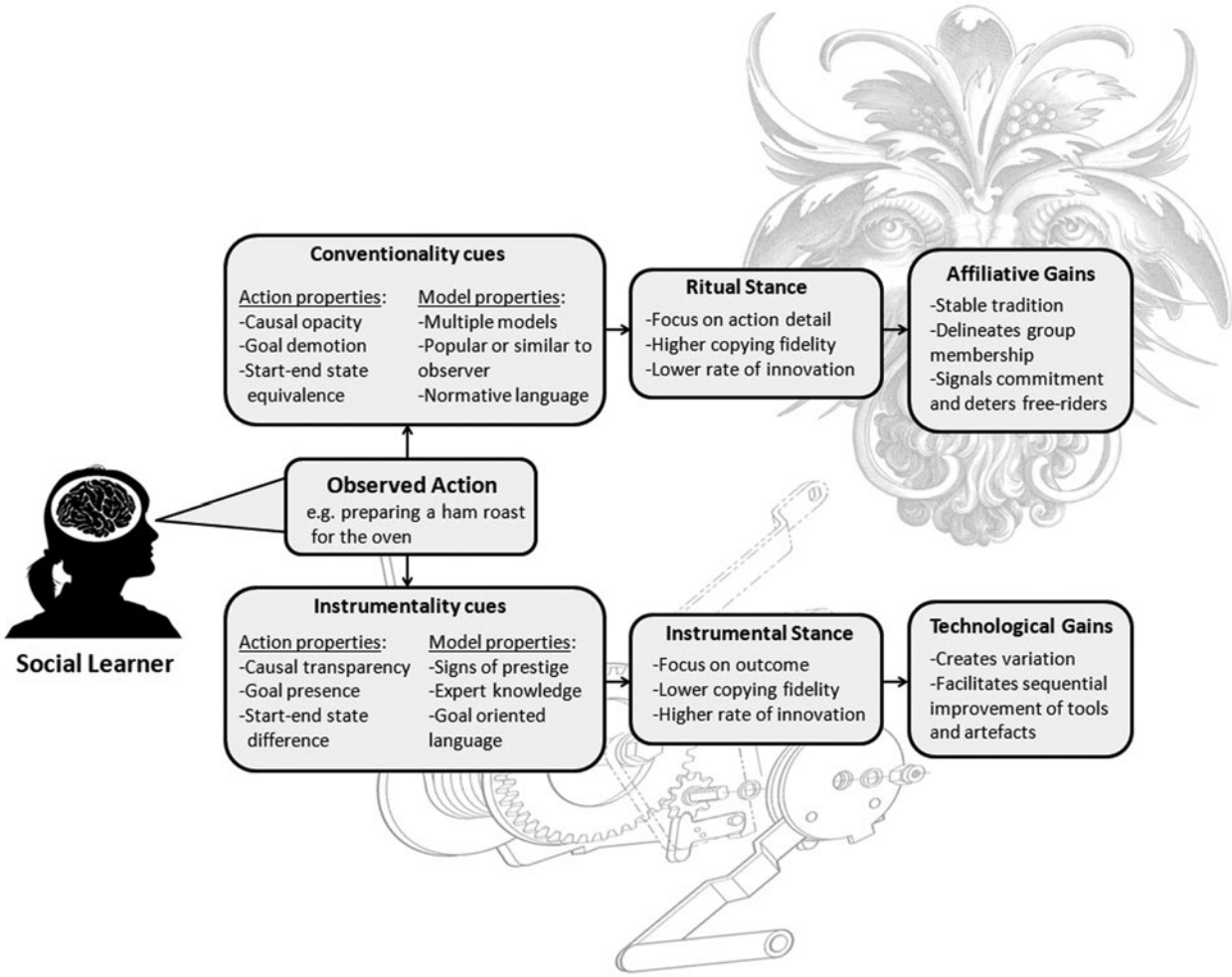

Figure 1. Schematic overview of the bifocal stance theory (BST).

and accessible to conscious awareness. We propose instead that the stances are best understood as states of increased attentiveness towards either the link between conventionality cues (Fig. 1) and positive social outcome or the link between instrumentality cues (Fig. 1) and improved goal achievement. In other words, the learner's sensitivity to properties of actions and the models performing them, and propensity to associate these properties with either conventionality or instrumentality, triggers differential learning approaches. In the case of triggered conventionality, the learner is more attentive to action details (such as the chronological order of the action sequence) resulting in overall higher copying fidelity and greater longevity of the modelled action during transmission, while in a scenario where the action is processed as instrumental, attention shifts more towards the outcome, thus resulting in overall lower copying fidelity and higher rates of innovation.

Importantly, this does not mean that the instrumental stance is incapable of producing stable practices. On the contrary, techniques that have proved reliable in achieving a certain goal often become fixed, preventing regression to more primitive states (Tennie et al., 2009). Conversely, innovation within the ritual domain occurs as well, and deviations from a script may even be encouraged, for example in the case of Congolese spirit play (Lewis, 2002) or status competition among the Tiwi (Hart, Pilling, & Goodale, 1988). Indeed, given that the ritual and instrumental stances are intimately interwoven in many human pursuits, we anticipate that both forms of social learning overlap and influence each other. For example, when learning a particularly complex technical skill, it helps to mix in a little bit of ritual. While too much ritualization impairs learning, perhaps due to cognitive load, a small amount of ritualization may enhance it (Kapitány, Kavanagh, Whitehouse, & Nielsen, 2018). Given examples of ritual innovation, technological stability, and stance admixture, the differences in transmission fidelity between the two stances are predominantly one of degree. All else being equal, practices that inspire copying via the ritual stance tend to be more accurately reproduced *relative* to those copied via the instrumental stance, making the former comparatively more resistant to change.

Overall, BST therefore seeks to explain the co-existence of adherence to convention and technological innovation in humans from an evolutionary perspective, where certain cues of the copied action influence the nature and degree of copying fidelity.

2.2 Stance deliberateness

A fundamental question prompted by the BST framework, largely unaddressed in previous literature (although see Whitehouse, 2002), is the degree of deliberateness with which instrumental and affiliative motivations operate. The stances could be automatic in the sense that they rely on psychological processes to which learners have little conscious access, or deliberative in

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that they rely on conscious cost–benefit calculations. More specifically, the stances could rely on type 1 or type 2 psychological processes (Evans & Stanovich, 2013; Kahneman, 2003; Norman & Shallice, 1986). Type 1 psychological processes do not depend on working memory; they are typically automatic, fast, associative, effortless, and non-conscious. Type 2 processes make demands on working memory; they are typically deliberative, slow, rule-based, more effortful, and conscious.

It is easy to imagine the stances running on deliberative type 2 processes. In this case, a boy watching an adult cross herself in church would make conscious decisions about the purpose and resolvability of the crossing action. Using explicit mentalizing (also known as "mindreading" and "theory of mind"), he asks himself what the adult intends to achieve through her action, and what she wants to communicate to him (Csibra & Gergely, 2009). Using causal reasoning, he asks whether the action generates an instrumental outcome and, if so, mentalizing again, whether anyone understands the action–outcome relationship. He may even engage in normative reasoning, asking whether the crossing action is required, encouraged, or prohibited for him by his social group. Based on these decisions – outputs of type 2 mentalizing, causal reasoning, and normative reasoning processes – the boy adopts a stance, attending to the details (ritual) or overall form (instrumental) of the action, and copies it with greater or lower fidelity with a specific motivation. For example, he may copy the crossing action with high fidelity expecting it to bring him divine grace, acceptance by his community, or the approval of the adult he is copying.

It is harder to imagine the stances running on automatic type 1 processes because these processes are not part of our intuitive psychology. They have been discovered by cognitive science rather than revealed by common sense. In the automatic case, a stance is triggered rather than chosen. Observable features of the action and context, the conventionality and instrumentality cues listed in Figure 1, send the cognitive system into one of the two stances via associative processes. For example, when the boy sees the adult performing an action where the start and end states are equivalent – her hands are joined in prayer when she begins to cross herself and come to rest in the same position – it activates the cluster of psychological processes that constitute the ritual stance, including attention to detail and a diffuse expectation of social rather than nonsocial rewards. He acts expecting to get something good from other people but does not know what it will be or have a theory about why he will get it. Like the associative links that mediate faster responding with the left hand to stimuli on the left of the visual field (spatial compatibility effects; Lu & Proctor, 1995) and faster reading of colour words printed in the colours they name (Stroop effects, MacLeod, 1991) the associative links that mediate automatic activation of stances could be innate or learned. More precisely, they could be genetically or culturally inherited (see sect. 5).

Everyday experience suggests that stance switching is at least sometimes deliberative in older children and adults. Most of us can remember asking ourselves in a new social context how faithfully to copy the locals. As a guest at a formal college dinner, should I wear an academic gown or just dress smartly; should I dip my fingers in the finger bowl, or just moisten my napkin? However, automatic stance switching would have significant advantages because it is faster and less cognitively demanding than deliberation. It would allow adaptive modulation of social learning in infancy and early childhood, before type 2 executive processes have matured, and agile movement between stances throughout the lifetime. Therefore, it is likely that stance switching, like linguistic "code-switching," is sometimes deliberative and sometimes automatic. In the case of code-switching, bilingual friends move back and forth between their languages, within a conversation or even within a sentence. Switching can be deliberate – for example, a speaker may decide consciously to switch to English for scientific terms which she knows are more familiar to the listener in that language – but switches can also be triggered automatically by the emotional tone of the conversation, or a quizzical look from the listener (Pietikäinen, 2014).

Priorities for future research are to discover whether stances can be selected automatically and, if so, when stance switching is automatic and when it is deliberative. To find out, we need to ask people why they have copied with high or low fidelity, and to check whether their answers match the cue conditions that modulated their copying behaviour. A good match would suggest deliberation, and a poor match would suggest that stance selection occurred automatically, and their statements were rationalizations after the fact (see sect. 2.4.3 on the difference between attributed and evolved functions). Similarly, children and adults could be given tasks that demand working memory alongside social learning tasks that call for stance switching. If these concurrent tasks do not interfere with efficient stance switching, it would suggest automaticity. If efficiency declines as working memory demand increases, it would suggest that, in the tested population and circumstances, stance switching is deliberative. Based on studies of mentalizing (Apperly, 2010; Heyes & Frith, 2014), metacognition (Goupil & Kouider, 2019; Heyes, Bang, Shea, Frith, & Fleming, 2020), and other cognitive processes that come in automatic (implicit) and deliberative (explicit) forms, it is likely that stance switching is automatic in infancy and early childhood and then becomes more deliberative, but only in circumstances where there is minimal time pressure and significant risk that automatic processes will produce error.

2.3 Ritual stance, affiliation, and group identity

Why would the copying of irresolvably opaque behaviour be motivated by the desire to affiliate? Rituals serve many social functions, as exemplified by scarification procedures that signal mate quality (Singh & Bronstad, 1997), ceremonies that commemorate and promote acts of heroism (Kertzer, 1988), as well as resource distribution practices that buffer against inequalities due to exogenous factors (Woodburn, 1982). Despite the multitude of different purposes rituals can serve, their common underlying thread is the regulation of group life – it is through affiliation that the individual gains access to the group as well as the benefits that come with it (resources, mates, cooperation, protection, etc.) (Durkheim, 1965; Kertzer, 1989; Khaldūn, 1958). We propose several reasons why ritual participation leads to group bonding. One is that arbitrary conventions serve as exclusive identity markers for members of the ingroup. Although (or indeed *because*) such behaviours may have precisely zero value from a technical–instrumental perspective, participation is an attractive prospect for anyone wishing to affiliate with the ritual community in question. This explains how rituals survive the selective environment of our cultural landscape; they are not replaceable by actions construed in instrumental terms because they fulfil an entirely different function, namely that of maintaining patterns of cooperation, ranging from group loyalty to obligations of reciprocity, conferring a selective advantage on the cultural groups adopting them (although we also discuss the case of magical procedures in section 2.4.2). As such, rituals establish *discrete*

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ingroups, in contrast with useful technologies that spread willy-nilly *across* groups (Whitehouse, 2012a).

Rituals also commonly generate social cohesion and thus cooperation via social synchrony, in the form of dancing in rhythm, choral singing, chanting, swaying, and marching, evincing well-documented effects on social bonding and cooperation (Catmur & Heyes, 2013; Fessler & Holbrook, 2016; Hagen & Bryant, 2003; Hove & Risen, 2009; Mehr, Krasnow, Bryant, & Hagen, 2021; Wiltermuth & Heath, 2009). Rituals typically require significant investment of labour and materials despite lacking any technical value or output and, as such, serve as costly signals of commitment to the group (Irons, 2001; Sosis & Alcorta, 2003). Indeed, the more costly and fitness-decreasing rituals become, the harder it is to square participation with dislike for the group, enabling cognitive dissonance effects to motivate group love (Aronson & Mills, 1959). Moreover, modulating the frequency and emotional intensity of collective rituals also produces distinctive effects on the intensity and scale of group bonding: High-frequency, low-arousal rituals facilitate rapid spread of stable identity markers to large populations (such as doctrinal religions and nations) while low-frequency, high-arousal rituals generate highly cohesive localized groups (such as initiation cults, military brigades, and terrorist cells) (Whitehouse, 1995, 2000, 2004, 2018, 2021).

A growing body of empirical research suggests that the ritual stance is sensitive to social cues indicating that modelled behaviour is conventional, normative, and otherwise relevant to group alignment, and therefore that the motivation to copy such behaviour is affiliative in orientation (Clegg & Legare, 2016b; Herrmann et al., 2013). We therefore expect role models who are strongly associated with the group, for example because they are popular or exemplify group values, to trigger the ritual stance among would-be learners. By contrast, the instrumental stance is sensitive to social cues indicating that the behaviour is technically useful and copying is rewarded by the acquisition of new practical skills. Thus, we would expect role models who signal competence, experience, and skill to trigger the instrumental stance among would-be learners.

2.4 BST and quasi-instrumental rituals

Practices signalling conventionality but also promising to deliver desirable end states are frequently reported in the ethnographic record. For example, competitive sports are oriented to outcomes, such as scoring goals, but in conventional, causally opaque ways (e.g., playing a ball into the opposing team's net but without using one's hands). Quasi-instrumentality is also a feature of conventional solutions to coordination problems (e.g., you must only drive on the left to avoid crashing into other vehicles). But it applies also to magical rituals (e.g., you have to utter a particular spell in order to make it rain). In all such cases, part of the causal pathway from action to intended outcome is underspecified (causally opaque). Most importantly, nobody expects there to be a causally transparent reason why you use feet and not hands in one sport, drive on the left not the right in some countries, or repeat this incantation rather than that to make it rain. It is simply the correct way of doing things in this region or that cultural setting – the recognized convention. To the extent that such behaviours activate the ritual stance, they can certainly serve to communicate information about the group alignments of the person adopting them. They can tell us, for example, what sports people grew up with, what countries they live in, and what cultural traditions they uphold. The process of observing these conventions therefore has an affiliative aspect. Nevertheless, in all these cases the instrumental stance is also likely to be activated because there are very salient end goals in play – such as communicating information, placing a ball in a net, driving safely, or ending a drought. Accordingly, this subsection discusses common examples from everyday life (such as games and the acquisition of language), but also focuses on how cases of magic can be accounted by BST, because so many rituals throughout the world's cultures (past and present) are concerned with bringing about end goals.

2.4.1 Games and language

Boardgames and pretend play provide rich sources of cultural examples of goal-focused activities in which successful participation relies on adherence to previously established group conventions (Rakoczy, Warneken, & Tomasello, 2009b). In chess, even though the explicitly stated goal is to "checkmate" the opponent's king, the pieces can only be moved based on a collectively agreed set of arbitrary rules that do not stand in any resolvable physical–causal relation to that goal (e.g., there is no non-arbitrary reason why a bishop would only be able to move diagonally across the board other than the stipulated rule that this should be so). Most importantly, in much the same way as navigating traffic, learning chess requires high-fidelity transmission of rules which are resistant to innovation – a player cannot suddenly decide that a piece moves differently than what is set out in the rules.

Analogously, pretend-play paradigms not only demonstrate children's propensity to adhere to non-instrumental rules but also their willingness to pick up specialized vocabulary that is exclusive to a discrete context. For example, Rakoczy, Warneken, and Tomasello (2008) taught children to associate a specific action sequence with the term *daxing*, and later observed a puppet perform a different action while applying the same name to it. Across multiple iterations, children protest whenever these action–terminology incongruences occur, suggesting a ritual or normative stance in the context of the game but also in vocabulary acquisition more generally. Indeed, language acquisition entails similar requirements to game participation or the solving of coordination problems: Learners must be willing to associate arbitrary but conventional and prescriptive phonemes with certain features of their environment – there is nothing inherent to a word that signals what it means. Much like the collective agreement that a chess piece can move in a certain way regulates the interaction between the two players, the language we acquire determines whom we can interact with, thus serving as an efficient identity marker and coordination device. Indeed, at least some aspects of children's word learning appear sensitive to the conventional nature of language (Graham, Stock, & Henderson, 2006) and young learners appreciate that newly acquired vocabulary can be understood by other members of their speech community (Diesendruck & Markson, 2001; Sabbagh & Henderson, 2007). Children also appear less inclined to learn a novel word when there is evidence that it is not shared by other speakers (Koenig, Cle, & Harris, 2004). Even where a language is less constraining by being spoken across different groups, local accents and dialects are often indicators of cultural origin. Past research has demonstrated an accent's ability to act as a hard to fake signal that is readily picked up by children, influencing their preferences for word utterances (Butler, Floccia, Goslin, Panneton, & Tech, 2011) and related objects (Mulak, Best, Tyler, Kitamura, & Irwin, 2014), as well as guiding their decisions about which models to trust and learn from (Kinzler, Corriveau, & Harris, 2011; Kinzler, Shutts, Dejesus, & Spelke, 2009). Given these affiliative

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motivations, it is plausible that language learning shares considerable overlap with the acquisition of cultural rituals and traditions.

2.4.2 Magic and resolvability

In order to explain the acquisition of magical rituals through the stances, we turn to the role of action resolvability (Box 1). The *resolvability* of an observed action (Legare & Herrmann, 2013; Legare & Souza, 2012, 2014; Whitehouse, 2011) concerns the extent to which the causal structure of an action is perceived to be knowable (in theory if not de facto) and thus whether a novice will seek to resolve uncertainties by trying to establish how the learned behaviour "works." There are many goal-oriented actions in day-to-day life which are causally opaque to the observer but which are in fact resolvable (Whitehouse, 2011). For instance, unless one possesses basic mechanical knowledge, the causal link between moving the gear stick in a car and the effect it has on speed and acceleration is generally obscure. However, it is assumed by the observer (either implicitly or explicitly) that, in principle, there is information available that explains why gears must be shifted in a certain way in order to go faster. On the other hand, the ritual stance operates on the assumption that a sequence has no knowable physical–causal structure (i.e., its causal opacity is irresolvable), but is used within the social realm as a means to affiliate, bond, and to promote cohesion. Much like with perceived instrumentality and causal opacity, we argue that resolvability lies in the eye of the beholder – in principle a learner can perceive the causal relationship between flicking a switch and a light coming on (which is objectively resolvable, given sufficient understanding of how electrical circuits work) as *unresolvable* when relevant information about electricity is unavailable but contextual cues that favour a ritual stance are present (e.g., as may have occurred during first contact in highland New Guinea; Lawrence, 1989). Conversely, in the case of an action sequence typically regarded as irresolvably opaque, an agent may nevertheless interpret the sequence as resolvable if learning cues render an instrumental stance more likely – for example, if I am told that handshaking is not an arbitrary convention but a way of demonstrating that one is unarmed and thus unthreatening.

Magical rituals are abound in the ethnographic and historical record and may take a great diversity of forms, from the simplest rubbing boards of the African Azande used to detect witchcraft (Evans-Pritchard, 1937) to the highly elaborate seafaring magic of the Melanesian Trobriand islanders (Malinowski, 1935). What most magical rituals have in common, however, is the end goal of warding off misfortune by supernatural means. The types of misfortune such rituals seek to prevent or reverse are immensely variable – from diseases of the body, mind, and failing relationships through to the deleterious effects of plague, pestilence, intergroup conflict, drought, fire, and flood. People everywhere recognize that many of these kinds of misfortune can be prevented by quite straightforward instrumental efforts via natural causation such as medical treatments, disease prevention, fertilizers, insecticides, flood defences, irrigation systems, and so on. Nevertheless, such efforts to ward off misfortune are not always enough and when the risk of failure is great and the means of preventing it limited, people frequently turn to magic and the ritual stance. Hopes are pinned on causal pathways that cannot be fully specified and are thus irresolvably opaque. In other words, such magical thinking often appeals not so much to instrumental processes of cause and effect via mechanistic principles but to the petitioning of supernatural agents and the invocation of reciprocal obligations and other kinds of cooperative principles. There is also a stronger element of affiliative concern and social bonding in quasi-instrumental practices than in more purely instrumental techniques and interventions. Thus, the providers of irresolvably causally opaque medical treatments (homeopaths, shamans, witch doctors, etc.) invariably foster closer and more affiliative relationships with their clientele than providers of purely instrumental cures.

Accordingly, BST proposes that, like Sylvia's recipe, magical practices can recruit the ritual stance or the instrumental stance depending on the relative number of perceived cues that convey conventionality or instrumentality. For example, if a learner observes a magical practice with a clearly defined end goal (instrumentality cue), which is nonetheless accompanied by normative language (conventionality cue), as well as performed by one or multiple highly similar models from one's own group (also a conventionality cue), then BST expects that this makes the activation of a ritual stance which prompts higher fidelity copying more likely. Similarly, an individual who is enlisting the services of a witch doctor, might view the practice through an instrumental stance if, despite the irresolvable opacity, there is a strong focus on the end goal combined with the perception that the witch doctor is an expert (both cues to instrumentality). Rituals performed in the context of baseball may also contain goal-focused cues to such extent that they overshadow the irresolvable nature of the action, thus allowing them to be viewed instrumentally.

Accordingly, the differentiation between emic resolvability (the learner's perspective of whether an action is causally opaque in a resolvable manner) and etic resolvability (whether the actions sequence is actually resolvable) comes with an important implication for researchers: a practice which appears from the outsider's perspective to be magical (irresolvably opaque) may not be interpreted as such by the population that engages in it (e.g., because the instrumental stance is triggered during its transmission because of a variety of cues that make end goals and assumed expertise of the model more salient). Consequently, it is important that researchers not only view ritual practices from an etic perspective, considering their evolved functions, but also from an emic perspective, taking into account the psychological processes of the learner. Moreover, in the next section, we turn towards discussing how the evolved reason a magical practice is transmitted can differ substantially from the explanations given by its practitioners in the context of stance deliberateness.

2.4.3 Cultural selection and evolution

BST proposes that stances are adaptive – having two modes of social learning, for conventional and instrumental behaviour, makes individuals and societies better able to thrive in their physical and social environments. Stance psychology could have evolved via biological or cultural selection. If stance psychology is a "cognitive instinct" (Pinker, 2010), individuals genetically inherit a very specific propensity to develop the two modes of social learning, and those who inherit a better version have more biological offspring. If, however, stance psychology is a "cognitive gadget" (Heyes, 2018a, 2019), individuals genetically inherit only domain-general psychological resources, for example, attentional, learning, and motivational processes that perform a variety of jobs. Using these domain-general processes, individuals learn stance psychology from older members of their community, and communities with a better version expand or proliferate (see sect. 5). Whether stance psychology is shaped by genetic or cultural selection, deliberative or automatic, there is significant potential for the emic (attributed) functions of rituals to diverge from their etic (evolved) functions.

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Although rituals may be performed for a consciously formulated reason (e.g., dancing *to make it rain*), we argue that implicit motivations (such as obtaining affiliative rewards) do not need to align with such attributed purposes. By associating the high-fidelity copying of actions that bear conventionality cues (such as end–start equivalence) with positive social outcomes (such as being included by the group), automatic copying can guarantee that a practice is propagated with the level of fidelity that is required in order to fulfil its etic/evolved functions, without the need of an emic/attributed function (which may or may not differ from the etic one). For example, singing in private may be consciously attributed to a purely goal-focused (if causally opaque) function (e.g., to encourage flowers to grow), but we argue that the process by which this song was acquired would have been a social and normative one, whereby the learner must have shown willingness to copy arbitrary words and melodies accurately via the ritual stance. Therefore, a consciously formulated function may differ quite substantially from the learner's implicit motivations which are likely selected for by the practice's culturally evolved function. Thus, costly practices such as magic do not persist because of their efficiency in solving instrumental problems (it is unlikely a song will be transmitted across generations by virtue of its emically conceived function of making flowers grow), but we argue that, among other benefits, their longevity within a group can be because of their contributions to the practitioners' collective identities.

Cultural selection is often guided not by individual goals and preferences but by environmental pressures. For example, low-frequency and high-arousal practices (imagistic rituals) may not have been intentionally designed for the purpose of maintaining cohesion in small groups, but may rather result from selective forces of cultural winnowing such as inter-group conflict or high-risk subsistence strategies that favoured those types of rituals over others (Whitehouse, 2018). Accordingly, an automatic account of BST (as discussed in sect. 2.2) works very well in explaining how goal-oriented practices that are irresolvably opaque can still be copied for affiliative reasons, simply because copying similarly opaque practices with high fidelity has yielded social rewards in the learner's past. This is in line with research that demonstrates equal levels of affiliative mimicry across conditions where a goal is consciously known or not (Lakin & Chartrand, 2003). In other words, affiliative copying does not have to rely on deliberate goal focus but may operate independently of it. Despite the possibility that the perspective of the learner diverges from the evolved function of the learned actions, we do not propose that emic explanations are without purpose or should be dismissed. On the contrary, as pointed out across previous sections, the causal opacity of an action sequence as well as its resolvability are embedded in emic interpretations (they are products of the learner's mind) and hence it stands to reason that both explanatory levels need to be considered in order to account for the high-fidelity transmission that is characteristic of traditional practices.

BST has the potential to generate many novel predictions about quasi-instrumental rituals by investigating how the presence and number of different cues modulate their frequency in a population. In some doctrinal religions, "little traditions" based around quasi-instrumental rituals become widespread (Redfield, 1955). There is some evidence that although doctrinal traditions may cultivate strong forms of affiliation with the religious community, commensurate with their focus on the ritual stance, little traditions serve more closely the interests of individuals and kin groups seeking to ward off misfortune (Stanford and Whitehouse, 2021). Quasi-instrumental practices associated with little traditions may also spread readily across the boundaries of the doctrinal traditions in which they originate. BST would predict that magical practices crossing a group boundary are likely to undergo modification (because they are more likely to be copied by outsiders via an instrumental stance) while the transmission of the same magical practice within a group would entail higher fidelity copying (because it is part of the conventional repertoire that is maintained via affiliative motivations). This would account for the tendency for magical practices to contribute to group identity (e.g., the "houses" associated with the mai or pai de santo in Brazilian candomblé traditions) while also allowing them to spread more freely across groups because of their goal salience (Whitehouse, 2011, 2021), which heightens the probability that they are transmitted via the instrumental stance.

3. Psychological foundations of BST

Much psychological research on social learning has been concerned mainly with the transmission of instrumental skills (Kenward, Karlsson, & Persson, 2011; Keupp et al., 2013; Lyons, Damrosch, Lin, Macris, & Keil, 2011; Nielsen, 2006; Nielsen & Blank, 2011; Nielsen & Tomaselli, 2010; Over & Carpenter, 2009), thus potentially missing a wide range of behaviours that are relevant to our understanding of cultural evolution. We therefore turn to an outline of empirical research directly motivated by BST, incorporating both instrumental and ritual transmission and showing that heightened fidelity of opaque action primarily occurs in social reparatory scenarios, for example, when an actor is facing the threat of ostracism (Watson-Jones et al., 2016; Watson-Jones, Legare, Whitehouse, & Clegg, 2014).

3.1 Psychological evidence supporting BST

The two functions of social learning (to acquire instrumentally useful information and to affiliate with others) as well as their links to differential copying strategies have been discussed in developmental science for some time (Over & Carpenter, 2013; Uzgiris, 1981). Here we seek to extend awareness of bifocal functionality by putting these discussions of social learning into a context where documented differences in copying fidelity can be linked to the salience of social and action-based cues (see also Fig. 1) that promote either the wish to affiliate via a norm-focused ritual stance or to achieve an end state via a goal-focused instrumental stance (Herrmann et al., 2013; Legare et al., 2015; Watson-Jones et al., 2014). Although BST is grounded in anthropological theories of social learning (Whitehouse, 2011), it has been the object of a series of empirical investigations aimed at disambiguating the causes and effects of ritual and instrumental stances respectively using carefully controlled experiments (Herrmann et al., 2013; Legare et al., 2015; Watson-Jones et al., 2014, 2016). BST proposes that the differential functions of the two stances (ritual and instrumental; see Box 1) favour a psychological division of labour where differing attentional and motivational states guide social learning in optimized ways. The ritual stance is prompted by irresolvable *causal opacity* and the absence of a salient goal or *goal demotion* (Box 1). In contrast, through the lens of an instrumental stance, actions are viewed as having a rational causal structure, each step contributing to an end goal. Accordingly, to be an efficient social learner, selectivity in the degree of copying fidelity is required. When learning a novel behaviour via action copying, we may rely largely on verbal or contextual cues that decide whether an action is best interpreted

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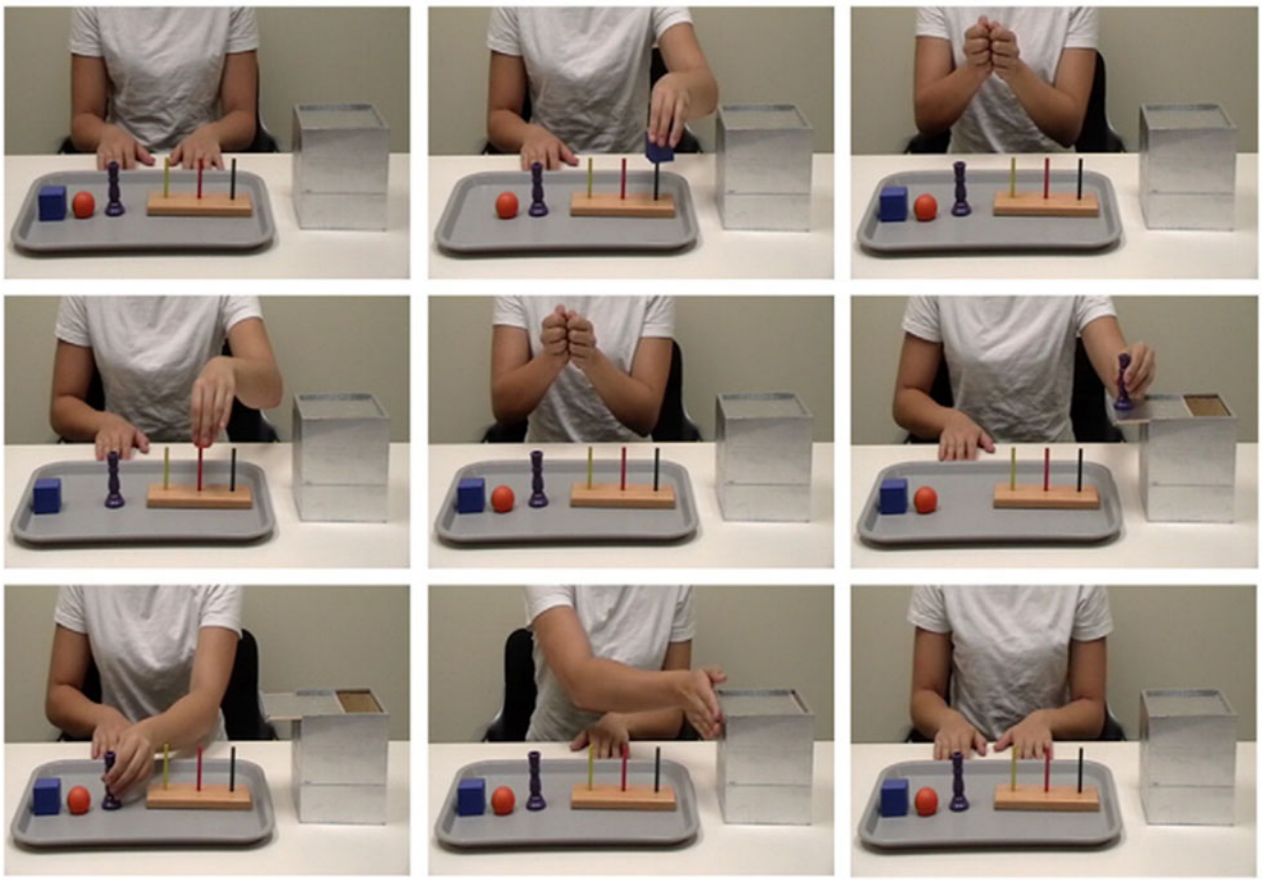

Figure 2. Start- and end-state equivalence, where item positions in the first step (first tile) of the sequence are identical to the end-state configuration (last tile), serves as conventional action condition (from Watson-Jones et al., 2014).

as conventional or instrumental (Clegg & Legare, 2016a, 2016b; Herrmann et al., 2013; Legare et al., 2015). Nonetheless, explicit cues in the form of verbal instructions are not always available (e.g., in the absence of pedagogy), so the action type itself often constitutes a source of either instrumentality or conventionality (Watson-Jones et al., 2014). If verbal or other extraneous contextual cues signal conventionality, then a learner should be sensitive to the action's social value and copy it with higher fidelity. Watson-Jones et al. demonstrate such a link by testing the psychological impact of witnessing third-party ostracism on copying fidelity in a sample of 3–6-year-olds when ritual versus instrumental stances were made differentially salient. Children were shown video primes consisting of moving geometric figures reacting in an exclusionary (ostracism condition) or inclusionary manner (control condition) when approached by a new shape and were then encouraged to copy actions shown by a model. The sequences were either conventional, exhibiting the same start and end states (Fig. 2), or instrumental, ending in a different end state than the one they began with. Copying fidelity was highest for conventional actions in the *ostracism* prime condition. As predicted by BST, the attentional advantage that causally opaque action holds over its transparent counterparts in social settings is also exacerbated by directly experienced ostracism, as shown by follow-up designs (e.g., Watson-Jones et al., 2016) that manipulated group affiliation (ingroup/outgroup) using the *Cyberball* paradigm – a virtual ball tossing game in which participants are either included (base condition) or excluded (ostracism condition). Children who were subject to exclusion from their ingroup showed the highest copying fidelity of a causally opaque action, surpassing the copying accuracy of those who were previously included by their ingroup as well as those who were rejected or welcomed by an outgroup. It appears that the anxieties associated with social exclusion, even in a very mild form, have potentially far-reaching consequences for how modelled action is processed and attended to by social learners.

The studies reviewed above show that either directly or indirectly experienced negative interactions with others can cue changes in young learner's copying behaviour, demonstrating sensitivity to links between causally opaque action and favourable social outcomes. Such results are potentially consistent with the ritual stance being innate, domain-specific, and rule guided (e.g., a biologically inherited module that is only active in social interactions and that follows a "*copy when ostracized*"-rule). Although such an account provides one possible framing (Whitehouse, 2021), we consider here the possibility that the observed data could just as plausibly be produced by domain-general processes such as associative learning, in which excitatory and inhibitory links between certain action types and social outcomes are forged during development (Heyes, 2012). For instance, the increased negative affect from social exclusion (rather than the exclusion itself) could result in additional efforts expended which, paired with the prediction errors that come from witnessed opacity, could result in overall higher fidelity scores for causally opaque action sequences but not causally transparent

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ones. Thus, an increase in non-specific arousal might have differential effects on ritual and instrumental copying, where heightened energetic investment in sequence copying could manifest in overall heightened fidelity, whereas putting more effort into endpoint copying does not result in as much accuracy gain given that the focus lies on the last step, the end goal. This potential alternative to a social reparatory account stresses the importance of efficient control conditions (e.g., general types of arousal as opposed to exclusion alone) in future BST designs to disentangle the potential specificity of stances from outputs that operate on mechanisms of general-purpose learning. If copying fidelity of opaque action is heightened in asocial conditions then domain-generality becomes a plausible interpretation.

Despite these outstanding questions that clearly show the importance of integrating BST into other fields of enquiry, the reviewed experiments are in line with much of the developmental literature and give rise to the reasonable assumption that at least a basic understanding of action–reward links precedes the fully fledged bifocal stance arrangement with which adults navigate society quite efficiently. Indeed, the literature documents a multitude of cases in which learning facilitates the acquisition and storage of social information such as norms, values, and beliefs (Legare, Evans, Rosengren, & Harris, 2012; Whitehouse, 2011). Norms are characterized as mutual agreements on how members of a group ought to conduct themselves in various social contexts and their acquisition marks a key milestone in development (Chudek & Henrich, 2011; Kenward, 2012; Kenward et al., 2011). Three-year olds intervene when witnessing norm violations through the use of normative language (Vaish, Missana, & Tomasello, 2011). Interestingly, children protest especially when an in-group member violates a norm but remain passive when witnessing transgressions committed by an unwitting outsider (Schmidt, Rakoczy, & Tomasello, 2012). Further, pretend play paradigms show how children are committed to arbitrary rules and the *proper* way to handle play scenarios (Nielsen, 2012; Rakoczy et al., 2008; Rakoczy, Brosche, Warneken, & Tomasello, 2009a, 2009b). In Keupp et al. (2013), children protested more when a third party omitted irrelevant actions whenever those were labelled as conventional, pointing towards a normative interpretation of play behaviour. Similarly, Clegg and Legare (2016a, 2016b) demonstrate that linguistic cues that are indicative of convention rather than instrumentality boost copying fidelity of 3- to 6-year-olds in a necklace-making activity, further reinforcing the notion that the interpretation of the context in which knowledge is acquired influences the way it is transmitted. Moreover, recent findings indicate that norm acquisition follows similar developmental trajectories across different societies (House et al., 2020). Overall, the reviewed findings paint a coherent picture of children's tendencies to attribute normativity when prompted, but instances of self-inferred norm attribution, occurring in contexts where it is not explicitly prompted, are also documented (Schmidt et al., 2016). Again, it is tempting to resort to cognitively rich explanations that accord children a fully fledged understanding of norms, group affiliations, and social dynamics. These findings are nonetheless suggestive that an early emerging rudimentary capacity to associate certain types of actions with certain types of outcomes lays the foundations for an appreciation of the affiliative value of cues signalling non-instrumentality. Accordingly, the ritual stance is geared towards obtaining social rewards, while the focus on reaping inanimate benefits within the context of goal achievement marks the instrumental stance (Herrmann et al., 2013; Legare et al., 2015; Watson-Jones et al., 2014).

In addition to studies tailored to test BST and normative protest, basic research on "overimitation" (Box 1) (Call, Carpenter, & Tomasello, 2005; Horner & Whiten, 2005; Nagell, Olguin, & Tomasello, 1993; Whiten, Custance, Gomez, Teixidor, & Bard, 1996) provides further support for our framework. While nonhuman primates sometime copy simple instrumental behaviours, giving rise to localized tool-using cultures in some natural settings (Boesch & Boesch-Achermann, 2000), humans copy not only technically useful behaviours, but also arbitrary social conventions to an extent unmatched by other primates (Horner & Whiten, 2005). Since at least the late Palaeolithic, we have produced and passed down increasingly complex cultural traditions, building cumulatively over generations (Hodder, 2012). This appears to have resulted from a subtle change in human learning strategies whereby instead of copying pragmatically any behaviour that produces desired outcomes, we also began to copy behaviour for which no causal rationale was available. Studies of the phenomenon have been carried out with western samples of both adults and children (Flynn & Smith, 2012; McGuigan, Gladstone, & Cook, 2012; McGuigan, Makinson, & Whiten, 2011; Whiten et al., 2016), as well as in a broad range of other cultural groups, from hunter–gatherers in Africa to swidden horticulturalists in Melanesia (Clegg & Legare, 2016a; Corriveau et al., 2017; Nielsen & Tomaselli, 2010; Nielsen, Mushin, Tomaselli, & Whiten, 2014; Taniguchi & Sanefuji, 2017).

Studies of overimitation often present research participants with tasks involving the extraction of a reward from a puzzle box following a demonstration of both causally transparent and causally opaque behaviours by the model (e.g., Horner & Whiten, 2005). In some cases, causal opacity is achieved by the insertion of behaviours that do not help with the extraction of the reward (e.g., "tapping the side of the jar with a feather and then unscrewing the lid"; Lyons et al., 2007). In other experiments, such behaviour does contribute to the end goal but only inefficiently (e.g., pushing a light switch with one's forehead rather than using one's hands; Buttelmann, Carpenter, Call, & Tomasello, 2007; Nagell et al., 1993). And in yet other designs, a more efficient method is available but overlooked by the model (Corriveau et al., 2017). In all such cases, human participants in the experiments copy the unnecessary or inefficient behaviour rather than prioritizing only the causally relevant aspects. Accordingly, BST proposes a much more pivotal role of non-instrumental imitative strategies, by drawing attention to its ability to act as signals of sharedness and aligned intention between actor and imitator (Over & Carpenter, 2012; Tomasello, Carpenter, Call, Behne, & Moll, 2005). For instance, using a puzzle box overimitation paradigm, Nielsen and Blank (2011) have shown that children tend to not copy the causally irrelevant parts of a solution when the demonstrator is absent during copying. Further, when previously primed by either a mimicry game or an instrumental game, 2-year-olds overimitate or engage in selective copying, respectively (Yu & Kushnir, 2014). Most importantly, the effects of the mimicry prime only persist if the experimenter is the same across both phases (thus excluding simple motor priming as an explanation). Additionally, 2-year-olds were also found to make use of unnecessary tools only in conditions where the model is physically present as opposed to shown on a screen (Nielsen, Simcock, & Jenkins, 2008). When learners copy observed behaviour accurately, they temporally increase similarities between themselves and the model, which in turn increases their likelihood of being perceived favourably by the model as shown by research

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documenting that children preferentially help those that imitated them previously (Carpenter, Uebel, & Tomasello, 2013; Over, Carpenter, Spears, & Gattis, 2013). Increased copying fidelity observed in scenarios of overimitation has the effect of conserving shared conventions in the cultural repertoire. This is in line with BST's core premise that the copying of causally irrelevant elements is because of the motivation to affiliate with the model. There are various potential points of proximate origin from which such motivations can spring. For instance, social learners might retrospectively pick up a link between opaque copying and the presence of social rewards, in a way that the behaviour becomes habitual and thus persists even in the absence of further incentivisation. A learning individual may also extrapolate an observed relationship between causally opaque elements and affiliative gains onto other exemplars of ritual behaviour (in a prospective fashion). Most likely both retrospective and prospective learning modes are involved in the ontogeny of BST, which is discussed in more detail in section 5.

We now turn to accounts of overimitation that potentially compete with BST. These suggest that non-instrumental copying is a mere by-product of our strong reliance on culture to generate technological solutions. Overall, BST provides an alternative view to such by-product explanations which attribute little to no importance to the type of action that is transmitted. Moreover, we argue that BST provides a more encompassing framework within which to understand the broad range of research findings on social learning.

3.2 By-product accounts of non-instrumental copying

One possible explanation for replication of instrumentally superfluous action might be the learner's over-estimation of its causal efficacy (Lyons et al., 2007, 2011). When children copy causally opaque behaviour, it could be because they think the model is trying to help them to acquire useful information and skills, even if it is not immediately obvious how or why (Buchsbaum, Gopnik, Griffiths, & Shafto, 2011; Hoehl, Zettersten, Schleihauf, Grätz, & Pauen, 2014; Vredenburgh, Kushnir, & Casasola, 2015). For example, an influential early study on this topic revealed that infants were willing to copy unnecessarily tortuous methods of activating a light switch (using the forehead instead of the hands) after observing an adult model doing it that way (Gergely, Bekkering, & Király, 2002). The infants in this study were, however, sensitive to clues as to why the adult was behaving so strangely. Thus, if the model was tightly wrapped in a blanket to constrain any arm movements, the infants inferred that this was why she used her forehead in preference to her hands to activate the switch and so they were more likely to use their hands to activate the light rather than to copy the more inefficient method modelled to them. This has led some psychologists to conclude that we only copy causally opaque behaviour on the assumption that it must have a sound rationale, even if that is not apparent to us right away. It has been suggested that such causal misattribution can be an implicit process, for instance when children given training to identify correctly the causally unnecessary elements in a modelled procedure still proceed to copy the irrelevant actions (Lyons et al., 2011). In these studies, children are actively encouraged to recognize that the actions are unnecessary and discouraged from reproducing them and yet they still engage in overimitation. A possible explanation for this is "automatic causal encoding" – that is, the copying occurs outside conscious control (Lyons et al., 2007). In other words, when children copy the unnecessary actions, they are motivated by implicit expectations of causal structure and efficacy without being aware of it. These interpretations assume that non-instrumental copying is merely a by-product of instrumental copying – *hyperactive* causal attribution which automatically over-ascribes instrumental goals to all goal-demoted and causally opaque actions. These accounts assume that the costs of falsely ascribing instrumental efficiency to functionally useless actions are offset by instances where those actions turn out to be teleologically efficacious.

Misattribution accounts are not without their critics (Kenward, 2012; Kenward et al., 2011). In line with BST, Kenward et al. (2011) propose that overimitation, rather than stemming from distorted causal beliefs, acts as facilitator in the development of norm acquisition. They found that when operating a puzzle box, children (aged 4–5) copy unnecessary actions despite verbally declaring their inconsequentiality to reward extraction. Answers that signal either unquestioned copying or deontic reasoning were given upon further prompting, suggesting a normative mindset that uses opacity to achieve social rewards.

Considering these findings, it may be tempting to regard these two interpretations of overimitation – automatic causal encoding versus affiliative motivation – as mutually exclusive alternatives. That is, the copying of causally opaque behaviour is *either* motivated by expectations of hidden causal structure based on the imputation of pedagogic motivations (the "instrumental stance") *or* by expectations of convention learning based on imputation of normative motivations (the "ritual stance"). Instead, BST proposes that humans oscillate between stances during social learning, responding flexibly to the kinds of cues available to them when they observe modelled behaviour. Accordingly, "when the model is thought to have expertise in the performance of a task (signalled by cues like confidence, experience, success, and authority) one may anticipate an opportunity to learn something of practical use about the affordances of objects and so adopt an *instrumental stance* on the behaviour. But when the model is thought to be exemplifying a 'proper' or normative way of behaving (signalled by cues relevant to affiliation, conformism, or deference to tradition) it may be more appropriate to adopt a *ritual stance* on the behaviour and assume that it is simply the correct or 'done' way rather than the most causally efficacious way, of acting" (Whitehouse, 2021, p. 35).

By-product reasoning also features in the action parsing model as applied to ritual (Lienard & Boyer, 2006; Liénard & Lawson, 2008). Action parsing encompasses three levels on which observed actions are processed: the *script* level, which describes the overarching theme of the action sequence (e.g., tidying the kitchen), *behaviour*, which is a direct and end-focused description of the action (e.g., cleaning a glass), and *gesture*, which describes the discrete sub-components of the behaviour (e.g., raising the glass, rubbing it with a cloth, etc.; Kapitány & Nielsen, 2017). Advocates of this approach argue that if instrumental outcomes of an action sequence are prevented by a missing causal link within the sequence (e.g., the glass and cloth are both raised but not brought into contact with each other during performance of a rubbing motion) then the attention of the observer shifts down to the gestural level. Accordingly, when witnessed, causal opacity and goal demotion cause a prediction error that comes from failing to parse the observed sequence on the level of *behaviour*, thus promoting "cognitive capture," which is characterized as increased allocation of attentional resources towards gestural components (Kapitány & Nielsen, 2017; Lienard & Boyer, 2006). This is in line with "predictive coding" accounts, proposing that the discrepancies between top-down predictions and bottom-up sensory stimulation result in

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recruitment of additional neural resources geared towards updating the internal model of the agent and improving the accuracy of future estimates (Baldeweg, 2006; Friston & Kiebel, 2009; Huang & Rao, 2011). Predictions based on expected causality are therefore violated by goal absence, requiring ambiguity resolution. Indeed, the attention-grabbing nature of causal opacity improves recall (Kapitány et al., 2018) and objects linked to opaque treatments are perceived as more special and desirable than occurring in causally transparent sequences (Kapitány & Nielsen, 2015). Causally opaque actions may make particularly unique (and hence efficient) identity markers precisely because they allow much greater combinatorial freedom on the gestural level rather than being confined to the realm of goal-directed *behaviour* anticipated by the observer.

The proposition that "steps become goals," that in causally opaque action sequences the absence of causal structure produces errors within the observer's mental prediction system that shifts attention away from the endpoint towards the sequence constituents, finds some limited support in developmental research. For instance, in one study (Carpenter, Call, & Tomasello, 2005), 12-month-olds observed pretend play scenarios performed by adults (making a toy mouse hop across a mat with sound effects) either with a salient endpoint (the mouse was placed in a toy house) or not (it remained on the mat). Copying of play sequences was found to be more accurate (hopping and sounds were reproduced) in the latter condition, suggesting that the absence of a goal prompted children to focus on the fine-grained level of gestural components. In similar designs, the level of fidelity with which young children copy decreases in conditions where they understand the purpose of the sequence (Williamson & Markman, 2006). Increased attention attributed to causally opaque action can therefore partially account for the heightened copying fidelity with which conventions and rituals are reportedly transmitted. Thus, the structure of an action sequence itself could drive observed differences in copying fidelity. As with explanations of casual misattribution given in the context of overimitation, the action parsing account would propose that transmission of causally irrelevant action is a by-product of error prediction systems that evolved for instrumental purposes. However, as argued by BST, which considers the tremendous social value of ritual participation (Whitehouse & Lanman, 2014; Xygalatas et al., 2013), this is unlikely to be the end of the story. For instance, the action parsing model fails to predict differences in copying fidelity primed by ostracism as foreseen by BST (and as reviewed above). Nothing about the level at which an action is parsed and attended to indicate why it should be more suitable for affiliation than some other type of action. Ultimately, we need BST to explain this type of modulation, where copying fidelity is not exclusively driven by attentional processes on the level of parsing (the cognitively "parasitic" nature of opacity and goal demotion) but also by the learner's social concerns and motivations during the process of transmission. More generally, we argue that the value of BST lies in its ability to add explanatory depth and nuance to the existing literature, while remaining consistent with the accounts described above: Causal misattributions, prediction errors, and the level of parsing, are all likely contributors to the high-fidelity transmission of conventions and traditions but none of them is sufficient to explain observed differences between ritual and instrumental learning.

In addition to its relevance to various sub-fields of social learning and cultural evolution research, another hallmark feature of BST is its emphasis on the importance of including different action types in experimental paradigms of social learning in order to disentangle its underlying motivations. In what follows, we make the case for using fine-grained distinctions between action characteristics in future research, stemming from a new framework of cultural action.

4. BST and the cultural action framework

To identify types of action elements that cue a certain stance (instrumental or ritual) we propose a cultural action framework (Fig. 3), in which all observed actions can potentially be classified by their unique pathways and can thus be studied more efficiently by cognitive and social scientists alike. Bifurcations in our framework are based on the research reviewed above, suggesting that each step depends on the presence or absence of social cues that make one or other of these pathways more salient at any given moment. If an action is observed for which no end goal is discernible, we view it as irretrievably causally opaque thus activating the ritual stance and prompting high-fidelity copying (because any aspect of the action could be socially salient, e.g., as a stipulated requirement for functioning as a group identity marker, one must heed and copy everything). By contrast, if an observed action does have a discernible end goal, this admits of two possible scenarios. In one scenario the means to this end goal is causally transparent and resolvable, activating the instrumental stance and prompting less faithful transmission (because what mostly matters in this case is to achieve the outcome by whatever method works), leaving room for innovation to occur. An alternative scenario, however, is that despite the presence of an end goal the sequence is causally opaque. If that opacity is perceived as resolvable, it activates the instrumental stance, again prompting lower fidelity copying. If it is unresolved, but nevertheless seen as resolvable in principle, it would motivate the "copy all, correct later" strategy that is typical of instrumental overimitation. The latter pathway is exemplified by "magical" practices which focus on an end goal yet underspecify the causal pathway leading to the desired outcome (see above).

This framework reveals the lop-sidedness of the current experimental literature. The vast majority of studies focus on one path: Actions that are causally transparent and have a clear end goal (e.g., Caldwell & Millen, 2010; Muthukrishna, Shulman, Vasilescu, & Henrich, 2013). Other studies that integrate causal opacity into their designs lack clear distinctions with regard to varying degrees of resolvability. The proposed framework therefore aims to disambiguate the cognitive processes giving rise to a multitude of cultural traits and to facilitate more fine-grained analyses of cultural transmission. For instance, *microsociety* designs make use of experimental diffusion chains where an action is copied from one person to the next to track how it changes over multiple intergenerational transmissions (Caldwell et al., 2018). BST predicts that under conditions where social cues are salient (e.g., presence of ostracism threat), the modelling of goal-demoted and irretrievably opaque content prompts greater resistance to deviation than instrumental and resolvable action. More specifically, this could be shown by modifying already popular experiments (e.g., using paper planes; Caldwell & Millen, 2008) by including causally opaque elements (such as particular types of folds that do not contribute to the plane's aerodynamics or superfluous gestures during construction) and then track the longevity of these elements compared to their functional equivalents. Thus, by capturing cultural elements that are beyond the realm of technology, existing research paradigms can be refined by the current framework in ways that allow for broader conclusions about cultural

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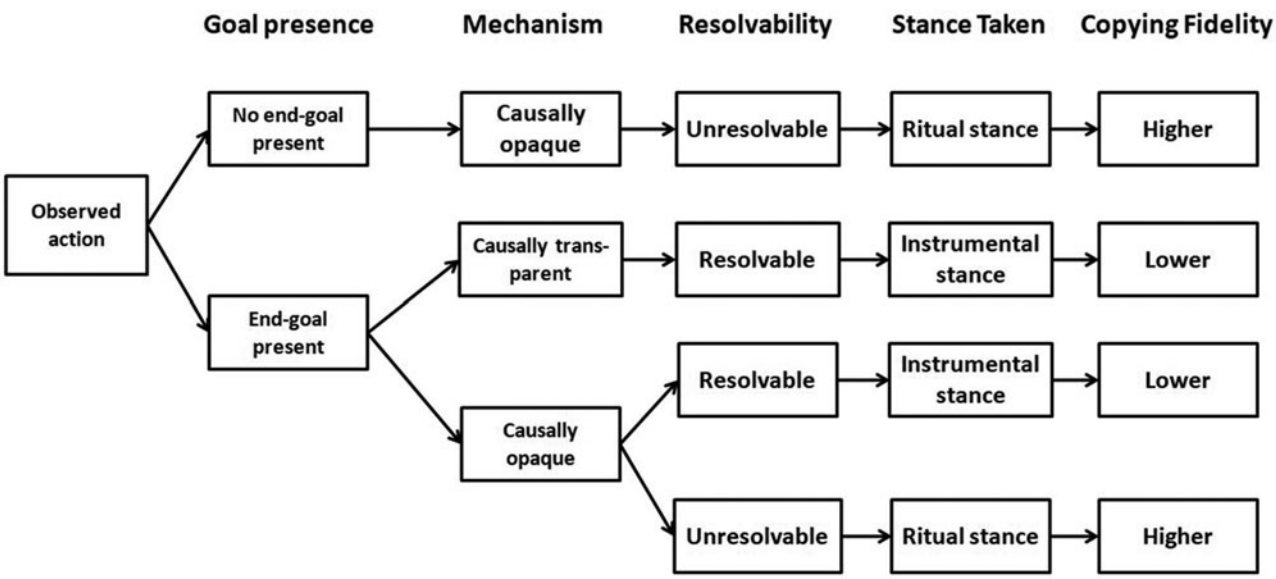

Figure 3. Cultural action framework based on goal-demotion, causal opacity, and resolvability of opacity.

evolution. As we will now discuss, investigations that are attentive to the differential transmission patterns of various cultural action types constitute fertile soil for future research.

5. Future of BST

By providing explanations for the co-existence of copying fidelity and innovative change, as well as an alternative framework to by-product accounts of overimitation, BST opens many new avenues for research on the psychological mechanisms and evolutionary-developmental origins of cultural learning. A key question about mechanisms asks whether the stances impact cultural learning by modulating attention, motivation, or – most likely – both. As the action parsing model indicates (Lienard & Boyer, 2006; Liénard & Lawson, 2008), early processing of observed action and its context could trigger attention to molar or molecular features of ensuing behaviour, promoting more effective learning about coarse-grain (instrumental stance) or finer-grain (ritual stance) features of the observed action (Leighton, Bird, & Heyes, 2010). While the attainment of a desired terminal configuration during instrumental copying emphasizes coarse and molar features, the sequence endpoint of opaque action is less salient because of its causal inconsequentiality, thus shifting attention towards the molecular features of the action (i.e., "steps become goals"). In addition, features of the action and context could encourage the learner to anticipate social or nonsocial rewards for successful performance (e.g., approval and/or a sticker) and to work harder, producing higher fidelity copying, when social rewards are both anticipated and needed – for example, because of recent priming of ostracism threat (Watson-Jones et al., 2014, 2016).

To investigate these possibilities empirically, the contribution of attentional processes could be assessed with eye-tracking, and with variants of the overimitation and start–end-state paradigm using recognition tests. In these variants, children could be asked to identify the action they have just observed from a set of images that differ from the target action at the molar or molecular level. If the stances have their effects via attention as well as motivation, more identification errors would occur when actions with a salient goal have been changed at the molecular level, and when actions without a salient goal have been changed at the molar level. In other words, if an observed behaviour is goal-oriented and thus encoded at the coarse and molar levels ("tidying the kitchen"), it should be more difficult to detect changes at the level of its sequence constituents (detecting whether a glass was first "raised" and then "scrubbed" or vice versa). Conversely, the attentional shift towards the molecular level as is the case for ritualistic behaviour ("the candle is the first item to be placed on the table"), should render identification at the molar level more difficult.

The contribution of motivational processes, already established using the start–end-state procedure (Watson-Jones et al., 2016) could be probed further by reversal studies where, in a novel context, low-fidelity copying produces social rewards, and high-fidelity copying produces nonsocial rewards. Once they are familiar with this looking-glass world, do adults and children begin to copy with higher fidelity when they want nonsocial outcomes? Such a reversal of the typical pattern would provide strong evidence that copying fidelity is motivated by expectations about the type of reward that is likely to follow. Similarly, looking-glass paradigms can be used to investigate action–reward reversals, where for instance, adopting the instrumental stance reaps social gains while irresolvable causal opacity is paired with inanimate rewards. Such designs can potentially uncover the motivational potency with which the anticipation of either reward modulates the fidelity of transmitted action.

Another important mechanism question asks whether the ritual and instrumental stances differentially recruit imitation and emulation. In imitation, narrowly defined, the observer copies body movements – the way that parts of the body move relative to one another (e.g., fist to chin) – whereas in emulation, the observer reproduces object movements (e.g., purple cube to red peg) (Heyes, 1993; Heyes, 2021a; 2021b; Tomasello, Kruger, & Ratner, 1993). Given that many group-defining communicative and ritual actions are intransitive, consisting of gestures and postures that do not involve objects (such as rhythmic dancing, marching, and more generally rituals that rely on joint and synchronous movements; Hove & Risen, 2009; Wiltermuth & Heath, 2009), it is likely that the ritual stance primes imitation more strongly than the instrumental stance. This would be significant because there is a substantial body of evidence that, unlike emulation, imitation

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involves distinctively human cognitive processes that are specialized for cultural learning (Tennie et al., 2009; Whiten, 2017). Previous experiments have not indicated a bias towards imitation in the ritual stance, possibly because the object movements in both conventional and instrumental sequences were highly salient compared with the body movements (Watson-Jones et al., 2014, 2016). Experiments designed to probe the roles of imitation and emulation would use action sequences in which body movements and object movements are equal in frequency, distribution, and salience, predicting higher fidelity copying of the body movements in conventional than in instrumental conditions.

More broadly, BST encourages research of a kind that is often neglected in developmental and evolutionary psychology; investigating the extent to which a focal behavioural competence depends on, rather than scaffolds, cognitive development. At the dependence end of this spectrum, stance behaviour – higher fidelity conventional rather than instrumental copying – may be deliberative (see sect. 2.2). Before copying, the actor categorizes the action they observed as conventional or instrumental; deliberates about the model's personal and communicative intentions; and reflects on their own desires to achieve affiliative rather than instrumental goals. In other words, stance behaviour may require a learner, even a young child, to have a range of concepts – including "convention" or "norm," "cause," "should," and "intention" – and to be capable of making inferences using these concepts in ways that are typically described as normative reasoning, causal reasoning, and mentalizing. In contrast, at the scaffolding end of the spectrum, a child may begin to show stance behaviour based on simple knowledge of contingencies. She may have noticed that high-fidelity copying is more likely to meet with social approval when the action and context have certain observable features, ABC, than when they have other features, XYZ. Consequently, without knowing why these contingencies hold – without understanding convention or instrumentality – she expects high-fidelity copying to produce richer social rewards under conditions ABC than conditions XYZ and acts accordingly (Grusec & Abramovitch, 1982; Young, Krantz, McClannahan, & Poulson, 1994). Thus, at the scaffolding end of the continuum, stance behaviour has humble beginnings, but it provides a crucial platform for the development of complex normative and causal cognition. Once the child can distinguish ABC from XYZ – once these two sets of observable cues are distinct in her mind – she can begin to build the concepts through which the two categories are understood by adult members of her culture. For example, she can connect adults' statements about what "we do" to ABC, and statements about what "works" to XYZ, and through these build concepts of convention and causation, and capacity for normative reasoning.

Another, related question concerns the way in which the stances are inherited, genetically or culturally (see sect. 2.2). On the one hand, bifocal stance psychology could be an "innate module" or "cognitive instinct" (Pinker, 2010; Tooby & Cosmides, 2005). In other words, it is possible that bifocal stance psychology evolved via natural selection operating on genetic variants, and that all (or nearly all) contemporary humans genetically inherit a specific propensity to develop the two stances; a propensity that is realized with minimal input from experience (e.g., only the opportunity to observe the behaviour of others). At the other end of the inheritance spectrum, bifocal stance psychology could be a "cognitive gadget" (Box 1); a product of natural selection operating on socially learned variants (Birch & Heyes, 2021; Heyes, 2018a, 2018b). In the gadget case, the genetically inherited ingredients would be nonspecific (domain-general as opposed to domain-specific; Box 1). These ingredients may include only an enhanced capacity for detecting action–reward contingencies, and heightened social motivation compared with our primate ancestors, but the experiential requirements for the development of bifocal stance psychology would be much more specific. For example, it may be necessary for children to grow up among adults who consistently approve high-fidelity copying of conventional actions, and who encourage active curiosity about how things work.

In principle, the two stances could be genetically or culturally inherited whether stance behaviour depends on, or scaffolds the development of, concepts and complex cognitive processes. However, given that stance behaviour emerges early in development (by the age of 3; Watson-Jones et al., 2014), when children have had limited opportunity to learn about normativity and other minds through conversation, high dependence on complex cognition would imply that bifocal stance psychology is at the genetic end, and high scaffolding would imply that it lies at the cultural end, of the inheritance spectrum. Consequently, the dependence and inheritance questions can be investigated together by examining co-variation between cultural learning experiences and the development of bifocal stance psychology – across individuals, groups, and cultures.

For example, do children who have been more consistently rewarded for high-fidelity copying of conventional actions, and encouraged to "have a go" with novel objects, develop stance behaviour sooner than children with less of this cultural learning experience? Do they develop a richer understanding of normativity indexed by verbal measures? Similarly, do children from more traditional cultures show signs of bifocal stance psychology sooner than children from less traditional cultures, and use different sets of cues to delineate conventional and instrumental behaviour? Affirmative answers to questions like these would suggest a powerful role for cultural learning in the development of bifocal stance psychology; that this cognitive specialization for the cultural evolution of practical skills is itself a product of cultural evolution.

6. Concluding remarks

No other species is as dependent on culture as humans. Cultural adaptations resulting from collectively accumulated bodies of knowledge turned a tropical primate into the ecologically dominant species on the planet. To explain why, we have argued for the bifocal stance theory (BST) of cultural evolution, which proposes that the co-existence of innovation and adherence to tradition results from our ability to adopt different motivational stances and associated copying paradigms attuned to the different functional affordances of the behaviour to be transmitted. BST stands in stark contrast to popular by-product accounts, which assume that faithful copying of causally irrelevant action is because of reliance on instrumental copying alone. We have proposed empirically tractable alternative accounts of the evolutionary origins of the two stances and a novel cultural action framework to help ensure that experimental designs approximate more closely real-life cultural transmission. BST not only illuminates historical patterns of differential cultural diffusion (continuity and change in both technology and ritual life), but also raises new questions about the cognitive underpinnings of cultural evolution. Above all, we propose that if our reliance on culture is what makes humans stand out on the tree of life, then studying the bifocal stances that enable culture may hold the key to understanding the evolutionary origins of human uniqueness.

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Open Peer Commentary

If you presume relevance, you don't need a bifocal lens

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Abstract

We argue for a relevance-guided learning mechanism to account for both innovative reproduction and faithful imitation by focusing on the role of communication in knowledge transmission. Unlike bifocal stance theory, this mechanism does not require a strict divide between instrumental and ritual-like actions, and the goals they respectively fulfill (material vs. social/affiliative), to account for flexibility in action interpretation and reproduction.

We argue that bifocal stance theory (BST) overlooks the central role that communication plays in guiding cultural transmission

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and outline an alternative framework that builds on the cognitive bases of human ostensive communication (Csibra & Gergely, 2009, 2011; Heintz & Scott-Phillips, 2022; Sperber & Wilson, 1986). Our main argument is that being addressed by knowledgeable others induces an expectation of relevance in naive learners, which is sufficient to account for both flexible (and potentially innovative) and high-fidelity aspects of cultural transmission. Communicative demonstrations function to bring into focus the parts of the ostensively manifested action that are relevant, and as such should be learned and faithfully re-enacted. As the authors also point out, given that the physical–causal relation between the observed actions and their consequent outcomes often appear causally opaque to the naive observers, relying on others' communicative behavior is an efficient strategy that novices can exploit to decipher what is relevant for them in a given context. Critically, the same instrumental action could be interpreted and represented as being transparent or opaque simply as a function of the particular context in which it is performed. For example, seeing someone take his hat off while sweating in hot weather could be interpreted by the observer as a causally transparent action performed to achieve the teleologically transparent goal of cooling one's head. However, if a juvenile learner observes the same instrumental action being performed by someone in a cool place such as a temple – a place of worship – then the sub-goal the instrumental action serves (as a means to express respect) remains teleologically opaque to the juvenile. In such cases ostensive behaviors accompanying the performance of the cognitively opaque means action can be highly useful to inform the naive learner that despite its apparent teleological opacity the ostensively highlighted means action is relevant for the apprentice to acquire and faithfully re-enact.

Several developmental studies corroborate the role that communication plays in relevance-guided cultural learning (e.g., Brugger, Lariviere, Mumme, & Bushnell, 2007; Király, Csibra, & Gergely, 2013; Nielsen, 2006; Southgate, Chevallier, & Csibra, 2009). For example, in a study by Király et al. (2013) an experimenter demonstrated a peculiar sub-efficient action, that is, lighting up a touch-sensitive box by contacting it with her forehead. When the demonstration occurred in a communicative context, 14-month-old infants were more likely to faithfully re-enact the sub-efficient manner through which the experimenter lit up the box and perform the causally opaque sub-efficient head-touch means action. In contrast, when they observed the same action but without being preceded by ostensive communicative behavior, infants tended to freely emulate the outcome in a more efficient way, by using their hands to light up the box. These findings demonstrate how ostension modulates action interpretation: When accompanied by communicative behaviors the sub-efficient manner was interpreted as a relevant sub-goal to achieve the end goal despite its apparent opacity. By contrast, in the absence of ostensive demonstration infants selected and used a more efficient behavior to emulate the end goal, while ignoring the observed causally opaque and sub-efficient head contact action. These findings, along with several others (e.g., Southgate et al., 2009) show how ostensive behavior can flexibly change how an action is interpreted, without requiring a bottom-up analysis of "the relative number of perceived cues that convey conventionality or instrumentality," which BST hinges on to induce either a ritual or an instrumental stance.

This relevance-guided learning mechanism can dispense with the need to postulate different stances associated with different motivational drives and specific sets of cues to yield different interpretations of observed actions: Variation in copying fidelity can be explained by the presumption that what is ostensively demonstrated is relevant for the addressees, even if it is opaque. Thus, learners do not need to rely on identifying the various cues indicative of the different stances and weight their combined strength to decide which stance is appropriate to take, which then activates the corresponding imitation profile. Furthermore, a relevance-guided learning mechanism does not assume a discrete partitioning of the reward landscape into social versus instrumental benefits, which, in the proposed BST framework, are respectively tied to the ritual and instrumental stance. We deem this assumption untenable for two reasons. First, social rewards often accrue to novices also when attending to demonstrations of transparent instrumental actions: Together with learning how to fulfill new instrumental goals, children extract information about the communicators' social and epistemic value, knowledgeability, reliability, and benevolence, which helps them preferentially interact with partners who are more likely to provide relevant learning opportunities in the future (e.g., Begus, Gliga, & Southgate, 2016; Brosseau-Liard & Poulin-Dubois, 2014). Second, many non-instrumental, goal-demoted, or causally opaque actions (which by BST criteria fall under the ritual stance) are established for reasons other than to signal affiliation: Conventions serving purely as coordination devices (e.g., driving on one side of the road) are typically enacted and complied with because they constrain individual behaviors in collectively profitable ways, not because they signal the group membership and degree of affiliation of their adopters (Bicchieri, 2006). Furthermore, the acquisition of such "opaque" practices is often not primarily motivated by affiliative needs, but by a fundamental epistemic drive to learn the relevant knowledge of their cultural communities (Gergely, 2013; Gergely & Jacob, 2012; Király et al., 2013). This is evidenced by selective imitation studies showing children's faithful copying of cognitively opaque actions from ingroup demonstrators even in their absence (Altınok, Király, & Gergely, 2022; Buttelmann, Zmyj, Daum, & Carpenter, 2013). In sum, unlike BST, which presupposes social interactions to reflect the segregation of diagnostic indexes (cues) and payoff types (rewards), the relevance-guided learning mechanism sketched here dispenses with such assumptions. It suggests instead that flexible acquisition and reproduction of socially shared practices are possible irrespective of whether these serve instrumental, coordinative, or affiliative functions. We conclude that studies of cultural evolution would strongly benefit from integrating the theories of ostensive communication, which provide key insights about why and when people faithfully copy opaque actions.

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Can bifocal stance theory explain children's selectivity in active information transmission?

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Abstract

To shed light on the key premise of the bifocal stance theory (BST) that social learners flexibly take instrumental and ritual stances, we focus on developmental origins of child-led information transmission, or teaching, as a core social learning strategy. We highlight children's emerging selectivity in information transmission influenced by epistemic and social factors and call for systematic investigation of proposed stance-taking.

In light of the bifocal stance theory's (BST) main premise that social learners flexibly take instrumental and ritual stances, we review emerging literature on child-initiated information transmission as a crucial component of active social learning toolkit. We argue that to fully understand the developmental origins of the proposed stances, we need to consider child-led teaching which is currently overlooked in the target article's focus on imitation.

Active teaching – or pedagogical information transmission – is a complex social learning strategy enabling knowledge exchange as an essential element of human cumulative culture (Burdett, Dean, & Ronfard, 2017; Kline, 2015; Strauss & Ziv, 2012). It allows to effectively convey acquired information or practical skills to less knowledgeable others, without the need for independent learning through trial and error. The presence of teaching behaviors early in human ontogeny supports the premise that children are not merely passive recipients of knowledge, but also actively seek and further propagate knowledge to others (Bazhydai & Harris, 2021; Gweon, 2022). Therefore, focusing on children as active teachers in complex social learning contexts can help uncover the underlying cognitive mechanism and the emergence of the proposed stances. Can we observe the indices of instrumental and ritual stance-taking in children's own information transmission?

Developmental research suggests that children start to actively share information with others from infancy (Gweon, 2022; Ronfard & Harris, 2018). Behavioral strategies used to propagate knowledge increase in sophistication with development (Strauss & Ziv, 2012). In the first 2 years of life, children use gestures, such as pointing to the location of objects for a naïve observer, and action demonstrations; at 3 years of age, they inform others by using elaborate demonstrations (e.g., how a game is played); demonstrations are accompanied by explanations when they are 5-year-old; and at around 7, they tailor information for learners' specific needs, such as by correcting mistakes and providing individual feedback.

The crucial question arising here is whether children are *selective* when they propagate information to others, and if so, how early in ontogeny such selectivity emerges? While the target article evidences stance switching from infancy by focusing on imitation behavior, more direct evidence to assess this key premise of the BST would come from child-initiated teaching behaviors. The expectation that children will be selective in their teaching, rather than exhibit a "teach all" pattern, arises, first, from evidence of children's selective trust in others' testimony based on informant's epistemic or social characteristics (Tong, Wang, & Danovitch, 2020). Second, already by preschool years, children hold explicit ideas about what constitutes good teaching (Sobel & Letourneau, 2016, 2018) and view providing relevant information as key to good teaching (Gweon, 2022). The relevance of information depends both on the nature of information itself and on the characteristics of the learners who vary in their goals, abilities, prior knowledge levels, and social affiliations, among other factors. A natural outcome of this relationship would lead to employing tailored approaches when teaching others.

Emerging findings support the notion that children flexibly make selective decisions on what kind of information to transmit, to whom and when. They consider learners' goals and abilities (Gweon & Schulz, 2019), social group affiliation (Karadağ & Soley, 2022; Schmidt, Rakoczy, & Tomasello, 2012), and occupations (Danovitch, 2020). Further, children do not transmit all learned information indiscriminately, but variably prioritize generalizable (Baer & Friedman, 2018; Gelman, Ware, Manczak, & Graham, 2013), cognitively opaque (Ronfard, Was, & Harris, 2016), simple (Bazhydai, Silverstein, Parise, & Westermann, 2020), and information acquired through explicit pedagogy (Vredenburgh, Kushnir, & Casasola, 2015). Finally, children consider how much it would benefit the learner and how costly it would be for the learner to acquire information independently (Bridgers, Jara-Ettinger, & Gweon, 2020).

Can BST explain children's selectivity in active information transmission? Research to date, while limited, lends support

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to this idea. For example, instrumental stance-taking may explain the finding that children provided more comprehensive information to the learner who requested information to enable them to effectively complete an action, and also when the learner was introduced as being "silly" compared to exceptionally smart (Gweon & Schulz, 2019). Ritual stance-taking might account for children's use of normative language and enforcement of conventional norms selectively with ingroup but not outgroup members (Karadağ & Soley, 2022; Schmidt et al., 2012). To directly investigate whether observed selectivity in information transmission stems from flexible stance-taking, future studies should focus on systematically manipulating factors that may potentially trigger these stances during transmission – those regarding both the nature of information and the social attributes of the learner. Here, while the target article acknowledges the role of information opacity and resolvability when discussing selectivity in imitation behavior, other epistemic and social factors may provide insight into children's motivations and pave the way for more targeted research into underlying cognitive mechanisms of stance-taking across social learning strategies. Thus, future studies should focus on selectivity in information properties, such as complexity, efficiency, and relevance, in conjunction with epistemic and social attributes, such as knowledgeability or group membership of both informants and learners.

Finally, while most of research to date stems from children of preschool age and above, when representations of knowledge and explicit understanding of its transmission develop (Ziv & Frye, 2004), research on active information transmission in pre-mentalizing age is in its infancy (Bazhydai et al., 2020; Flynn, 2008; Karadağ, Bazhydai, & Westermann, 2022; Liszkowski, Carpenter, Striano, & Tomasello, 2006, 2008; O'Neill, 1996). This limits our ability to draw generalizable conclusions with regard to the developmental trajectory of children's selectivity and stance-taking, domain specificity, or generality of the underlying cognitive mechanism and deliberateness or automaticity of these processes.

We conclude that BST has the potential to explain children's emerging selectivity in active information transmission and propose future directions for systematic investigation of instrumental and ritualistic stance-taking to further our understanding of the factors that affect the level of sophistication, diversity, and flexibility of the developing social learning toolkit.

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No tinkering allowed: When the end goal requires a highly specific or risky, and complex action sequence, expect ritualistic scaffolding

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Abstract

On Jagiello et al.'s cultural action framework, end-goal resolvability and causal transparency make possible the transmission of complex technologies through low-fidelity cultural learning. We offer three further features of goal-directed action sequences – specificity, riskiness, and complexity – which alter the effectiveness of low-fidelity cultural learning. Incorporating these into the cultural action framework generates further novel, testable predictions for bifocal stance theory.

According to Jagiello et al., because low-fidelity cultural learning relies on individual causal reasoning and trial-and-error, it is only likely to be successful in some circumstances. For example, when the goal-directed action is causally transparent and the end goal is resolvable. When such circumstances do not hold we should expect the adoption of the ritualistic stance and high-fidelity cultural learning. Despite being in broad agreement with Jagiello et al., we suggest an addition to bifocal stance theory. In particular, there are circumstances where low-fidelity learning will robustly fail despite the causal transparency and/or end-goal resolvability of the cultural trait involved. Such circumstances feature three key characteristics: *specificity*, *riskiness*, and *complexity*.

Specificity concerns the range of possible action sequences for achieving a desired goal. When this range is very narrow (i.e., the specificity is high), there is little room for learning error. Correspondingly, there is limited scope for the learner to tinker with the action sequence being modelled, as deviation from the appropriate sequence will not achieve the desired end. For example, preparing an edible flour from the sporocarps of the Australian nardoo fern, *Marsilea drummondii*, requires following a highly specific action sequence of washing and other activities (Earl & McCleary, 1994; see also Boyd, 2017, pp. 9–19). If this sequence is not followed, the consumption of the resultant flour over prolonged periods leads to thiaminase poisoning. In such contexts, we should expect to see selection for the ritualistic stance to reduce the possibility of error. In contrast, when there is a broad range of possible action sequences capable of producing a desired end goal (i.e., the specificity is low) there is room for the learner to engage in tinkering whilst still achieving success. For instance, an egg can be cracked on a sharp edge, using a knife, or using a custom-made tool. Unlike in the high-specificity case, here the instrumental stance is likely to be sufficient for robust transmission of the cultural trait.

The *riskiness* of an action sequence also influences whether employing the instrumental stance is a fruitful strategy (regardless of whether the specificity of the action sequence is high or low). Riskiness concerns the costs the learner will incur should they make a mistake (rather than the risk they will make the error in the first place). When the risk of error is high (e.g., where failure of the learner to perform the exact sequence of actions produced by the model results in death or serious injury) the trial-and-error style learning characteristic of low-fidelity cultural inheritance is expensive and inefficient. Conversely, action sequences with low-risk profiles offer a potentially fruitful opportunity for innovation. Again, food processing is illustrative. Bitter yam, *Dioscorea dumetorum*, is a staple carbohydrate amongst some Nigerian cultures which, like nardoo, is poisonous without careful processing by soaking, washing, and drying. Unlike nardoo, however, even a very small amount of poorly or unprocessed bitter yam can prove fatal (Omefe, Ajetunmobi, Onyema, & Atoyebi, 2021). Whilst both action sequences are highly specific, bitter yam processing is more risky for the learner than nardoo processing because failure to carry it out properly is very likely to cause immediate death or severe illness.

For both risky and high-specificity action sequences the costs associated with error (either in failure alone, or death or serious injury) mean we should expect to see selective pressure for the ritualistic stance. As Jagiello et al. note, casual transparency and resolvability can mitigate this possibility by increasing the likelihood that the learner will rationally recreate the action sequence of the model with high accuracy. Whilst causal understanding goes some way to overcoming the challenges posed by riskiness and specificity, we are sceptical that even perfect causal understanding is entirely up to the task when the action sequence in question is complex in nature.

Action sequences vary in their *complexity*: the number and variety of steps they are comprised of. A simple action sequence may have only one step which is repeated (e.g., cracking an egg). A more complex action sequence may have multiple, heterogeneous steps (e.g., processing nardoo). For simple sequences the learner has relatively little to rehearse and memorise to successfully achieve the desired goal. Even if highly specific, with anything but a very high cost of error, simple sequences can be expected to be rapidly learned with low-fidelity learning and causal understanding. For complex action sequences, however, there are many steps to rehearse, order, and memorise to achieve the desired end goal. The cognitive load is much higher. Where an action sequence is complex and involves high risk and/or high specificity, this challenge is even greater, as trial-and-error or tinkering is costly and/or ineffective. Whilst causal understanding would be beneficial, it remains much harder for the learner to achieve the desired outcome with low-fidelity learning than in the low-complexity case because of the sheer number of possible "wrong moves."

This sort of situation (high specificity or high risk, plus complexity) would not have been unusual in the history of our lineage. Even focusing solely on foods, there are many plants and animals (pufferfish, raw kidney beans, bitter almonds, cassava, to name a few), which require specific, complex processing to make them edible by humans. In our view, such situations would generate selection pressure for the ritualistic stance, regardless of causal understanding. This would lead to the cultural evolution of various forms of cultural scaffolding designed to invoke the ritualistic stance (and thus high-fidelity learning). This sort of scaffolding might include song, narrative, ceremony, and other typically ritualistic cultural practices we see used around the social transmission of technology. A work song, for example, which invokes the order of steps of a highly specific task makes it easier for a teacher to successfully transmit the correct action sequence to the novice. This is a testable prediction that, if found to be true, would provide further support for the bifocal stance theory.

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Fidelity, stances, and explaining cultural stability

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Abstract

The bifocal stance theory posits two stances – the ritual and the instrumental – each a learning strategy with different fidelity outcomes. These differences in turn have long-term consequences for cultural stability. Yet we suggest the key concept of "fidelity" is insufficiently explicated. Pointing to counter-examples and gaps in the theory, we suggest that explicating "fidelity" reveals the stances to be *heuristic explanatory strategies*: first-pass explanatory glosses of learning and its consequences, not descriptions of the inner machinery of agents.

We are on board with the authors' broad enterprise: to identify, sort, and understand influences on social learning and their downstream effects on the stability of cultural traditions. Yet we have reservations about two key elements of the project: the role of the posited stances and the use of the "fidelity" concept. The two concerns are related. Reflecting on fidelity shows the stances provide only rough approximations of learning and its outcomes. This suggests the stances are not descriptions of cognitive processes, but rather, are rough-and-ready heuristic strategies for explaining downstream consequences of learning.

Consider first that acquiring ritual behaviour does not straightforwardly involve molecular (fine-grained behavioural) learning, or instrumental behaviour molar (goal-oriented) learning. Cases abound where learning goal-oriented behaviour requires attending to specific action sequences and the fine-grained details of those actions. The Levallois method of flint-knapping requires learning not just the core-trimming sequence through flake removal (molar), but also the specific kinematic profile for achieving the correct angle, velocity, and force of impact (molecular) (Roux & Bril, 2005). Cases also abound where attentiveness to a ritual's goal is more important than its fine-grained profile: think of ritual handwashing, dressing-up for a wedding, or properly kneeling during *salah*. The lessons to take from these counterexamples are two-fold: the grain at which traits are learned varies with the behavioural specifics, irrespective of ritualistic or instrumental cues, and this undermines anything but a contextual, particularist evaluation of fidelity (Charbonneau & Bourrat, 2021).

Building on this, a second concern emerges out of the proposed links between the stances and long-term cultural stability. The authors suggest the two stances generate fidelity differences, understood as a propensity to produce faithful learning episodes (Charbonneau, 2020). Yet these propensity claims extrapolate from single episodes of learning without attending to the task structure or its effects on transmission. To see why this is a problem, consider two learners, each perfectly exemplifying one of the two stances: one ritual and one instrumental learner. Both learners observe the same model acting in order to complete a task. Some actions are causally transparent and instrumentally relevant, others opaque and conventional. Adopting the ritual stance, the first learner copies all actions faithfully. By contrast, the learner adopting the instrumental stance drops causally opaque actions, retaining only those transparently linked to task completion. To simplify matters, let us assume this leads the instrumental learner to acquire the *optimal* approach to the task.

After this first learning episode, the ritual learner will have acquired a trait with more fidelity than the instrumental one – the ritual learner's behaviour will be more similar to the model's than the instrumental learner. The situation changes, however, when we consider a *second generation* of stance-exemplary learners. In a lineage of ritual learners, the full sequence will be retained – including the instrumental and the conventional actions. In a lineage of instrumental learners, however, the full sequence, composed strictly of causally transparent action, will *also* be copied faithfully, as there are no further opaque or ineffective actions to be dropped. This can be projected into the future. While more content – more information – will be passed on in the ritual lineage, both lineages will be characterized by faithful transmission episodes. Though differing, both will be equally stable. What this toy example shows is that the authors' distinction between the (long-term) fidelity of the two stances extrapolates from an insufficiently characterized learning episode: an initial and uncertain encounter with a learning input composed of both causally transparent and causally opaque actions. This extrapolation misses important facts, notably, that the task structure can itself influence transmissibility, and in turn, have important effects on stability over multiple episodes (Claidière et al., 2018).

Third, this points to an important explanatory gap between accounts of learning and accounts of long-term fidelity. Bridging this gap requires attending not only to the learning of traits, but also to their *expression* (Morin, 2015). If traditions are to remain stable over time, individuals must be motivated to produce behaviour similar to what they have learned.

In some situations – say, when they know the optimal trait – agents will express the same behaviour day in, day out. Otherwise, the stable expression of behaviour requires additional, often exogenous, machinery: social sanctioning, reputation loss, threats of supernatural punishment, and so on. Deviant behaviour needs to be recognizable, (potentially) punishable, and (definitely) correctable. When this social machinery is weak or absent – for instance, when agents find themselves in novel social contexts – opportunistic behaviours might creep in. Even longstanding rituals might give way to instrumental exploration.

The emerging science on the acquisition of behaviour and norms suggests that learners – especially children – learn not just *how to produce an action*, but also *what not to do*, which they can use to decide *what they can get away with* (Nichols, 2021). Work studying moral sense acquisition in children dovetails with cultural evolution, showing how children are sensitive to the in-group/out-group statuses of agents, authority-dependence of prescriptive norms, and influence this has on regulating their own behaviour and that of other agents (Ayars & Nichols, 2020; Nichols, 2021; Schmidt, Rakoczy, & Tomasello, 2012). Explanations of the long-term stability of culture, in

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other words, must incorporate the wide range of information that agents acquire and weigh when deciding what behaviour to express (Buskell and Tennie, forthcoming; Morin, 2015).

Are the "ritual" and "instrumental" stances descriptions of real cognitive patterns? Do these patterns correspond to differences in fidelity? The complex interplay between informational cues, trait history, and expression undermines easy inferences between learning and fidelity. Because of this we think that, rather than offering insight into the black box of cognition, the authors' stances are best understood as *heuristic explanatory strategies*; first-pass glosses that orient the *investigator* towards trait features influencing the learning, expression, and long-term fidelity of culture that can be fleshed-out with further investigations into the task, social context, and historical pressures. The stances are not descriptions of what goes on in the heads of learners, but useful guides for explaining the stability of traditions.

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Bifocalism is in the eye of the beholder: Social learning as a developmental response to the accuracy of others' mentalizing

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Abstract

This commentary argues the case for developmental psychopathology in understanding social learning. Informed by work on "epistemic disruption," we have described difficulties with social learning associated with many forms of psychopathology. Epistemic disruption manifests in an inability to move between innovation and conformity, and arises from poor mentalizing, which generates difficulties in identifying social cues that trigger the correct stance.

Bifocal stance theory is cogently positioned as a transdisciplinary integrative approach to explaining the flexibility with which humans move between imitation and innovation in order to maximize opportunities for social learning. Here, we seek to extend the transdisciplinary range to hold an emphatic place for developmental psychopathology. Theorists of social cognition tend to use a model of normatively archetypal functioning but we suggest that such platonic idealism in relation to human social cognition forms a missed opportunity, for two reasons: (a) psychopathological functioning can illuminate processes as they become distorted and (b) social cognition does not take place at the level of abstraction – rather ruptures, misattunements, and the socially nested task of achieving joint attention are the stuff of higher-order cognition.

We will begin with our first point, what we can learn from psychopathology. Informed by clinical thinking on "epistemic petrification," we have described particular difficulties with flexible social learning that are associated with certain forms of psychopathology, most centrally, borderline personality disorder (BPD) (Fonagy, Luyten, & Allison, 2015). It has been observed that individuals with this diagnosis tend to be particularly vulnerable to epistemic disruption, which arises out of a poor capacity for mentalizing and generates breakdowns in social communication and learning. Mentalizing – the ability to understand actions as underpinned by mental states, in both other people and the self – may be essential in making the effective use of the bifocal stance possible. Appropriate switches in stance depend on being able to make use of social cues about what is being demonstrated or communicated. Difficulties in mentalizing on the self-other dimension (Fonagy & Luyten, 2009), can lead to either or both: (a) my imagined image of myself in the world, and (b) the image of myself and the world that I imagine my "teacher" to hold of me, becoming disrupted or distorted. As a result, I may resort to slavish imitation (perhaps because my image of myself is so diffuse that any communication about what I should do and who I am in the world is accepted) or unmoored innovation (perhaps because I cannot recognize myself as accurately recognized in my communicator's image of me and it is better to work things out instrumentally on my own than trust their view about how to navigate the world) (Fonagy, Allison, & Campbell, 2019). Where mental disorder is indicated, an individual is stuck in one position or another – excessive imagination is as pathological as excessive copying when it comes to social adaptation. We would suggest that what we have identified as epistemic trust, mistrust, and credulity (Campbell et al., 2021) might manifest as difficulties in adopting a flexible bifocal stance. Some individuals might be stuck in an imitative mode or in an instrumental mode, others may oscillate between the two but with insufficient discrimination – we have described this as the epistemic dilemma which individuals with some forms of personality disorder experience. In such a state, individuals veer between excessive epistemic credulity (imitation) and a repudiation of the content of others' minds (which might be

understood as a form of unmoored innovation). We have conceptualized a number of forms of psychopathology as understandable in terms of such epistemic disruption (Fonagy et al., 2021).

Where our model diverges from Jagiello and Heyes is in our emphasis on the interactional nature of the processes and the significance of the quality of communication. The theory of epistemic trust, in the form that we have proposed, is based on developmental psychopathology. Social learning first takes place in the context of early caregiving relationships. The biological predisposition of the caregiver to respond contingently to the infant's expressive displays creates the foundation for the infant to acquire further knowledge from that individual. During what we have termed "marked mirroring interactions," the attachment figure will "mark" referential emotion displays to signal the generalizability of knowledge and effectively to instruct the infant about the infant's subjective experience (Fonagy, Gergely, Jurist, & Target, 2002; Fonagy & Target, 2007; Gergely & Watson, 1996). "Marking" by the caregiver as part of "good enough" mirroring serves as ostensive cues that enable a child to feel recognized as a subjective, agentive self, which in turn reinforces epistemic trust, optimizing the effectiveness of social transmission of knowledge. Being able to appropriately adjust one's bifocal stance between imitative and instrumental learning to specific contexts, we suggest, requires both epistemic trust and epistemic agency that (a) constitute a developmental achievement, incubated by particular social experiences, and (b) are necessarily subject to being closed off in response to social interaction which suggests that such cooperative learning is not self-protective (Sperber et al., 2010). The authors cite Watson-Jones' experiment of social copying in children, which found that children who were first exposed to social exclusion by their in-group in a virtual ball-tossing game showed the highest fidelity in copying a causally opaque action, compared to both those who were included by their in-group and those who were rejected or included by an out-group. Developmental literature indicates that children are more likely to protest norm violation when it is committed by an in-group rather than an out-group member. We also know that individuals with BPD, who are prone to epistemic credulity (social copying), also tend to show heightened sensitivity to social rejection (Hanegraaf, van Baal, Hohwy, & Verdejo-Garcia, 2021); effect sizes across studies are large with BPD patients more likely to be reporting feelings of exclusion even in social inclusion conditions (e.g., Brown et al., 2017).

This emphasis on the role of the quality of the relationship between the source of knowledge and the learner takes us to our second point – that higher-order social cognition cannot be understood as an abstraction. This position has been influenced by recent work on the origins and functions of some of the characteristics which we identify as central to our identity as a species as being inherently social. Mahr and Csibra (2017), for example, have argued that episodic *memory* principally functions to enable social communication. Memories of personal experience provide us with a rationale for our behaviour and locate us in relation to our obligations and commitments to and from others. Memories of interpersonal encounters tell us who we can rely on and who we should treat with caution. Similarly, Mercier and Sperber (2017) have argued that the human capacity for *reason* is primarily social, that the function of logic and reason is to enable us to cooperate, negotiate, and agree social terms with others – reasonings allow us to negotiate our social terms with others, providing the basis for cooperation and the regulation of complex social relationships (Mercier & Sperber, 2017). The embedding of social cognition in the social environment makes it inseparably linked to its function and dysfunctions.

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Culture is an optometrist: Cultural contexts adjust the prescription of social learning bifocals

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Abstract

The "prescription" of humans' social learning bifocals is fine-tuned by cultural norms and, as a result, the readiness with which the instrumental or conventional lenses are used to view behavior differs across cultures. We present evidence for this possibility from cross-cultural work examining children's imitation and innovation.

Jagiello et al. propose that humans' social learning is shaped through the lenses of interpreting others' behavior as either an opportunity for instrumental learning or for conventional learning. They suggest that humans switch their focus interchangeably between these two possibilities – much like someone wearing bifocals – based on the social and contextual cues available related to the behavior of interest. We agree with the authors' suggestion that human social learning is guided by these two lenses. We would like to expand on this idea to suggest that the "prescription" of these social learning bifocals is shaped by culture, such that sensitivity to particular cues and thus the readiness with which the instrumental or conventional lenses are used to view behavior is fine-tuned by cultural norms. Below, we support this idea with examples from work examining children's imitation and innovation in distinct cultural contexts.

As indicated by Jagiello et al., research suggests that children across cultural contexts engage in higher fidelity imitation when presented with cues that indicate the goal of a behavior is conventional rather than instrumental (e.g., Clegg & Legare, 2016; see also Rawlings, Dutra, Turner, & Flynn, 2019). This same work also suggests that baseline imitative fidelity might be higher in cultural contexts that privilege conformity over creativity (Clegg & Legare, 2016; Clegg, Wen, & Legare, 2017; Wen, Clegg, & Legare, 2019). To illustrate this, we will focus on one such cross-cultural comparison between children from the United States and Vanuatu based on on-going work examining imitation, innovation, and children's sociocultural contexts.

When presented with the same necklace-making task, U.S. and Ni-Vanuatu children engaged in higher imitative fidelity if given a conventional goal for the task than if given an instrumental goal; thus, displaying use of social learning bifocals. When comparing children's imitation after being presented with an instrumental goal, however, the Ni-Vanuatu children engaged in higher fidelity imitation compared to the U.S. children (Clegg & Legare, 2016). One possible explanation for the difference in U.S. and Ni-Vanuatu children's imitation when presented with an instrumental cue is that their bifocals have slightly different prescriptions, with Ni-Vanuatu children's bifocals focusing more readily on the conventional lens. The tendency to use one lens versus another is shaped by the social norms of each culture. These social norms are implicitly and explicitly communicated and reinforced by children's learning partners (both caregivers and peers) and include beliefs about the importance of conformity. This possibility is supported by work examining such beliefs which found that Ni-Vanuatu adults are more likely than U.S. adults to endorse children's high conformity in a necklace-making task as indicative of a child being intelligent and well-behaved (Clegg et al., 2017).

In addition, caregivers' ethnotheories about children's learning (e.g., Harkness & Super, 2002) and experience with formal education (e.g., Greenfield, 2009) impact how they guide children's learning and attention (Rogoff et al., 1993). We propose that these cultural factors, in turn, also adjust the prescription of children's social learning bifocals. Further evidence for this can be illustrated by additional research comparing Ni-Vanuatu and U.S. children's learning environments. When working together with children to complete a puzzle, Ni-Vanuatu caregivers used practices consistent with expectations that children learn using observation whereas their U.S. counterparts engaged in high levels of scaffolding and direct instruction (Clegg et al., 2021; as a note, these findings are consistent with Chavajay & Rogoff [2002] and Hewlett, Fouts, Boyette, & Hewlett [2011] among others). These different teaching norms may coincide with children's tendency to use the conventional or instrumental lenses more readily in different cultures. When observational learning is expected, it may be more efficient to use the conventional lens and focus on closely replicating an observed process until more expertise is gained (for a review, see Hoehl et al., 2019). Thus, because of a greater cultural value placed on conformity and observational learning, Ni-Vanuatu children may have a prescription that is more attuned to the conventional lens. In contrast, U.S. children's bifocal prescription may tend toward the instrumental lens because of a greater emphasis placed on creativity and direct instruction.

Finally, as Jagiello et al. note, innovation represents the other side of the cultural evolutionary coin, affording the generation of new behaviors, customs, and technology. As such, although the authors present the bifocal stance theory to challenge a tendency to focus on innovation within work on cultural evolution and instead shift the focus to high-fidelity transmission of cultural traditions and rituals, we also propose that just as the lenses of the social learning bifocals are shaped by culture, the same must be true of innovation. Cultural variation in societal norms, institutions, and values likely contribute to cultural variation in the prescription of children's bifocal lenses that result in different approaches to innovation. Research examining differences in children's innovation across cultures lends support for this possibility. Urban non-Indigenous Australian children demonstrated higher success rates on tool-based innovation tasks than rural Indigenous Australian children, and children in Vanuatu and rural South Africa (Neldner, Mushin, & Nielsen, 2017, 2019). As with the differences in imitation of an instrumental task described above, differences in success in innovation tasks between children in post-industrialized and developing countries have also been attributed to differences in an emphasis on conformity and adherence to others' actions and exposure to formal education (Lew-Levy, Pope, Haun, Kline, & Broesch, 2021; Rawlings, 2022). Attending school may facilitate creative capacities through emphasis on problem solving, peer-collaboration, and access to novel information.

Examinations of children's imitation and innovation suggest both consistencies and differences across cultures. This work indicates that cultural values and ethnotheories play an important role in shaping children's social learning behaviors. We thus encourage Jagiello and colleagues to consider that the bifocal lenses of social learning may be shaped by culture and that these lenses impact both children's imitation and innovation.

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When instrumental inference hides behind seemingly arbitrary conventions

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Abstract

We review recent evidence that game rules, rules of etiquette, and supernatural beliefs, that the authors see as "ritualistic" conventions, are in fact shaped by instrumental inference. In line with such examples, we contend that cultural practices that may appear, from the outside, to be devoid of instrumental utility, could in fact be selectively acquired and preserved because of their perceived utility.

The authors propose a plausible case for the idea that detail-focused copying fulfills an affiliative function, and underlies the cultural evolution of apparently arbitrary conventions. In their own terms, the actions behind "social etiquette, clothing fashions, tea ceremonies, and even the rules of childhood games" are "simply copied without question" because "their purposes remain mysterious" (target article, sect. 2, para. 6). While we do not deny this possibility, we suspect that the cultural evolution of many seemingly arbitrary conventions may be, despite appearances, mostly driven by instrumental inference at the cognitive level. We argue that many conventions which, from the outside, may appear devoid of instrumental utility, and "slavishly" learned simply because it's the "done" way to behave, are in fact selectively acquired and preserved, by the people involved, because of perceived instrumental benefits (see also André, Baumard, & Boyer, 2020; Singh, 2020). While demonstrating this on each instance of apparently arbitrary convention would require a whole research program, we here illustrate this point on the following examples – game rules, social etiquette, and religious rituals.

1. Sport and game rules

Sport and game rules are widely deemed typical examples of arbitrary conventions (Schmidt & Tomasello, 2012). The authors similarly argue that competitive sports (e.g., football), despite being oriented toward some instrumental outcomes (e.g., playing a ball into the opposing teams' net), are constrained by slavishly copied, causally opaque conventions (e.g., the prohibition to use one's hands to do so). We argue, however, that people adopt an instrumental stance toward *these conventional rules themselves*, designing and selectively retaining them to satisfy the goals they pursue by playing or watching sports and games – such as being entertained and signaling one's skills (Lombardo, 2012; see Dubourg & Baumard [2022] for another example of entertainment technology).

This is manifested by the fact that sport and game rules are transformed, under people's impulse, in a direction that increasingly satisfies those goals. Sport federations have adapted their rules throughout history to maximize players' and spectators' enjoyment, and the possibility for players' to signal their physical skills. The "offside rule," for instance, has been explicitly designed and retained because it prevents players from "goal-hanging," thereby making the game harder to play and funnier to watch (Zhao, 2021; see Fig. 1 for other examples). Even at a more micro-level, non-professionals who play street football spontaneously adapt the official rules of football to the context (e.g., the pitch dimensions). For instance, they commonly remove goalkeepers and reduce the number of players, to make the game funnier and more physically challenging (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011). In other words, we doubt that people would slavishly copy rules that would make a sport boring and hard to use to signal

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Date	Modified rules	Effects
1993	Give a warning through yellow card to players who deliberately delay the game, meanwhile the opponent carries out indirect free kick in the place of foul.	Make the match fluent and ornamental.
1998	The referee will show the red card to directly severely penalize those who maliciously foul with vile nature.	Guarantee the safety of players and encourage them to break through and attack.
1998	Standing on offside position doesn't foul. Players foul if they stand on offside position and obtain benefits.	Emphasize defense and encourage attack, promote the development of attack tactics.
2006	The referee may directly show the red card to penalize diving with vile nature.	Guarantee fairness of competition at the meantime make the competition fiercer.

Figure 1 (Dubourg et al.) Instrumental effects justifying rules modified by the international football federation (from You, 2017).

or train their physical skills. Taking back the authors' example, we propose that people who (copy people who) use their feet and not their hands, do it because it makes the game funnier and allows better display of gross motor skills.

2. Social etiquette

As the authors note, rules of etiquette also appear as purely arbitrary conventions, compliance to which is motivated solely by a "need to belong." Yet closer examination again suggests that their cultural design and preservation also obeys non-arbitrary, instrumental criteria. In a famous study, Nichols (2002) showed that, of the table manners promoted in etiquette manuals of the European Renaissance (see Elias, 1939), those that prohibited behaviors eliciting disgust (e.g., spitting) were more likely to have been culturally preserved to the point of being still part of contemporary social etiquette. Rules that didn't elicit disgust, by contrast, were more likely to go culturally extinct, presumably precisely because they appeared to people as more arbitrary (Nichols, 2002). If social etiquette was culturally preserved because of slavish, affiliative copying, etiquette rules should have been preserved whatever their content. Rather, what seems to have happened is that, despite their apparent arbitrariness, etiquette rules have stabilized because people perceive them (not necessarily consciously) as satisfying some intuitive goal, such as not imposing on others the unpleasant experience of being disgusted while eating (Baumard, 2016; Royzman, Leeman, & Baron, 2009).

3. Supernatural rituals

The authors also argue that magico-religious rituals, despite being oriented toward some instrumental goal (i.e., warding off misfortune), are socially learned through the ritual stance because of their "causal irresolvability." Yet a growing body of research suggests that the social learning of such cultural traits is mostly driven by instrumental inference. For example, Hong and Henrich (2021) present abundant historical and ethnographic evidence that people adopt (or not) divination practices primarily based on their evaluation of whether the latter "works" (or not) for revealing accurate information. People, moreover, "carefully discriminate among diviners according to perceived skill, ability, or success … in pretty much the same way as [they do for] any other artisans whose abilities can be evaluated by other community members" (Hong & Henrich, 2021, pp. 625–626). Hong, Slingerland, and Henrich (2022) similarly review historical evidence that, despite the apparent "exoticity" of rain-making rituals to modern people, early Chinese mostly adopted a "problem-solving," instrumental mindset toward rain-making methods, willingly abandoning – rather than slavishly copying – methods that seemed ineffective in making rain fall (see also Boyer, 2020; Fitouchi & Singh, 2022; Singh, 2021, 2018; for other examples).

4. Conclusion

To be clear, we do not deny that the ritual stance may, in the end, underlie the social learning and preservation of some arbitrary cultural practices. We also understand that, according to the authors, the ritual and the instrumental stances often coexist and alternate during social learning, in a "bifocal spectacle." Our point is simply the following: The fact that many conventions which initially appear as "ritually" acquired are in fact, on closer inspection, substantially shaped by instrumental inference, suggests that this may be the case for many other apparently arbitrary conventions – from weddings (see e.g., Boyer, 2018) to codes of conducts to initiation and puberty rites. If this is the case, the ritual stance should not be put on the same level of importance as the "instrumental stance" as a cognitive foundation of cultural evolution. As things stand, we doubt that the "ritual" part of human social learning is large enough, and causally powerful enough in driving cultural evolutionary dynamics, to justify a "*bi*-focal" theory of cultural evolution.

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Revisiting an extant framework: Concerns about culture and task generalization

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Abstract

The target article elaborates upon an extant theoretical framework, "Imitation and Innovation: The Dual Engines of Cultural Learning." We raise three major concerns: (1) There is limited discussion of cross-cultural universality and variation; (2) overgeneralization of overimitation and omission of other social learning types; and (3) selective imitation in infants and toddlers is not discussed.

The target article brings renewed attention to the complexity of cultural evolution and the many ways the instrumental and conventional/ritual stances complement each other. We look forward to the continued debate it will generate and encourage the authors to consider additional relevant literatures not covered in the current article.

It is well-documented that children will flexibly switch learning approaches based on the ebb and flow of changing social and instrumental motivations (Carpenter & Call, 2009; Over & Carpenter, 2012). Children's proclivity for doing so was highlighted in several overimitation studies (e.g., Herrmann, Legare, Harris, & Whitehouse, 2013; Legare, Wen, Herrmann, & Whitehouse, 2015) and then elaborated as the "Dual Engines of cultural learning" – an integrative account that outlines how the instrumental (innovation) and conventional/ritual (imitation) stances (Herrmann et al., 2013; Legare et al., 2015) can work in tandem to facilitate cumulative cultural evolution (Legare & Nielsen, 2015). The target article reiterates much of this theoretical framework, adding greater emphasis on rituals and cognition. We appreciate Jagiello et al.'s detailed explanation of relevant key concepts, but note omissions regarding cross-cultural generalizability issues, other types of social learning, and imitative flexibility in infancy and toddlerhood.

First, although some questions related to cultural factors are raised (target article, sect. 5), Jagiello et al. have not discussed extant theories and evidence of the ways cultural factors can influence the development of stance behavior. They mention that overimitation has been studied in a broad range of cultural groups (target article, sect. 3.1), but none of the cross-cultural study results are discussed. For example, imitative nuances between Ni-Vanuatu and US children in Clegg and Legare (2016) are neglected. Compared to US children, the instrumental stance of Ni-Vanuatu children involved higher fidelity, likely because of the population valuing conformity more than those from the United States (Clegg, Wen, & Legare, 2017). Similarly, within-population variation in Corriveau et al. (2017) is not mentioned. In that study, more Asian (but not Caucasian) American children opted for a conventional/ritual stance when social pressure was high. This risks perpetuation of a false assumption that high-fidelity imitation mechanisms across all populations are universal. Although children seem to generally display a propensity for high-fidelity imitation, its degree, underlying motivations, and contexts across different populations remain uncertain.

For example, overimitation studies conducted with hunter–gatherers in Africa reported mixed findings. Aka (Congo Basin) adults but not children displayed overimitation in a classic puzzlebox task (Berl & Hewlett, 2015). Hai||om children (Namibia) tended to overimitate only in tasks that involved tool-use (Stengelin, Hepach, & Haun, 2020). However, !Xun and Khwe children (Platfontein) replicated ritual-like actions with high fidelity (Nielsen, Tomaselli, & Kapitány, 2018). The underlying mechanisms and motivations for imitation among hunter–gatherer children should not be assumed to resemble those in other societies. They grow up in an egalitarian society, are given a high level of autonomy, and engage primarily in observational and peer-to-peer

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collaborative learning (e.g., Boyette & Lew-Levy, 2020; Lew-Levy et al., 2020). Their social dynamics contradict typical didactic, pedagogical interactions in socially stratified societies. How the bifocal stance theory (BST) may be applied to explain social learning of other forms, such as observational, collaborative, and explorative learning remains unclear (see Legare, 2017).

Second, "Instrumentality cues" under "schematic overview" (Fig. 1) covers overimitation but does not include the context of other imitation and conformity instances. Notably, many human learning scenarios do not necessarily involve causally opaque behaviors, but instead feature culturally unique methods, which are often arbitrary and less efficient (e.g., eating rice with chopsticks even when lacking experience and a spoon is available). The classic example of Sylvia's recipe (target article, sect. 2.1) also does not involve casually opaque actions (cutting both ends of the ham is causally transparent). High-fidelity copying in this case is driven by the arbitrariness of Sylvia's behavior, but not causal opacity (Gergely & Csibra, 2006).

Many social learning paradigms (including some cited in sect. 2.4.1) do not include causally opaque actions, but examine how children process the interplay between conventional and instrumental factors by manipulating effectiveness/optimality of the modeled approach (e.g., Corriveau et al., 2017; Dickerson, Gerhardstein, Zack, & Barr, 2012; DiYanni, Corriveau, Kurkul, Nasrini, & Nini, 2015; Fong, Imuta, Redshaw, & Nielsen, 2021a, 2021b, 2021c; Liszkai-Peres, Kampis, & Király, 2021; Schillaci & Kelemen, 2014), prior experience (Williamson, Meltzoff, & Markman, 2008), agent (Fong, Sommer, Redshaw, Kang, & Nielsen, 2021c; Sommer, Redshaw, Slaughter, Wiles, & Nielsen, 2021), presentation medium (Fong et al., 2021a; Strouse & Troseth, 2008), or time pressure (Fong, Imuta, Redshaw, & Nielsen, 2021b). Children's performance in these studies can be interpreted using the BST, yet we cannot assume social and cognitive mechanisms discovered in overimitation studies to be generalizable to these contexts.

Although the authors indicate that children differentiate between the ritual and instrumental stances based on behavioral measures beginning around age of 3, the target article is silent against flexible imitation in infancy and toddlerhood. Jagiello et al. describes "rational imitation" established in Gergely, Bekkering, and Király (2002) (target article, sect. 3.2) without considering that it was discovered in 14-month-old children. A substantial body of research suggests that infants and toddlers do not learn and copy blindly, but make decisions about who, when, and what to copy based on various contextual factors (e.g., Buttelmann, Zmyj, Daum, & Carpenter, 2013; Howard, Henderson, Carrazza, & Woodward, 2015; Woodward, 1998). For example, 18-month-olds tended to employ an imitative rather than an emulative approach only when the model was socially engaging (Nielsen, 2006). In Meltzoff (1995), 18-month-olds produced the target actions even after observing only failed attempts, instead of replicating the failures blindly. They also only did so when the demonstration was shown by an adult but not a machine. Does early flexible social learning serve as an early marker of the development of stance behavior?

Lastly, Jagiello et al. point out that while cultural learning research has focused on instrumental learning (innovation), it has paid less attention to high-fidelity transmission. Missed is noting how in developmental psychology the opposite is true, where there is a long history of investigation into children's developing imitative proclivities but study of their capacity for innovation may be considered an emerging field. Our understanding of cultural evolution will be richer with continued efforts at more fully integrating disparate fields of study such as these.

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The ritual stance does not apply to magic in general

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Abstract

Contrary to the author's proposed classification scheme, I argue that most magical practices are better viewed as "instrumental" rather than "ritualistic." Much ethnographic and historical evidence shows that magicians and ritual experts often have elaborate causal theories regarding how magic actions lead to the putative outcome, and the "physical/mechanical" versus "supernatural" distinction in causal mechanisms needs serious reconsideration.

While the overall classificatory system of cultural action proposed by Jagiello, Heyes, and Whitehouse is laudable, I am concerned about the portrayal of magic as "quasi-instrumental" and its grouping as ritualistic. Under their description, despite magic's explicit, overall goal, the causal mechanisms via which this goal is obtained by magical actions are "irresolvably" opaque in principle. That is, from the perspective of the observer, how magical actions achieve some worldly outcome has no knowable physical–causal pathway. This account of magic suffers from a major issue: Ample historical and ethnographic evidence shows that many magic practices are genuine instrumental efforts (Hong & Henrich, 2021) and the practitioners often believe that they possess the causal knowledge regarding how the putative outcomes are produced by their actions (Edmonds, 2019; Hong, 2022a). My study on Chinese rainmaking, for example, shows that ancient scholars have explicitly theorized the mechanisms of how specific "ritual" actions causes rain, and many rainmaking methods were the direct results of cosmological theories in a way not very different from modern engineers designing practical solutions to pressing problem based on their understanding of the causal nature of the problem (Hong et al., forthcoming). There is also a great deal of "experimentation" where people would try out different methods in an effort to induce rain, a key feature of the "instrumental stance" in Jagiello et al.'s) proposed bifocal stance theory.

A crucial aspect of individual's understanding of magic (or any technological practice) is that the knowledge of the exact causal mechanism via which action achieves outcome is often possessed by a few experts in the community, and lay people typically are aware of the existence of such experts to whom they turn when specialized help is needed (Kominsky, Zamm, & Keil, 2018). Jagiello et al. alluded to this sparingly in the target article, but I suggest that this knowledge distribution plays a much more important role in human societies. In a discussion of religious beliefs, Dennett (2006, p. 218) refers to this phenomenon as the "division of doxastic labor," where lay people do the believing, and defer the complicated understanding of the underlying religious dogmas to the experts. The same dynamics readily applies to magic: Lay people need only believe that a town should close its southern gates and open those on the north in order to induce rain (Snyder-Reinke, 2020), and leave the *yin-yang* theory that serves as its theoretical foundation to scholars and specialists. Importantly, the (often implicit) deference of causal understanding to experts may occur even when such expert knowledge is practically inaccessible, as in the case of ancient/lost knowledge (Hong, 2022b).

It is worth noting that such division of causal understanding is not restricted to religious cognition but rather a general feature of human cognitive life. In modern societies, few people understand the exact causal mechanism of how pressing a button on a remote control turns on the TV, yet most of us would agree that it is a purely instrumental action. This leads to my other concern which has to do with Jagiello et al.'s classification of causal mechanisms into the resolvable physical/mechanistic and the irresolvable supernatural. Although Jagiello et al. do not explicitly define "supernatural" in the target article, it is largely used to refer to actions that involve interaction with spirit beings. In section 2.4.2, they suggest that in order for the instrumental stance to be triggered, the action–outcome causal pathway needs to be *physical*, with the implication that people view physical (transparent, resolvable) and supernatural (opaque, irresolvable) causations as qualitatively different kinds of processes. While it is true that many magic practices do involve personalized spirits, there are two problems with this dichotomization. First, whether individuals themselves make this emic distinction is highly debatable (Lohmann, 2003; Weiskopf, 2020), with some authors suggesting that religious practices in small-scale societies are simply practical know-how, along with various hunting and gathering techniques (Dennett, 2006, p. 161). Second, even if we grant that this emic distinction exists, it is unclear why causal opacity of some mechanism depends on the presumed involvement of spirits. In fact, the logic behind petitioning to a deity is very straightforward and closely resembles that of asking for favors from a capable human individual (Horton, 1960). One may not only supplicate,

but also bribe and/or coerce the deities to achieve specific outcomes (Cohen, 1978). As such, the negotiation with these human-like entities can be a very creative process where action details are not blindly observed and reproduced; rather, they are understood as instrumental components to achieve the outcome and may be modified if circumstances demand (Hong et al., forthcoming). For example, in ceremonies that involve meat offerings to some deity, the animals to be sacrificed may change as a result of pragmatic constraints (McCauley & Lawson, 2002).

As Jagiello et al. rightly point out, the instrumentality or conventionality of an action lies in the eyes of the beholder, and the same cultural action may be interpreted either way based on the background knowledge of the observer as well as the contextual cues that happen to be present in the learning episode. Therefore, my arguments above are really to make the qualitative point that *most magic practices are better viewed as instrumental actions for most individuals in their communities most of the time*. Indeed, if we consider magical actions that do not explicitly involve spirits (e.g., classic Frazerian sympathetic magic), then its boundary with pseudo-science can be extremely fuzzy, as in the case of alchemy (Clements, 2017) and astrology (Thagard, 1978). I worry that stripping off the instrumentality from magic may lead researchers to misinterpret the genuine effort that people made in trying to explain, predict, and control worldly events (Horton, 1967).

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Psychological closeness and concrete construal may underlie high-fidelity social emulation

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Abstract

We compare bifocal stance theory's (BST) approach to social learning to construal level theory's (CLT) – a social-cognitive theory positing that psychological closeness to a model influences action-representation and thus modulates how concretely or abstractly observers emulate models. Whereas BST argues that social motives produce higher fidelity emulation, CLT argues that psychological closeness impacts cognitive construal and produces more concrete emulation across diverse motivations for emulation.

Jagiello et al. ask why and when do social learners engage in low- versus high-fidelity copying? What are the factors that influence the nature and degree of copying fidelity during social learning, and what are the cognitive mechanisms by which they do so? In this commentary, we connect and compare bifocal stance theory's (BST) answers to such questions with those of construal level theory (CLT; Liberman & Trope, 2008; Trope & Liberman, 2010), a social-cognitive theory that views psychological closeness to a model as a major driver of action representation and thus a modulator of how concretely or abstractly observers emulate social models (Genschow, Hansen, Wanke, & Trope, 2019; Hansen, Alves, & Trope, 2016; Kalkstein, Hubbard, & Trope, 2018; Kalkstein, Kleiman, Wakslak, Liberman, & Trope, 2016).

BST proposes that social emulation fidelity is largely influenced by which of two modes of observation, or stances, people adopt during social learning: The ritual stance, which is more detail oriented and produces more concrete, or higher fidelity emulation; or the instrumental stance, which is more outcome oriented and produces more abstract, or lower-fidelity emulation. Like BST, CLT also proposes that social emulation fidelity is influenced by how observers process the modeled behavior. CLT argues that any action or event can be processed and mentally represented at varying degrees of abstraction, or at different levels of construal (Gilead, Trope, & Liberman, 2020). Lower level construals (i.e., more concrete representations) focus more on how the action is performed and include specific details such as

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movements and gestures. Higher level construals (i.e., more abstract representations) focus more on why the action is performed and the end goals the action serves. Thus, lower level construals of the modeled behavior should lead to more concrete, higher fidelity emulation, and higher level construals of the behavior should lead to more abstract, lower-fidelity emulation.

While both BST and CLT posit that attention to more concrete versus more abstract aspects of a model's behavior influences social learning and emulation, the two theories differ in the psychological factors they focus on as antecedents to these different processing modes. BST focuses on learners' motivations – social/affiliative motives versus knowledge/skill acquisition motives. By contrast, CLT focuses on the degree of psychological closeness that observers feel to a model (Genschow et al., 2019; Hansen et al., 2016; Kalkstein et al., 2016). This work shows that increased psychological closeness to a model leads observers to construe the model's behavior at a lower level and engage in more concrete emulation, or literal imitation of the model. On the other hand, increased psychological distance away from a model leads observers to construe the model's behavior at a higher level and increases observers' tendency to emulate the model based on higher level, or more goal-oriented representations of the model's behavior. This effect of psychological closeness on level of emulation has been demonstrated across the four dimensions of distance identified by CLT – social (e.g., ingroup vs. outgroup members), spatial (e.g., models located in the same city vs. a distant city), temporal (e.g., models from a video recorded recently vs. over 10 years ago), and hypothetical (e.g., real vs. fictional models).

To be sure, psychological closeness factors in as a psychological variable within both BST and CLT. However, within BST, closeness is presumed to increase social motivations to affiliate with the model, which in turn promotes the adoption of the ritual stance and more concrete emulation. CLT, on the other hand, draws on extensive research documenting a basic relationship between psychological distance and level of construal (see Liberman & Trope, 2008; Trope & Liberman, 2003, 2010) to posit that a more general cognitive construal process may also be involved in the effect of psychological closeness on emulation. According to CLT, the tendency for increased psychological distance to promote more abstract processing of modeled behavior is a functional response to the cognitive challenge of learning across distance (Hubbard, Kalkstein, Liberman, & Trope, 2021; Kalkstein et al., 2018). As a model becomes more distant from oneself, the potential increases for the details surrounding their experience and behaviors to differ. Moving to a more abstract level of representation ensures that the lessons extracted from the model remain stable and applicable when transferred to the self. While borne out of functionality, CLT argues that this relationship between distance and level of abstraction has become overgeneralized in the mind such that it persists even when concrete details of a distant event are readily applicable to one's own circumstance. Colloquially, the central idea of CLT is that when immersed in processing close events, it is easy to get lost in the weeds and details of what one is observing; taking a step back and getting some distance away from the event can help observers see the bigger picture.

A general prediction that follows from CLT, but diverges from BST, is that *psychological closeness will increase concrete emulation and distance will increase abstract emulation across diverse motivations – both social and nonsocial*. Thus, CLT predicts that even when inspired by social motivations, emulation may become more abstract as those that one is seeking to affiliate with become more psychologically distant. Past research applying CLT to social learning has focused primarily on skill or knowledge acquisition and has left this prediction largely untested. However, it may be an intriguing avenue for future research.

Another unique prediction by CLT is that as our world becomes increasingly interconnected, and as people increasingly interact with and learn from distant and diverse others, rates of cultural innovation should increase (Kalkstein et al., 2018). This prediction draws on the general hypothesis that increased distance between a model and an observer decreases copying fidelity during social learning and thereby increases innovation during cultural transmission. On the other hand, high-fidelity transmission of traditions and rituals should be expected to persist most when those traditions and rituals are passed through socially and psychologically close connections.

Overall, we applaud the efforts of Jagiello et al. to integrate diverse social sciences on the important questions of social learning and cultural transmission. Here, we aimed to introduce the social-cognitive perspective of CLT to the discussion as it has many points of convergence with BST as well as intriguing divergent predictions.

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Confucius and the varifocal stance

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Abstract

We put the bifocal stance theory (BST) into dialogue with the Confucian approach to ritual. The aim of the commentary is two-fold: To draw on BST to provide an explanatory framework for a Confucian approach to social learning and, while doing so, to show how Chinese (Confucian) philosophy can contribute to debates in cultural evolution.

The idea of ritual as an integral aspect of life features prominently in the Confucian tradition, elements of which have been embraced by some East Asian societies for over 2,000 years. We see in the *Analects* (1965) (a pre-200 BCE multi-authored text capturing the lives of the early Confucians; see Nylan, 2014; Olberding, 2014) close alignments with the claim in the target article. Among these is the commitment to behaviours which strongly activate the ritual stance, that include relatively mundane behavioural conventions. In Confucian philosophy, appropriate ritual practices (*li* 禮) were to guide human interactions not only in the formalized contexts of official courts (e.g., *Analects* sects. 3.17–3.19), but also in daily life and domestic contexts (A2.5, 3.26). There is emphasis on both strict adherence to ritual (A3.17) and ritual's being indispensable in human relationality – and hence on ritual's centrality to human wellbeing (A2.3, 8.2). Ritual practices were closely aligned with music (*yue* 樂), both being important features of cultural evolution and human collaboration (A17.11; see Lai, 2003). Also in line with the target article's emphasis on flexible shifting between the ritual and instrumental stances, the Confucian approach to ethico-social learning encompasses and interweaves both stances: A person participates in social life via engaging in ritual but may at the same time forge new practices in being goal-oriented. In this way, individuals participate in and contribute to the ongoing evolution of their cultural tradition.

Approaching the role of Confucian ritual through the lens of the bifocal stance theory (BST) provides a new interpretive framework for understanding famously intriguing passages such as *Analects* 9.3. There, Confucius abandons the requirement of a linen cap at a ceremony, instead wearing one of silk (as silk was more economical) but, in relation to another ritual, he adheres to the traditional practice of bowing *before* he ascends the steps to an altar (as he deemed the emergent practice of bowing *after* ascending the steps irreverent). The flexible shifting between ritual and instrumental stances in BST thus aptly captures the way in which ritual in the *Analects* is not merely focused on compliance but on the continual development of cultural forms that enable human flourishing, and is thus open to ongoing evolution (Lai, 2006; Olberding, 2012).

In the exploration of Confucian ritual through BST, we also propose that Confucian ritual may serve as a helpful case study of BST in practice, prompting some questions about BST. It is likely that ritual has played a significant role in the successful transmission of Confucian culture across millennia; this is partly fuelled by Confucian ritual's being fundamental to, and partially constitutive of, human interactions and relationality. Here, we focus on two interrelated tensions that emerge when BST is placed in dialogue with the Confucian approach: The relation between the ritual and instrumental stances, and the tension between transmission and "tailoring."

The BST proposes that the ritual and instrumental stances are the mechanisms by which human culture is both transmitted in high fidelity, and evolves through innovations. These are presented as a binary, of flexible shifting between the two stances as a result of attending to different aspects of the learning environment. Nevertheless, the use of the "bifocal" metaphor indicates that one is either taking one stance or the other. And yet the authors also talk about "the flexibility with which humans alternate between varying degrees of high-fidelity copying and innovation" (target article, sect. 1, para. 3). This indicates that they have in mind something rather less binary than the bifocal metaphor suggests, with the stances having gradations within and between them that are activated in a context-sensitive manner. Perhaps we should think of the glasses through which the observer views others' actions rather as having *varifocal* lenses; lenses that have the ritual and instrumental binary at their extremes but a gradation between these, allowing the wearer to slip between degrees of the stances spontaneously, unreflectively and in quick succession. Such fluency is underscored in Confucius' adept handling of ritual such as we see in *Analects* 9.3.

Looking at how ritual is embraced in Confucianism can give us some conceptual tools for capturing the subtleties of the appropriate movement between stances in response to contexts. We have seen above that while it was important for Confucius to transmit ritual faithfully, nevertheless there is some place for innovation. But, more than this, Confucius seems to expect a measure of discretion in ritual behaviour. On one occasion he expressed disappointment that his followers engaged in culturally refined behaviours, but did not know how to tailor (*cai* 裁) their responses fittingly to the situation (A5.22). The Confucian tradition is acutely aware that such capacities, to tailor one's responses fittingly, need to be honed and cultivated (Cua, 1978; Lai, 2018; Li & Ni, 2014). The transmission of culture is not through those who mindlessly imitate or comply with ritual behaviours – what the text calls the "village worthy," who is a "thief of virtue" (A17.13, see also 6.13; see Slingerland, 2003, pp. 205–206).

A ritual is not merely performed; it is enacted within a community that embraces it. This makes rituals similar to communal memory traces, in that they are re-activated when retrieved and are therefore vulnerable to changes (insertions, deletions, etc.). Their transmission relies on a delicate balance between high-fidelity imitation and differences in each enaction; differences which are physical and temperamental, but also a result of tailoring the specific ritual to the relevant context. The entire process, moreover, derives legitimacy (or not) within the inherited cultural tradition. How should we understand this "tailoring" within the BST? Tailoring is not mere innovation. It seems to neither be quite captured by the ritual stance, nor the instrumental stance: While it takes place within the ritual stance it requires a context and goal-sensitivity that is more akin to the instrumental stance. Does tailoring therefore emerge as a function of the movement between the stances? Or should we perhaps be looking to include it as a new capacity in the cognitive gadget toolbox?

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What is the simplest model that can account for high-fidelity imitation?

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Abstract

What inductive biases must be incorporated into multi-agent artificial intelligence models to get them to capture high-fidelity imitation? We think very little is needed. In the right environments, both instrumental- and ritual-stance imitation can emerge from generic learning mechanisms operating on non-deliberative decision architectures. In this view, imitation emerges from trial-and-error learning and does not require explicit deliberation.

The target article raises many important questions about the nature of human high-fidelity imitation. We zoom in on two of them: (1) whether high-fidelity imitation is underpinned by generic learning processes such as associative or reinforcement learning; and (2) whether imitation depends on explicit deliberation or not. Here we sketch an account where a non-deliberative system is trained by generic learning mechanisms.

We adopt an approach based on building connectionist agent models. This approach complements that of the target article which mainly reviews empirical studies. In any such constructive approach it is necessary to select a computationally significant problem to solve. Here there are two: (1) transmission of complex skills and (2) establishing cooperation based on prosocial norms.

The specific models we consider are based on multi-agent learning algorithms developed by the artificial-intelligence research community. In these models, multiple agents co-inhabit a virtual environment resembling a computer game. The researchers can specify the physical dynamics of the simulated world, for example, irrigation is needed to grow crops. The agents process raw visual sensory information formatted as images. Using a deep neural network, they transform the raw sensory input at each moment in time through a series of intermediate representations into a low-level motor action (e.g., move forward, turn left, etc.). Behavior is temporally coherent because the network retains information about the past via an internal state representation. Various learning mechanisms can be used to train the neural network. Reinforcement learning is the most prominent but other approaches are also possible and it is common to use more than one simultaneously in the same agent (e.g., Jaderberg et al., 2016).

In *model-free* approaches to reinforcement learning, the algorithms do not infer internal models of their environment and do not include explicit planning. As such, they are often considered as models of habit-learning and automatization (Dolan & Dayan, 2013). They are associated with implicit and procedural forms of memory as opposed to declarative or episodic memory. Model-free agents are contrasted with *model-based* agents like Schrittwieser et al. (2020), which do employ explicit planning.

The first critical question is whether or not mostly unstructured *tabula-rasa* agents can transmit causally transparent skills from one to another. Several recent results suggest this is possible. It is now clear that in the right environment, imitation itself, both the tendency to engage in it and the skill at doing so, can emerge spontaneously from processes resembling trial-and-error learning in the presence of a demonstrator agent. These results were obtained using generic learning methods with no built-in inductive bias for imitation. Borsa, Piot, Munos, and Pietquin (2019); Ha and Jeong (2022); Woodward, Finn, and Hausman (2020), and Bhoopchand et al. (2022) all used model-free reinforcement learning. Ndousse, Eck, Levine, and Jaques (2021) combined reinforcement learning with inference of an internal model but did not use it for explicit planning. Thus all five results showcase emergent imitation based on non-deliberative processes. The learning mechanisms employed in these models are consistent with those posited by the associative sequence learning account of imitation (Catmur, Walsh, & Heyes, 2009). However, unlike associative sequence learning, where imitation may be either goal directed or not (Heyes, 2016), these models depend critically on the presence of a goal, which must be used to define the reward signal. Thus, in the language of the target article, such results show that generic learning mechanisms may underpin instrumental-stance imitation but not ritual-stance imitation where there may be no concrete goal.

The second critical question concerns whether generic learning mechanisms without any imitation-related inductive bias are sufficient to establish cooperation based on prosocial norms. Indeed, mirroring evolutionary models where individual fitness maximization cannot on its own explain the evolution of altruism, self-interested reinforcement learning agents do not cooperate in social dilemmas (Leibo, Zambaldi, Lanctot, Marecki, & Graepel, 2017; Perolat et al., 2017). Groups with prosocial norms however can resolve the social dilemmas they face. For instance, some norms – such as those regulating interpersonal conflict – elicit third-party enforcement patterns that once established have the effect of discouraging antisocial behavior.

In keeping with the target article, we regard ritual stance imitation as norm learning. Normative behavior has two main components: (1) enforcement and (2) compliance (Heyes, 2022).

Given a stable background pattern of enforcement, such as that provided by adults in a society, it is then easy for agents to learn compliance by trial-and-error because deviations from the norm are punished (Köster et al., 2022). One study endowed agents in a social dilemma setting with an intrinsic motivation to punish the same behavior as others in the group and found prosocial norms supporting cooperation sometimes emerged (Vinitsky et al., 2021). However, it is likely that an even simpler model would work where the shaped behavior itself involves punishing transgressions when they occur (a meta-norm). Therefore we conjecture, the same generic and non-deliberative learning mechanisms that can learn to imitate instrumentally could also learn to imitate for affiliation if applied in the right environment. Notice that this also implies copying fidelity should be higher for norm learning because it is based on punishment for deviation.

Of course none of these considerations mean that deliberation is never important for high-fidelity copying. All such computational modeling can ever show is that some mechanism is sufficient to generate some outcome. However, insofar as the argument for deliberateness rests on the apparent implausibility of the non-deliberative mechanism, then these results should be seen as weakening the case for deliberation's importance. Indeed there are numerous theories that treat deliberation largely as post-hoc rationalization of decisions made by other means (e.g., Haidt, 2001; Mercier & Sperber, 2017). The sufficiency of non-deliberative mechanisms for transmitting complex skills and norms lends support to these theories.

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Creativity and tradition: Music and bifocal stance theory

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Abstract

We argue that music can serve as a time-sensitive lens into the interplay between instrumental and ritual stances in cultural evolution. Over various timescales, music can switch between pursuing an end goal or not, and between presenting a causal opacity that is resolvable, or not. With these fluctuations come changes in the motivational structures that drive innovation versus copying.

We believe that music, as a model system of culture, offers a time-sensitive lens into the interplay between instrumental and ritual stances in cultural evolution. Music perception and production has been posited as a real-time, flexible form of creativity (Loui, 2018). As such, musical experiences can switch between pursuing and not pursuing an end goal. Musical actions can present a causal opacity that is at times resolvable, and at times unresolvable. With these fluctuations come changes in the motivational structures that drive innovation and tradition.

These motivational shifts unfold at various timescales. At the slowest timescale, consider the decades-long evolution of musical styles. Take jazz music: Rhythmic syncopation and the use of swing tempo are hallmarks of jazz. This signaling may have arisen from a causally transparent goal to create variation from its predecessor of ragtime, such as by Morton's re-recording of Joplin's "Maple Leaf Rag" (Temperley, 2004), which activated the instrumental stance. In the hands of a modern jazz performer, however, swing and syncopation are automatically adopted, or copied with high fidelity from "the greats" during jazz instruction. The use of syncopation and swing can be seen as ritualistic, as they are normative articulations of action sequences that signal one's membership as a jazz musician, as opposed to, for example, a classical musician. Here, over the course of decades, the shift from instrumental to ritual stances drives the production of music from innovation to cultural evolution.

At a faster timescale, social interactions in music-making unfold on the order of minutes. Many experiments in music

cognition have shown that a few minutes of moving in rhythmic synchrony with a partner leads to more prosocial behavior in children and adults (Cirelli, Einarson, & Trainor, 2014; Hove & Risen, 2009; Kirschner & Tomasello, 2010; Rabinowitch & Meltzoff, 2017; Stupacher, Witek, Vuoskoski, & Vuust, 2020; Tarr, Launay, & Dunbar, 2016). Applied to bifocal stance theory (BST), moving in time entails action sequences that activate the ritualistic stance, supporting social bonding (Savage et al., 2021). At an even finer timescale, the brain generates predictions that are continually tested with millisecond accuracy by incoming events on the musical surface (Vuust, Heggli, Friston, & Kringelbach, 2022). The dopaminergic system relates musical sounds to reward by learning from the systematic fulfillment and violation of these predictions (Salimpoor, Zald, Zatorre, Dagher, & McIntosh, 2015). Thus the acoustic and statistical properties of music help minimize prediction errors, freeing up attentional resources to be directed toward specific gestures embedded in observed actions, and activating more "type 1 processing" in social learners.

Studying imitation versus innovation in musical interactions where goal-relevance is rigorously controlled could provide an excellent test model for BST. Each of the pathways of the cultural action framework depicted in Figure 3 of the target article could be probed by musical interactions with child participants. For the first row, in which no end goal is present, children could enter a room with a drum, sitting across from an experimenter drumming a rhythmic pattern followed by pauses during which the child could join in. For the fourth row, in which the end goal is present, but causally opaque and unresolvable, children could be expressly told when they enter that they are trying to play a rhythm that will make a set of puppets dance. The experimenter would play the rhythmic pattern, after which a second, unseen experimenter would make the puppets move in a different rhythmic pattern. Again in this situation, the prediction would be that children's drumming would show high levels of exact copying of the rhythmic pattern drummed by the experimenter. For the second and third rows, the children would once more be expressly told that their goal is to play the rhythm that makes the puppets dance. But in the case of the third row, where the causality is opaque but resolvable, when the experimenter's drumming stops, the puppets will dance in the same rhythm as had just been played on the drum, rendering the relationship resolvable. The child could extrapolate the relationship between drumming and dancing to conclude that the puppet would move to whatever rhythm they play, resulting in more novelty and less copying in their own drumming pattern. In the case of the second row, the relationship between drumming and dancing would be made causally transparent by the puppets moving once per strike to the experimenter's drumming pattern as it is played. Here, the prediction is that children, fully aware of the mechanics of the interaction, would explore more with novel drumming patterns.

What makes music an especially useful domain within which to explore switching between the ritual and instrumental stance is that copying is a highly common, ecologically valid mode of interacting musically; music is characterized by more repetition at more different levels than speech (Margulis, 2014). Musical behaviors can be explored not only in the context of production, as in the examples above, but also in the context of perception. In the case of perception, copying behavior may consist of listening and relistening to the same song or exploring new ones. Consider the listening behaviors that adolescents adopt when they see their friends listening to certain songs outside the context of a specific end goal, versus when one is clearly present: Listening to hype themselves up for a party that night, or to increase focus during studying, or to help them lift heavier weights at the gym. The first case might inspire the teenager to cue up their friend's specific songs, whereas the latter ones might yield a wider range of choices, involving the exploration of new playlists designed for a similar function.

Makers and consumers of music with expressly functional roles – aiding relaxation, soothing infants, rallying troops – may adopt an instrumental stance when using it toward an end goal. In contrast, people who download and listen to the same music may not be able to resolve its causal mechanism. Thus, they may view it instead from the ritual stance, motivating the "copy all, correct later strategy" of overimitation.

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Activation of stance by cues, or attunement to the invariants in a populated environment?

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Abstract

While I agree with the distinction between *expedient* and *proper* ways of action, I find Jagiello et al.'s account of "stance switching" debatable. Fundamental to theories of cultural evolution is the fact that the shared environment is indefinitely rich, in which individuals are provided with opportunities for learning to tune themselves to specific affordances that are relevant to emerging situations.

The target article concerns the important distinction between two modes of attention in social learning: (1) attention directed toward the opportunities that afford expedient action (instrumental stance), and (2) attention directed toward the opportunities for action that are considered proper within a given culture (ritual stance). I agree with the idea that social learning involves these distinct modes of attention of individual learners, and that selection processes that shape the two modes of attention are of different nature (cf., Gibson, 1950). What I find debatable is the following mechanism of activation of stances assumed in the bifocal stance theory: Different saliences of end goals or causal structure trigger different motivational states in the minds of cultural learners – anticipation of social or non-social rewards – that activate one of the two stances and modulate the fidelity of transmitted action (Figures 1 and 3 of target article).

Consider the everyday context of mealtime. Mauss (1935/1973, p. 84) recounted that the Shah of Persia, the guest of Napoleon III, insisted on eating with his fingers. The Emperor urged him to use a golden fork. "You don't know what a pleasure you are missing," the Shah replied. The use of hands and fingers is often sufficient for transporting food to the mouth. In some cultures, however, an infant who is finger feeding would show willingness to abandon this effective strategy to transport food directly to the mouth in favor of the mode of feeding using a utensil, at sometime around the second year of life when the infant is still incapable of using the utensil for getting food (Nonaka & Goldfield, 2018). The following facts may be relevant to the present discussion. First, it is typically the infant who shows willingness to take the spoon in the caregiver's hand used for feeding the infant, prior to parental encouragement (Gesell & Ilg, 1937). Second, when the infant secures the spoon during mealtime, she tends to manipulate it in various non-goal-directed ways, waving arms with spoon in hand, scratching a table surface, and so on. Third, instead of inhibiting the infant's improper spoon use, the caregiver tends to organize the environment where such goal-irrelevant activities of the infant are tolerated (e.g., moving a cup with liquid out of reach), and keep feeding the infant while she is playing with the spoon. As the infant orients the spoon to the food, the caregiver would gradually introduce the opportunities for functional feeding encounters (e.g., steadying the dish so as to help the infant to get food on the spoon) (Nonaka & Goldfield, 2018). Fourth, sometime during the second year of life, the infant tends to persist in using spoon for food getting, in which attention is focused on process over outcome, and she may even return the spilled food to the spoon instead of putting it directly into her mouth. Mealtime behaviors of adults that children can observe are structured around the salient end goal with highly transparent physical–causal structure – the intake of food by bringing food to the mouth. Why would, contrary to the prediction of the bifocal stance theory, the transparent causal structure of mealtime behavior NOT activate the instrumental stance focused on the outcome (i.e., food intake), but instead focus infants' attention on adults' way of doing over the end goal (i.e., ineffective spoon use over effective finger feeding)?

It is interesting that in normal mealtime circumstances infants are, at least initially, not forced to act properly, or have no obvious external rewards for doing so. The question of interest is what motivates children to attend to those affordances of the environment (e.g., properties of the utensil) that are relevant to the specific setting of mealtime. The analysis of the social interaction of infant–caregiver dyads during lunchtime suggested the presence of two distinct streams of reciprocal informational coupling between the caregiver and the novice spoon feeder (Nonaka & Stoffregen, 2020): (1) Caregiver attentively adjust the action opportunities available on the table for infants, and infants actively look at the caregiver's hand (or a utensil in hand) acting on the objects in the environment. (2) After infants had actualized one or another affordance of spoon (e.g., ingestion of food or playful behavior), infants looked at the face of the caregiver more often than chance, as if to obtain the information about the "interpersonal self" (Neisser, 1988). These results seem to indicate that infants are concerned about the situation they are engaged in, actively exploring the information about that which matters in the mealtime situation. In addition, the fact that the flow of infant's attention is systematically coupled to the flow of caregiver's action implies that the interpersonal context provides the foothold for the infant's attention, who is actively developing a "nose" for the specific situation of communal practice (cf., Rietveld, 2008).

It is important to note that social norms are observable events in a populated environment that are as real and publicly verifiable as the sky turning red in the west at sunset. The opportunities are available for developing individuals to attune themselves to the multiple layers of invariants of the populated environment concerning both what they *can* do and what they *should* do in a specific situation. At the same time, the context of skill development frequently involves more than one individual, in which learners are exposed to the opportunities of their environment in a specific manner, according to the peculiar concerns shared within their community (Reed, 1993, 1996). Given the rich regularities manifest in the environment in which social learners find themselves, the theory about associations in the mind of learners seems superfluous (e.g., in terms of having an anticipation of social or non-social reward, activated by causal opacity, or salient end goal), for the individual is already immersed in the environment with rich regularities that can be potentially discovered (cf., Gibson, 1966). Rather, fundamental to theories of cultural evolution is the fact that the shared environment is indefinitely rich, in which individuals are provided with opportunities for learning to flexibly tune themselves to specific affordances that are relevant to emerging situations (Nonaka, in press).

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Bifocal stance theory, the transmission metaphor, and institutional reality

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Abstract

Biologists have replaced the metaphor of "genetic transmission" with a detailed account of the molecular mechanisms underlying the phenomenon which Darwin referred to as "like produces like." Cultural evolution theorists, in contrast, continue to appeal to "imitation" or "copying." The notion of ritual and instrumental stances does not resolve this issue, and ignores the institutions in which people live.

One of the observations which provoked Darwin to propose his theory of "descent with modification" was the phenomenon that "like produces like." Darwin named this phenomenon "inheritance" and wrote of characteristics being "transmitted" from one generation to the next, but confessed that he knew little about the mechanisms involved. With the Modern Synthesis (Huxley, 1942) "inheritance" became viewed as "genetic transmission" of characters, although Huxley argued strongly against what he called "the one-to-one or billiard-ball view of genetics" (p. 19) in which each trait in the offspring is assumed to reflect transmission of a single gene.

It is now known, of course, that genes are not literally "transmitted" from parent to offspring. In procreation, chromosomes are replicated by complex cellular machinery and then offspring self-assemble as those copies, shuffled in the process of recombination, become active in the equally complex cellular machinery of the egg cell. In other words, "genetic transmission" is a metaphor, and the actual molecular mechanisms that underlie "like produces like" are complex. In addition, as proponents of the Extended Evolutionary Synthesis point out, non-molecular mechanisms are also involved (Laland et al., 2015).

One would expect, then, that when supporters of cultural evolution theory write of the "transmission" of knowledge and values from one generation to the next (or within generations) they too would intend this as a metaphor. After all, they consider cultural evolution to be a "Darwinian evolutionary process" (Mesoudi, 2016). The phenomena which provoke the authors of this article are tradition and innovation, but although they declare, like Darwin, that they wish to identify the "mechanisms through which these [phenomena] are expressed" in fact this identification moves no further than the claim that two distinct "stances" underlie them.

Do these stances actually serve as an explanation? The authors tell us they are not stances in Dennett's sense of a "strategy of interpreting behavior" (Dennett, 1971), though how they differ remains unclear. The stances seem to function simply as intermediaries between two types of perceived action and two types of imitation. The instrumental and ritual stances are invoked, we are told, by ritual and instrumental actions respectively, or by the ritual and instrumental components of an action. There seems some circularity here. Instrumental actions are characterized by features such as salient end goals, action resolvability, and instrumentality. Ritual actions are characterized by causal opacity, conventionality, and normative language. In the case of the former, low-fidelity copying is the appropriate response; that is to say, imitation with innovation. In the case of the latter, high-fidelity copying is appropriate. This "selectivity" in the "degree of copying fidelity" is necessary, we are told, to be an "efficient social learner." All this leads the reader to suspect that the mechanism that is in fact offered to explain the two aspects of cultural evolution is the usual suspect, "social learning." It is "copying" or "imitation" or "mimicry," with either "low or high fidelity." In short, transmission.

Is imitation not an adequate explanation? What is wrong with proposing that one-to-one copying is the mechanism of social learning and cultural transmission? Principally because, as with "genetic transmission," it is only one part of a larger system. People do imitate each other, of course. But just as the replication – the copying – of genes requires a complex molecular apparatus, so too human imitation arises from a complex cognitive apparatus. Imitation does not stand alone. In Piagetian terms it is the primacy of accommodation within a larger process of equilibration. One might say that imitation functions as one component in a network of self-teaching, social focusing, and teaching-elicitation devices (Parker, 1993). "One-to-one" imitation alone cannot serve as an explanatory mechanism for social learning, let alone for the evolution of culture.

Since the work of Piaget, developmental scientists have accepted that individual learning is a matter of active construction of knowledge structures, with stage-like qualitative transformations. But if individual learning is so complex can we expect social learning to be simply imitation? That seems implausible, at best. Anyone who has taught knows that when students simply copy or imitate what they hear, their learning is superficial. To define social learning as "Information acquisition through interaction with- and observation of other individuals and their products" is to revert again to the transmission metaphor, thinly disguised as "acquisition."

The authors do promise to disclose the "cognitive underpinnings," the "underlying cognitive architecture," and the "distinctive motivations" of these two "modes of cultural transmission" (there it is again), and in particular "the level of deliberateness and domain-specificity" that is involved. However, bets on these particularities are hedged. The stances, we are told, may be innate or learned, automatic or deliberate, and domain-specific or general. It is also unclear whether they are cued by features of actions or are distinct ways of interpreting the same action.

Only two kinds of action exist in the barren world envisaged by bifocal stance theory: means-ends and affiliative actions. We would suggest that attention to the institutions, the institutional reality, in which all humans live would be helpful (Packer & Cole, 2021). Every instrumental action is conducted within one or another institutional setting. And institutions involve ceremonies which can appear to be mere ritual but are in fact procedures which confer rank, status, or role on a person or object. A student receiving a doctorate, the blessing that makes water holy, the marriage of bride and groom; all are institutional procedures which involve causality that is constitutive rather than instrumental, in the sense that a new entity is constituted by the procedure.

Attention to institutions would also invite a more nuanced approach to normativity. Norms are defined in this article as "mutual agreements on how members of a group ought to conduct themselves in various social contexts." But such an approach doesn't distinguish among promises, customs (we all bring a bottle to the party), role-obligations (teachers must evaluate students' work), and laws (drive on the left). Children understand institutions, and their normativity, in different ways at different ages, just as their understanding of instrumental causality develops.

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Action sequences, habits, and attention in copying strategies

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Abstract

Understanding how culture evolves in society is an extremely difficult task. The bifocal stance theory (BST) deploys two copying strategies which can be linked to dual-system theories of behavior. BST would benefit from incorporating results from these theories, such as the evolution of attention to goals or steps of a behavioral sequence, and the role of the environment in prompting different copying strategies.

In bifocal stance theory (BST), rituals and traditions are more likely to appear when end goals are less salient whereas instrumental stances appear when there is a causally transparent end goal. Copying fidelity is weaker in the latter, leading to innovation. This is an excellent idea. Here I want to talk about a few aspects that I think remain ambiguous or underdeveloped in BST based on what we know in the psychology and neuroscience of learning and decision making.

BST can be directly paralleled with the literature of goals and habits where a distinction is made between a conscious system that controls behavior in anticipation of goals, and a relatively unconscious system that controls habits which are automatically performed in the presence of certain cues, and independently of the current goal. In this framework, the goal of a social learner agent should be to observe, attend, and copy in accordance with whether she believes the observed actions to be goal-directed or habitual. Attentional resources are directed to causal structure and end goals in the former, but to each step in a chain of actions in the latter.

As proposed, a general issue with BST is the lack of specification of the conditions under which a social learner will ascribe causality and end goals to an observed behavior. To ascribe intentionality to other people's behavior, the learner needs independent evidence that the person is indeed performing the action in a goal-directed manner, which is not possible to obtain without knowing what the person will do when the causal link between the behavior and the goal is degraded, or the value of the goal modified (Perez & Dickinson, 2020). These belief and desire criteria were first proposed by one of the authors of the paper (Heyes & Dickinson, 1990), but are not considered in BST. Although it remains unclear how these criteria may be applied in social, non-controlled settings, finding natural experiments where the criteria could be applied should help elucidating the mapping between the features of certain sequences of behaviors and instrumental or ritual stances.

BST establishes a direct link between instrumental stances and innovation and proposes that they should be more likely to be observed the more transparent an end goal is. The experimental evidence suggests that when a behavioral sequence is continuously performed under similar conditions, attention to the goal diminishes and actions transition will be automatically performed, or become habitual. At this point, attention shifts toward the actions and so should be copying by others (Thrailkill, Trask, Vidal, Alcalá, & Bouton, 2018). It seems, therefore, that BST would predict at the same time continuous innovation and stable tradition, which is at variance with the fact that continuous innovation seems to be the rule, at least in modern societies (Schumpeter, 2014 [1942]).

Recent experiments in animals seem to agree with the hypothesis of BST that the salience of end goals should be critical for acquiring an instrumental stance. When animals are habitized

by training them for long periods of time until their attention is shifted away from the goal, changing the goal restores goal-directed behavior (Bouton, Broomer, Rey, & Thrailkill, 2020). Although changing the goal altogether is a somewhat extreme manipulation, it is not difficult to anticipate that random variations in the outcome of a stable behavior should produce changes in the outcome and reestablish instrumental stances that might have gone away once there was no variation in the consequences of the behavioral sequence. For example, a population might have been innovative in the creation of a canoe as the instrumental stance is prompted when there is significant trial and error at the beginning of the endeavor. As the canoe quality becomes optimal, there is little variation in the outcome and the actions performed, which shifts attention toward actions, prompting high-fidelity copying. Random variations in the outcome may thus lead attention to be directed back to the goal, and another period of instrumental copying should follow.

As presented, BST leaves as an outstanding issue the optimal temporal resolution by which behavior should be analyzed by a social learner. This opens a myriad of other issues which have been relatively well studied in psychology and neuroscience, such as the sensitivity to different reward schedules. It is now well established that these schedules can affect whether behavior is goal-directed or habitual. More precisely, the evidence suggests that the molar aspects of behavior seem to be considered by people when deciding to act on the environment in a goal-directed manner and that the molecular aspects are more important for behaving habitually (Perez & Dickinson, 2020; Pérez & Soto, 2020). So far, I know of no experiment in which molar and molecular aspects are encouraged by experimental manipulations, but it is likely that they will also play a role in how observers ascribe causality to actions and therefore imitate (copy actions) or emulate (copy intentions to obtain a goal).

Whether people imitate or emulate does not seem to depend only on the existence of causality and end goals, as emphasized in BST, but on aspects of the environment which are outside the control of the agent. Recently, Charpentier, Iigaya, and O'Doherty (2020) have demonstrated how the conditions of the environment prompt human participants to arbitrate between imitation and emulation depending on the reliability of each strategy. Imitation is more likely to be deployed when the environment is uncertain, such as when the outcome of a given behavior is difficult to predict. This is another critical factor in the neuroscience literature which BST should consider in further developments of the theory.

BST is an innovative and creative approach including aspects of anthropology, psychology, and ecology. Incorporating some of the topics discussed here should help it evolve into an even more comprehensive theory of cultural evolution.

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Considering individual differences and variability is important in the development of the bifocal stance theory

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Abstract

Jagiello and colleagues offer a bifocal stance theory of cultural evolution for understanding how individuals flexibly choose between instrumental and ritual stances in social learning. We argue that the role of culture, developmental age-related differences, and the intersectionality of these and other individual's identities need to be more fully considered in this theoretical framework.

In presenting their bifocal stance theory of cultural evolution for understanding how individuals flexibly choose between instrumental and ritual stances in social learning, Jagiello and colleagues review much of the developmental literature on copying strategies in social learning. They note attentional differences of the two approaches in facilitating effective social learning and selectively engaging in the most efficient degree of copying fidelity. We argue that despite a few minimal references to research with culturally diverse samples, the authors leave the role of culture, environment, and intersectional identities largely unexplored. Indeed, although Jagiello and colleagues note some differences across culture in social learning strategies, other research indicates that variability within cultures may be an important driving factor in how children navigate between the ritual and instrumental stances. That is to say, choosing whether to follow a ritual stance to achieve social affiliation may be a very different process for a child from a minority group than that of a child from the majority group within the same country. These differences may be further exacerbated by the intersection of the child's additional identities, which may impact the stance they take in learning from others. In addition to the lack of consideration of culture, the authors tend to look across a wide range of

ages with little note of developmental differences that may be present across these ages. We highlight the importance of each of these considerations below.

Children's preferences for social affiliation and learning have been shown to be influenced by their own racial identity and that of those around them, suggesting that both context and children's own identity are important to consider in their social learning even within cultures (Gaither et al., 2014). For example, in the United States, recent immigrants from China both copy actions, and transmit information, with higher fidelity than children who have lived in the country for several generations (Corriveau, Kim, Song, & Harris, 2013, 2017; DiYanni, Corriveau, Kurkul, Nasrini, & Nini, 2015). Similarly, the relation between children's high-fidelity copying of family members varies depending on a host of family contextual factors, such as the extent to which the family identifies as a religious minority within their culture (Cui et al., 2020; Davoodi et al., 2020; McLoughlin, Jacob, Samrow, & Corriveau, 2021). Parental authoritarianism also drives the way in which information is presented to young learners, and in turn, the weight children place on high-fidelity copying (Reifen Tagar, Federico, Lyons, Ludeke, & Koenig, 2014). Further, the degree to which children within a culture are exposed to racial out-group members influences their learning and socialization preferences (Chen, Corriveau, Lai, Poon, & Gaither, 2018). Taken together, these data highlight the important role of within-cultural factors that drive social learning decisions.

In addition to such within-culture variability, research has also highlighted important developmental mechanisms that impact children's employment of imitation and innovation. For example, children's willingness to engage in overimitation increases with age, with children as young as 23-months-old showing no tendencies to copy irrelevant actions (McGuigan & Whiten, 2009). Similarly, 5-year-old children were more likely than 3-year-olds to overimitate irrelevant causal actions rather than engage in more effective emulation processes, even when less information was presented (McGuigan, Whiten, Flynn, & Horner, 2007). Additional research has shown that these tendencies to overimitate continue into adulthood, with 5-year-olds and adults imitating irrelevant actions at more similar rates than 3-year-olds, suggesting that for older individuals imitation is an adaptive strategy to maintain task efficiency (McGuigan, Makinson, & Whiten, 2011). Such developmental differences are especially apparent when considering features of the model, such as age or prestige. When the model is an adult, rather than a child, older children and adults are significantly more likely to defer to her (McGuigan et al., 2011), even when the adult model proclaimed they did not know how to complete the task (Wood, Kendal, & Flynn, 2012; for a review see Over & Carpenter, 2012). However, other work modifying features of the model has found that older children are less likely to engage in imitation than younger children, for instance if the actions are performed by an antisocial ingroup member (Wilks, Kirby, & Nielsen, 2019). As such, these findings reveal important developmental differences that impact children's social learning strategies, as well as additional considerations about how identities of the model may intersect with those of the child.

Indeed, research has yet to fully consider children's intersectional identities and the role these play in how children selectively engage in social learning strategies. Some work suggests that children from non-Western cultures may follow different developmental trajectories with their over imitation being significantly reduced until they are older (Berl & Hewlett, 2015). Additional research across has alluded to gender differences in children's tendencies to overimitate but has found conflicting evidence in separate studies (Frick, Clément, & Gruber, 2017, 2021). Although some work suggests boys may imitate more than girls (Frick et al., 2017), another research using similar paradigms finds the opposite and suggests these gender effects may be interacting with age-related differences despite being unable to fully elucidate these mechanisms (Frick, Schleihauf, Satchell, & Gruber, 2021). Taken together, these data reveal some evidence, as well as important future direction, for considering children's multiple identities and contexts when exploring their social learning strategies.

In sum, the bifocal stance theory of cultural evolution to understand the flexible weighting of innovation and high-fidelity copying provides an important framework for situating and understanding this vast body of literature. We believe there are necessary considerations around variability within cultures and across developmental ages that warrant consideration. Future research on how these different factors intersect and influence children's social learning choices is imperative in fully understanding and using a bifocal stance theory of cultural evolution.

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Implications of instrumental and ritual stances for traditionalism–threat responsivity relationships

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Abstract

Jagiello et al.'s bifocal stance theory provides a useful theoretical framework for attempting to understand the connection between greater adherence to traditional norms and greater sensitivity to threats in the world. Here, we examine the implications of the instrumental and ritual stances with regard to various evolutionary explanations for traditionalism–threat sensitivity linkages.

Theoretical and empirical work links traditionalism with greater sensitivity toward threats in multiple domains (Claessens, Fischer, Chaudhuri, Sibley, & Atkinson, 2020; Hibbing, Smith, & Alford, 2014), including pathogens (Murray & Schaller, 2012; Samore, Fessler, Sparks, & Holbrook, 2021; Samore et al., 2022; Tybur et al., 2016), violence (Griskevicius, Goldstein, Mortensen, Cialdini, & Kenrick, 2006), and culturally transmitted information about hazards in general (Fessler, Pisor, & Holbrook, 2017; Samore, Fessler, Holbrook, & Sparks, 2018). Researchers have proposed that culturally and/or biologically evolved mental mechanisms may adaptively link traditionalism and threat sensitivity when traditional norms reliably ameliorate the costs of particular threats. Such linkages could result in stable dispositions over individual lifespans, and/or facultative adjustments in response to the frequency of threat cues. Given widespread variation in the extent to which people conform to traditions – and the connection with political preferences in large-scale democracies (Duckitt, Bizumic, Krauss, & Heled, 2010; Jost, Federico, & Napier, 2009) – understanding potentially causal antecedents of that variation has substantial real-world relevance.

The bifocal stance theory (BST) and cultural action framework advanced in the target article bear substantially on the question of how traditionalism and threat sensitivity may be connected, and provide a useful lens for bringing greater theoretical clarity to the potential evolutionary underpinnings of that connection. Specifically, the extent to which individuals adopt the instrumental versus ritual stance in response to traditional norms may structure the individual-level relationship between traditionalism and threat sensitivity.

One pathway by which the traditionalism–threat sensitivity relationship could obtain is if specific norms have culturally evolved to instrumentally address recurrent threats in the local environment. For example, in the face of pathogen threats, some traditional norms (those related to food handling, greetings, etc.) may effectively reduce the risk of infection (Murray, Fessler, Kerry, White, & Marin, 2017; Tybur et al., 2016). Per the BST, if individuals explicitly engage in the instrumental stance toward such norms, then threat-sensitive individuals will frequently adopt them. Even though these traditions' threat-mitigating mechanisms are resolvable (Whitehouse, 2011), not all individuals embrace them. Rather, adoption depends on the precise cost–benefit structure of a given tradition, and this varies across individuals and contexts (Gul et al., 2021; Samore et al., 2021; Tybur, Lieberman, Fan, Kupfer, & de Vries, 2020) – in part as a function of individual differences in threat sensitivity.

If, in fact, individuals assume an instrumental stance toward many threat-mitigating norms, then the observed correlation between traditionalism and threat sensitivity may reflect individual cost–benefit analyses on a norm-by-norm basis, rather than a general tendency to embrace traditions in the face of threats. The extent to which traditions writ large associate with sensitivity to a wide range of threats would thus depend in part on the frequency with which the ameliorating functions of traditional norms are perceived to be resolvable, and the frequency with which the norms, or observations of their enactment, trigger the instrumental stance.

Despite the instrumental benefits of some traditions in the face of particular threats, the causal mechanisms of cultural practices are often opaque (Henrich, 2011; Zwirner & Thornton, 2015), and this is true even when the underlying instrumentality is in theory resolvable (see sect. 2.4.2 in the target article). It is possible that, if a sufficient proportion of traditions are (accurately or not) viewed as instrumentally effective, whether within conscious awareness or not, more threat-sensitive individuals may more often make inductive bets (Barrett, 2015) that the cost–benefit structure of practicing traditions is favorable for them. However, although the proportion of a given culture's threat-relevant norms that are adopted via the instrumental stance is an empirical question, the apparent frequency of both causal opacity and perceived unresolvability suggests that the instrumental stance is unlikely to be the sole – or even the primary – basis of the threat-sensitivity/traditionalism association. Rather, this association likely largely arises via a greater tendency to adopt ritual stances and faithfully copy traditional practices as a function of threat sensitivity.

Consistent with Jagiello et al.'s perspective (see sect. 2.3 in the target article) on the possible functional logic underlying the ritual stance wherein rituals maintain cooperation, reciprocity, and social cohesion despite a lack of instrumental effect, the practice of traditional norms can indirectly mitigate threats by increasing social support. For example, endorsing traditions may signal in-group identity for the purposes of cooperation, and/or facilitate coordination via shared, long-standing markers (McElreath, Boyd, & Richerson, 2003). While the benefits of cooperation and coordination are diffuse, they plausibly include cost mitigation in the face of threats, for example by eliciting resource buffering and care during times of illness or injury; defense against hostile out-group

members; and so on. In this view, the indirect social benefits of traditional norms may loom larger in the (often unconscious) cost–benefit calculations of more threat-sensitive individuals. Greater threat sensitivity may thus associate with traditionalism via an increased tendency to adopt the ritual stance, leading to a broad embrace of the practice of traditional norms.

While the above questions are not yet settled, future research testing the proposed evolutionary link between traditionalism and threat sensitivity could benefit from adopting perspectives derived from BST, and attending to the pathways specified in the cultural action framework. Specifically, a deeper understanding of whether individuals adopt an instrumental or ritual stance in response to potentially threat-mitigating traditional norms – and the extent to which those norms are perceived as resolvable – may shed light on whether traditionalism and threat sensitivity are broadly linked as has been posited, or instead narrowly linked in particular circumstances when instrumental functions and causal transparency align. Of course, consistent with the ability for flexible oscillation between stances proposed by Jagiello et al., these possibilities are not mutually exclusive. Rather, the precise configurations likely vary across contexts at the level of the individual, group, and physical environment, among others.

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Cultural evolution is not independent of linguistic evolution and social aspects of language use

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Abstract

The bifocal stance theory (BST) focuses on cultural evolution without alluding to associated processes in linguistic evolution and language use. The authors briefly comment on language acquisition but leave underexplored the applicability of BST to linguistic evolution, to changes of language representations, and to possible consequences for constructing social identity, based on, for example, collective resilience processes within language communities.

Linguistic material (i.e., sounds, words) is subject to change. Such changes might be related to the instrumental or the ritual stance proposed in bifocal stance theory (BST), a relation not explicitly expressed in the target article. For example, the need to accomplish a specific communicative goal may drive a specific change or innovation in the language system that would be based on the instrumental stance. On the other hand, a language user's desire to affiliate with group members may promote

conventionalized communicative expressions based on the ritual stance. In the following, we expand on how BST might be able to link linguistic research to research in cultural evolution and social psychology.

Linguistic research has shown that analytically composed words or phrases contrast with opaque and holistic forms. This contrast is exemplified in the English past tense (Pinker, 1998). Here, the regular past tense (e.g., "Googled") contrasts with the irregular past tense (e.g., "slept," not "sleeped"). Regular word formation can be associated with the transparent communicative goal to express an action that occurred in the past. The goal is transparent because regular past tense forms accomplish "end-goals via potentially knowable causal pathways", as expressed in Jagiello and colleagues' theory. This "knowable causal pathway" is the symbolic language rule to suffix *-ed* to verbs, a rule that also applies to verbs that are newly added to the language ("to Google" → "he Googled"). From a BST perspective, regular forms are therefore related to an instrumental stance. By contrast, irregular verbs (e.g., "slept") do not undergo symbolic rule application; as such, there might not be a "knowable causal pathway" to that goal (i.e., the past tense form). The holistic nature of irregular forms therefore brings them closer to a ritual stance. The regular/irregular distinction is not the only one to possibly align with the instrumental versus ritual stance. It seems that all complex words without "knowable causal pathways" to their current form (e.g., ancient "thou" instead of "you") are more likely to be associated with ritual language, and thus, with the ritual stance. This also seems to apply to formulaic use of Latin (in Catholic tradition) and Old Church Slavonic (in Orthodox tradition) with forms not necessarily transparent regarding their meaning or origin.

If indeed processes related to the ritual stance are opaque and refer to holistic entities, independent evidence for the aforementioned linguistic parallel stems from research on analytical versus holistic ways of thinking (Nisbett, Peng, Choi, & Norenzayan, 2001). There, differences in cognitive processing are culture-specific with a broad distinction between analytical (combinatorial) and holistic (gestalt) thinking. These distinctions have specific repercussions for the respective cultures and societies. Notably, there is no strict dichotomy between Western and East Asian cultures based on these differences, but rather, language is a moderating or even predicting factor in these relations (Rhode, Voyer, & Gleibs, 2016). Rhode et al. (2016) suggested that the more pronounced holistic attentional bias in Korean compared to Chinese speakers depended on language rather than on culture. As BST proposes that the ritual stance relates to processes without a "knowable causal pathway" to a goal, holistic thinking seems to parallel the ritual stance, rather than the instrumental stance; however, depending on the goal to be achieved and depending on whether this goal is defined by language or by culture, the instrumental stance could theoretically also align with holistic thinking.

Differences within the language expressed by regular/irregular or analytic/holistic word forms also relate to differences in language-inherent resilience, akin to the relative stability of language representations. Frequent, irregular forms seem to be particularly resistant to language change (Lieberman, Michel, Jackson, Tang, & Nowak, 2007). Frequently used irregular forms are thus resilient to both regularization and forgetting. Lieberman et al. (2007) note that less frequent irregular forms are more likely to disappear or to be replaced by a regular form. BST might offer functional explanations for these phenomena. Frequently used irregular forms are conventionalized and their similarity to their historic roots demonstrates high copying fidelity, that is, transmission of linguistic material with relatively little change between older and more recent stages in linguistic history. As such, these forms better align with the ritual stance. At the same time, if irregular forms oppose the instrumental needs of a community (e.g., if a rule rather than a form conventionalizes), then these communities may readily dispense with these forms (and past tense forms altogether). This is evidence in the progressive loss of past tense (preterite) forms in younger German speakers (Fischer, 2018). This, in turn, could mean that resilience within the language system may have repercussions for language users.

Language representations correlate with language use within language communities (Behrens, 2009). Language use is one aspect of constructing social identity (Tajfel & Turner, 1979), whereby holistic thinking may further promote the strength of social identity (White, Argo, & Sengupta, 2012). Holistic cultures with an interdependent self-construal face threats "by activating and embracing their belonging to multiple groups." Analytic thinking cultures with an independent self-construal, on the other hand, focus on "protecting the individual self" (White et al., 2012, p. 252). Further, as Charbonneau (2020) concludes, faithful copying is inextricably linked to resilience processes. Thus, collective resilience processes in holistic cultures might be tightly knit to social identity. There, the ritual stance provides a relation to high-fidelity transmission of linguistic and extra-linguistic conventions, in turn fostering group coherence. Social identity theory and collective resilience processes therefore appear to be highly dependent on the two stances proposed by BST and need further attention in future studies to predict the resilience of threatened communities or even endangered languages.

In sum, extending BST to linguistic evolution, the cognitive architecture of language representations and social aspects of language use seems to be a fruitful endeavor for the cross-fertilization of interdependent research fields and traditions. It has the potential to promote not only interdisciplinary research but also more integrated views on cultural and linguistic diversity and how linguistic changes may relate to collective resilience.

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Non-instrumental actions can communicate roles and relationships, not just rituals

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Abstract

Actions that do not have instrumental goals can communicate social goals that are not rituals. Many non-instrumental actions such as bowing or kissing communicate a commitment to or roles in dyadic relationships. What is unclear is when people understand such actions in terms of ritual and when they understand them in terms of relationships.

When people take actions that cannot be understood as efficient means toward goals, observers often interpret the action as acts of communication. The target article focuses on one type of message that can be communicated in such situations: That the action is a ritual that defines a social group and that other groupmates should imitate such actions to maintain group cohesion and ingroup/outgroup lines. However, there are many cases where non-instrumental actions communicate another type of message: What kind of relationship the actor has with the target. For example, imagine you are observing two people who belong to the same group and are walking in one another's pathway. In one situation a person moves out of the way by stepping aside and continues walking. In another, the person bows deeply and then steps aside. While they both achieve the same goal of allowing the other person to pass, the second situation includes actions that are not necessary for achieving the goal of moving aside. How should the recipient of the action react to these two different actions? While we agree with the target article that the second action would be interpreted as social communication, we disagree it needs to be about marking ingroups from outgroups. The bower is going out of their way to acknowledge a specific type of relationship: a difference in rank exists. While this communicates something social, and indeed could communicate a desire for a relationship, it also communicates what kind of relationship those people have. In most cultures, the bower would be assumed to be lower ranked, while in some they may be assumed to be higher ranked (Kajanus, Afshordi, & Warneken, 2019). However, in either case the bowing does not need to be imitated for it to be meaningful for the bower, the person being bowed to, or the onlookers. In fact, most actions that communicate roles in hierarchical relationships are appropriately asymmetric.

There are many such actions including those that are cross-culturally salient, such as bowing, kneeling, gift-giving, and kissing, which are not efficient means toward instrumental goals, but also not meant to mark ingroups and outgroups by way of ritualized imitation. Instead, these actions acknowledge or establish certain types of relationships and relative roles within those relationships. Unlike actions that define group rituals, actions that communicate relationships can be asymmetric, and thus do not elicit copying. Indeed, many such actions may be an especially bad marker of ingroups because there are features of them that are shared across cultures. For example, in many cultures, lowering the body in an action communicates submission in a hierarchical relationship, and consensually transferring bodily fluids communicates an intimate or communal relationship (Fiske, 1992). Indeed, even infants recognize that a non-instrumental action that transfers saliva (putting one's finger in the other's mouth and then in one's own mouth) communicates a closer relationship than a similar action that does not transfer saliva (putting one's finger on the other's forehead, and then on one's own forehead; Thomas, Woo, Nettle, Spelke, & Saxe, 2022): Infants predict that the recipient of the saliva-transferring action is more likely to respond to their social partner's distress, compared to the recipient of the forehead action. Neither of these actions has an obvious instrumental goal, and no imitation occurs in the study, yet infants use them to predict other actions associated with close affiliation or social intimacy. In summary, non-instrumental actions have social meanings, but not all such meanings concern rituals to mark the ingroup from the outgroup. This has implications for the cultural action framework proposed in the target article. In this framework, actions that have no obvious instrumental goal and that are causally opaque nudge observers into a "ritual stance." However, if our proposal is correct, then these same attributes should sometimes nudge observers into something like a "relationship stance" where observers understand these actions as ways to communicate social relationships and roles within those relationships.

The critical question for future research is: How do people, including even infants, identify the relevant one, of the many possible, communicative goals of non-instrumental actions? When does a person interpret non-instrumental goals as ritual, when do they interpret them as a desire to communicate about a relationship, and when do they write off the action as meaningless? One possibility lies in proposals by Fiske (1992); Kaufmann and Clément (2014); and Thomsen and Carey (2013). These proposals suggest that infants are born with core concepts that allow them to recognize certain types of relationships, including the actions that go along with them. If this is true, then infants and children may be attuned to interpret *other* non-instrumental actions, which do not fit into these categories, as rituals, especially when they are imitated. While many rituals often "borrow" actions that would be a part of this innate repertoire, culturally specific rituals often include other arbitrary actions and symbols. For example, take the Catholic ritual of crossing oneself. Catholics often kneel while crossing themselves. Kneeling or making yourself small is a common marker of deference, indeed shared with

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other species (van Vugt & Tybur, 2014). Here the kneeling may serve to communicate deference to God. However, Catholics also cross themselves in a specific way. While the action carries meaning, it wouldn't be easily understood by someone who had never seen it before or didn't understand the context. It is an arbitrary symbol. Thus, new humans may solve the complex problem of understanding people's non-instrumental actions, first by asking whether they communicate about relationships and roles, then by computing whether they fit the structure of innate concepts of social relationships. If not, infants may then interpret them as ritual actions, especially when imitated. The bifocal stance theory could therefore be expanded to include non-instrumental actions that are meant to acknowledge or communicate desires for specific types of relationships or roles within them.

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On the evolutionary origins of the bifocal stance

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Abstract

In this commentary we advance Jagiello et al.'s proposal by zooming in on the possible evolutionary origins of the "bifocal stance" that may have enabled a major transition in human cultural evolution, arguing that the evolution of the bifocal stance was driven by an explosion in cultural complexity arising from cooperative foraging, which led to a feedback loop between the ritual and instrumental stances.

Jagiello, Heyes, and Whitehouse offer an exciting proposal for a theoretical unification of work in cultural evolution on both high-fidelity transmission of knowledge and the production of innovations. Not only does their *bifocal stance theory* (BST) mimic Daniel Dennett's highly successful attempt at building a theoretical framework for the study of thinking about other minds (the intentional stance; see Dennett, 1987; Veit et al., 2019), but it also provides us with a decidedly teleonomic framework. Indeed, they offer us an evolutionarily plausible explanation for why the mimicking of causally irrelevant behaviour can itself be explained in an adaptive way, rather than just seeing it as a by-product of the copying of successful actions by others. We find these features of their account extremely compelling as a pathway to bring together the diversity of work on cultural evolution, showing that rather than having one type of cultural learning arise only as a by-product of the other, both can be seen as adaptive in their own right.

Our goal in this commentary is to further advance their proposal by zooming in on the possible evolutionary origins of the bifocal stance, which may have enabled a major transition in human cultural evolution. As Jagiello et al. recognize at the end of their article, "the bifocal stances […] may hold the key to understanding the evolutionary origins of human uniqueness" (target article, sect. 6, para. 1) and it is this idea that we want to focus on here, because the authors themselves appear to treat this as the greatest potential of their theoretical framework.

The BST describes two different stances agents can take towards social and cultural learning. The first is the instrumental stance, which focuses on the accomplishment of end goals and allows for innovation to achieve these ends, and the ritual stance, where the focus is on affiliation with group members, and through which high-fidelity transmission takes place. As the authors note, the truly unique part of the bifocal stance is the second of these. The ability to learn socially is fairly widespread throughout many species of mammals and birds, and potentially even some invertebrates (Whiten, 2019). This appears to be via the instrumental stance, where animals are focused on the end goals. However, what is not seen in other species is the behaviour of "overimitation," in which causally irrelevant idiosyncratic aspects of a behavioural sequence are also copied. This ability, a signifier of the high-fidelity copying associated with the ritual stance, appears unique to humans; while other animals typically ignore behaviours that are unrelated to the goal (Horner & Whiten, 2005).

Humans appear to have the ability to adopt these two different stances towards social learning, along with an acuity towards identifying situations in which innovation matters more than cultural fidelity and vice versa. What, then, is the unique feature of human social life that has allowed for the development both of the ritual stance alongside the more common instrumental stance,

and the bifocal stance that allows flexible switching between both? We think that light can be shed on this question through an investigation of how it may have emerged in our hominid ancestors. Following Sterelny's (2012) account of the evolution of human cognition, which emphasizes feedback loops between learning, environmental scaffolding, and cooperative foraging, we maintain that the evolution of the bifocal stance should be understood in the context of cooperative foraging. This type of social arrangement creates unique pressures and opportunities that can support the development of both types of cultural learning, as well as the ability to move between them as appropriate.

Successful cooperative foraging can provide a surplus under which investments into cultural learning can be sustained before they inevitably have to pay off. Elsewhere, one of us has argued that it is in this context that we can understand the evolution of resolve as a means to enable interpersonal exchange (Veit & Spurrett, 2021). Here too, the value of the instrumental stance increases. With sharing and trading becoming a central feature of the lives of our early hominid ancestors, there was a need to evolve both motivation and attention towards keeping track of the instrumental value of different actions, which could be scaffolded to promote a greater awareness of the instrumental value of both behavioural innovations and other people's actions. With more complex foraging methods, the value of learning and innovation also increases, further expanding the human foraging niche. However, importantly, this also has the potential to have facilitated the development of the ritual stance. Human societies are unique in the degree of reliance of individuals on the community. Under these conditions, the risks from social ostracism are much higher, as it would be near impossible for an individual to survive in isolation. As the authors have demonstrated, the salience or threat of social ostracism seems to lead into the ritual stance, where copying fidelity increases. In general, as the rewards of social cohesion increase, along with the costs of ostracism, we should expect to see the elaboration of the ritual stance; and this is precisely what occurs with the rise of cooperative foraging.

Cultural learning is far more complex in humans than any other species, seemingly responsible for many of the features we take to be unique about human cognition and societies. Although other animals, particularly some nonhuman primates, show some forms of social learning and cultural transmission, right now it appears that only humans are capable of the high-fidelity copying that arises from the ritual stance, and of moving flexibly between the different types of learning as need suits. We suggest that it is through the emergence of cooperative foraging, and the unique selective environment thus created, that the bifocal stance will have truly come into its own, creating feedback loops that have led to its current form.

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Representational exchange in social learning: Blurring the lines between the ritual and instrumental

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Abstract

We propose that human social learning is subject to a trade-off between the cost of performing a computation and the flexibility of its outputs. Viewing social learning through this lens sheds light on cases that seem to violate bifocal stance theory (BST) – such as high-fidelity imitation in instrumental action – and provides a mechanism by which causal insight can be bootstrapped from imitation of cultural practices.

According to bifocal stance theory (BST), how faithfully someone imitates depends on their goals. We copy actions faithfully to affiliate with others or to highlight our membership in a group (the "ritual stance"), but selectively copy only what is necessary to achieve instrumental goals (the "instrumental stance"). We agree that social learning can serve both affiliative and instrumental ends. However, we disagree that high-fidelity copying is necessarily triggered by non-instrumental goals. Humans can perform a variety of computations to learn from others, from faithfully copying others' actions to inferring the values and beliefs that caused them. Collectively, these computations trade off the cost of performing the computation against the flexibility and compositionality of its outputs. Understanding social learning through the lens of this trade-off can guide theorizing about when high-fidelity imitation and mentalizing may be deployed toward the same goal, and provides a mechanism by which causal insight can be bootstrapped from faithfully transmitted cultural practices.

A general principle of intelligent behavior is to use simple methods whenever possible and more complex strategies when necessary. An emerging framework has framed the arbitration between simple and complex strategies as a resource-rational trade-off (Lieder & Griffiths, 2020). Much like a thrifty shopper or an efficient long-distance runner, adaptive organisms should not only maximize rewards, but also account for the cognitive costs of different strategies. While resource-rational adaptations have been widely studied in the context of individual decision making (Kool, Gershman, & Cushman, 2018; Shenhav et al., 2017), we propose that a similar trade-off exists in social learning (Wu, Vélez, & Cushman, 2022).

To illustrate this trade-off, suppose you are watching your friend bake baguettes. As she pops the loaves into the oven, she pours boiling water into a skillet on the bottom rack. There are several ways that you could learn from this observation. First, you could directly imitate this action the next time you bake baguettes. This may quickly improve your technique, at the cost of flexibility: You may continue copying this action even when it is unnecessary or maladaptive. Alternatively, you could try to infer *why* she performed that action. For example, you could infer she used the boiling water to create steam, because steam gives bread a crunchy crust. Inferring the goals and beliefs driving your friend's actions is more costly than simply copying her, but it affords increased flexibility. The next time you bake bread yourself, you could use this insight to find alternative solutions to the same goal (e.g., by spraying water on the loaves) and to skip it when it is not needed (e.g., when baking soft, chewy breads).

What distinguishes these possibilities is not the observer's goal, but whether the benefits outweigh the computational costs. This trade-off helps identify cases where high-fidelity imitation is not only possible, but even preferable to mentalizing in instrumental contexts. If you are baking bread for the first time, or operating a complex and expensive MRI machine, you will likely maximize your rewards (and avoid catastrophic costs) by strictly following procedure.

Just as high-fidelity imitation can sometimes be beneficial to instrumental action, this computational trade-off can also guide theorizing about contexts where strategic innovation may be deployed in ritual. For example, medieval charms often required certain words to be invoked verbatim, but allowed ingredient substitutions (Luft, 2020). One charm for curing rabid dogs involved buttering a slice of barley bread ("or if you cannot get that [type of bread], take another") and writing ritual words on it before feeding it to the dog (Leach, 2022). It is possible these deviations from ritual were guided by intuitive theories about which aspects were causally relevant – perhaps the charm depends on the words, but not on the type of bread on which they are written. Indeed, recent work suggests that modern adults' judgments about magic, such as the difficulty of a charm, are governed by intuitive theories of how the real world works (Lewry, Curtis, Vasilyeva, Xu, & Griffiths, 2021; McCoy & Ullman, 2019). While we agree that rituals serve an important affiliative function, these examples raise the possibility that rituals have their own causal logic and may allow a greater degree of behavioral flexibility than accounted for in BST.

So far, we have identified cases where observers may use high-fidelity imitation or mentalizing in the service of the same goal. This flexibility also provides a mechanism by which causal insights can be bootstrapped from faithfully transmitted cultural practices, thus blurring the lines between ritual and instrumental actions. Returning to the baking example above, you may assume that your friend's technique is the result of rational planning – that is, that she understands why each step in the recipe works and has arrived at her technique through deliberate utility maximization. But this is often not the case. The chemical reactions involved in bread-baking are sufficiently opaque that even a seasoned baker may faithfully copy a technique out of habit or conformity to cultural norms, without understanding why it works. If an observer were to then impute beliefs and rational planning to the demonstrator where there were none, they would be constructing a fiction – a "rationalization" of the demonstrator's behavior (Cushman, 2020).

This fiction can be quite useful. Technologies are often adopted and refined long before we discover why they work (Henrich, 2015). For example, the bark of the cinchona tree was used to treat malaria for centuries before its active ingredient, quinine, was first isolated and its pharmacological mechanism understood (Achan et al., 2011). Rationalization provides a means of representational exchange across different forms of social learning, enabling observers to extract generalizable, causal insights from cultural practices. This exchange may enable observers to innovate by design, by re-examining and refining long-held practices using their current internal models of the world.

In sum, beyond faithful copying, humans have access to a variety of cognitive capacities that enable us to learn from others. These capacities can be flexibly deployed and can support one another through representational exchange. Viewing social learning through the lens of computational trade-offs paints a more dynamic, agentic picture of how humans build culture.

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Tradition–invention dichotomy and optimization in the field of science

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Abstract

The central idea of the bifocal stance theory (BST) by Jagiello et al. has substantial relevance to scientific research. Both tradition-following and exploration-innovation are important in science and researchers subconsciously try to optimize their strategies. We outline three important dimensions of this optimization and argue that attempts to understand this complex process can help us design better science education, research training, investigation, and science publication.

The dichotomy between following tradition versus innovating and the ability to switch between the two as described by Jagiello et al. is very much central to the pursuit and progress of science. Science is not discovery and invention alone. A substantial part of the practice of science consists of following tradition more or less unquestioned. Innovation in the right place and right proportion would facilitate healthy progress of science. Very parallel dichotomies exist at different levels of science. Thomas Kuhn's "normal science" versus "revolutionary science" (Kuhn, 2020) is a dichotomy very parallel to bifocal stance theory (BST) albeit at a different level.

Jagiello et al. further recognize the importance of optimization between the two strategies. However, they have not sufficiently explored the underlying evolutionary principles of optimization. A working scientist needs to optimize tradition–innovation. The complex process of optimization is influenced by multiple factors including innate human behavior, culture, belief systems, social structure, economics, education, and prevalent academic systems. Much is being talked about flaws, biases, misconduct, reproducibility crisis, and conformity in today's science out of which conformity bias is directly related to BST (Padalia, 2014; Weatherall & O'Connor, 2021) the roots of which are claimed to lie in evolved neuro-behavioral mechanisms (Germar, Albrecht, Voss, & Mojzisch, 2016; Morgan, Laland, Biele, Yoon, & Burke, 2012; Watve, 2017, 2019). It is possible that insights into the details of the subconscious optimization models of researchers will allow us to design the education, training, institutionalization, and organization of science practice toward healthy, unbiased, and rapid progress of science.

An oversimplified model of optimizing tradition–invention is the snowdrift game (Sasaki & Okada, 2015). If two cars are stuck because of a snowdrift, either or both the drivers can get down and shovel the snow to clear the path. If one is shoveling the snow, the other can very well sit in the car and enjoy the benefit, saving personal cost. Tradition is more likely to be a strategy of the driver sitting in the car. Innovator is the other driver taking the risk and efforts. Although innovation is considered desirable in science, the history of science has many examples where innovation faced rejection (Tröhler, 2005; Weatherall & O'Connor, 2021). Exploration or invention can be assumed to have higher risk, with some chance of giving high return. However, if successful, others can imitate the new trait and get the fruits of the invention. By the snowdrift dynamics, the cost–benefits of the alternative strategies are frequency dependent and the equilibrium lies in co-existence of both strategies. The reaction norm of frequency dependence will be the main determinant of the optimum combination. Real-life contexts are almost always more complex than classical theoretical games, but it is possible to refine the models contextually. The design of and the norms followed by academia would influence the parameters of frequency–cost–benefit relationship in a complex way and insightful research is needed to understand these reaction norms.

The other dimension of real-life complexity is that novelty or departure from tradition is not a binary but a continuous variable. Therefore, the question of interest is how much of innovation is optimum in a given context. Making innovation as a continuous variable demands an entirely different class of optimization models. There is likely to be an optimum novelty that maximizes the probability of acceptance by the community. So far there has been little effort to explore this possibility theoretically or empirically.

The third dimension of the complexity is differential individual propensity to innovate. Individual differences can arise partly from frequency-dependent selection. Not only humans have differences in individual creativity with a neurological basis (Beaty et al., 2018), differential propensities as well as contextual flexibility are also known in animals. In animal models, the individual-learning strategy is often determined by their behavioral type ("personality"), age, social rank as well as social interactions (Coussi-Korbel & Fragaszy, 1995; Laland, 2004). For example, in European starlings (*Sturnus vulgaris*), dominant individuals are less neophobic and thus learn a novel task quicker than subordinate group members (Boogert, Reader, & Laland, 2006) while in jackdaws (*Corvus monedula*), dominant individuals are far more likely to monopolize resources leaving little opportunity for subordinates to learn individually (Federspiel, Boeckle, von Bayern, & Emery, 2019). However, in archerfish (*Toxotes chatareus*), only the personalities of individuals predict their learning propensity and not the social ranks (Jones, Spence-Jones, Webster, & Rendell, 2021). Within an individual, the choice between asocial learning, social learning, and innovation is flexible. In a given context, the choice depends on the cost of asocial learning, reliability, and usefulness of social information and the certainty of one's own information (Kendal, Coolen, van Bergen, & Laland, 2005; Laland, 2004). Thus, when learning by experience is costly (e.g., predator recognition and evasion, poisonous foods) or when the prior information possessed by the individual is unreliable (e.g., foraging in a heterogeneous or new patch), they resort to copying others. On the other hand, when both social and individual information is unusable, innovations are expected to occur. The same principles can apply to rituals where the perceived cost of learning through exploration or innovating changes with context, individual traits, and social standing. Certain trends in copying others also depend on the social ranking. In chimpanzees an innovation by high-ranking individuals is copied more readily by others as compared to one by a low-ranking individual (Biro et al., 2003; Kendal et al., 2015).

It is very likely that the ability to judge the context-specific parameters has evolved to very fine levels in humans which contributes further to the variance in innovativeness. But this complexity remains underexplored. The three dimensions of complexity, namely frequency dependence, continuous nature of innovation, and individual propensity need to be investigated using theoretical as well as empirical tools. The field of science and the process of research has not been studied from a behavioral perspective barring a few attempts (Chapman et al., 2019; Watve, 2017, 2019). BST is likely to be the platform on which to initiate the process. Understanding this complexity, at least in part, will help us design better science education, research training, research environment, and science publishing.

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Conformity versus transmission in animal cultures

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Abstract

The principal contrasts that Jagiello et al. highlight are among many cultural transmission biases we now know of. I suggest they are also reflected more widely in social learning decisions among nonhuman animal cultures governing whether cultural innovations spread, or are instead over-ridden by immigrants' conformity in their new group. Such conformity may serve either informational or social-integrative functions.

Jagiello et al. pose a welcome and important question that cultural evolution research has yet to realistically answer: What causes "some traits to change within a few generations while others retain their form and stability for millennia"? (target article, sect. 1, para. 1). The authors offer some compelling but only partial answers: Their metaphorical bifocals are constrained by some tunnel vision.

One aspect of this is the exclusive focus on human culture. In recent decades, the transmission of cultural practices across populations and generations has been documented in mammals, birds, fish, and insects, as well as many different domains of behaviour, from tool use to vocal repertoires (Allen, 2019; Aplin, 2019; Whitehead & Rendell, 2015; Whiten, 2021). As in humans, at least one sex disperses at maturity, avoiding incest, so when an animal possesses cultural knowledge lacking in the community it enters, the contrast quoted above is in play. Will the individual display and thus potentially spread the cultural innovation concerned, or will it instead conform to existing local customs? And *why the difference*? In chimpanzees for example, cultural transmission may occur, as in the between-community spread of using a fine probe to fish ants from under tree bark (O'Malley, Wallauer, Murray, & Goodall, 2012), whereas in other cases conformity overrides this, as when female immigrants to new communities adopt local ways of using natural hammers to crack nuts (Luncz & Boesch, 2014).

Jagiello et al. assert in their abstract that "studies of cultural learning have tended to prioritize instrumental learning … over conformism and the preservation of conventions." But recent research has revealed that conformity is widespread in animal cultural transmission – one of several adaptive biases in social learning (Kendal et al., 2018). In a recent review (Whiten, 2019a) I distinguish three main forms of conformity, the most basic being copying majority preferences in one's social world. A second, more intense manifestation is "conformist bias," in which an individual witnessing a certain majority (e.g., 70%) preference for some behavioural option displays an exaggerated disposition to adopt it (e.g., 90%). The other intense kind of conformity I labelled "Aschian conformity" which involves an individual abandoning their existing preference or behaviour in favour of an alternative observed in a majority of others. In chimpanzees we have evidence for both the first (Haun, Rekers, & Tomasello, 2012) and third of these (Watson, Lambeth, Schapiro, & Whiten, 2018) – and not only in apes (Aplin et al., 2015). Identifying the second type requires large populations but we have such evidence for birds (Aplin et al., 2015) and insects (Danchin et al., 2018).

All have been identified in humans of course. My point is that the very particular focus of Jagiello et al. on ritual as a context for conformity neglects the probability that such phenomena likely did not arise out of the blue but instead built on phenomena widespread in our species' evolutionary past. Social psychologists distinguish prescriptive (or injunctive) conformity from

descriptive (or statistical) conformity (Lapinsky & Rimal, 2005). It is the former on which Jagiello et al. focus ("one should do X"). We have yet to see compelling evidence for this in nonhuman species: The forms of conformity in nonhumans outlined above seem consistent with merely statistical conformity. However, Eriksson, Strimling, and Coultas (2015) showed that people readily generate injunctive norms from observation of mere statistical majorities among their companions. A corresponding process may plausibly have occurred on organic or cultural evolutionary timescales.

There is a further potential parallel in animal culture concerning the distinction that Jagiello et al. focus on, between conformity (and over-imitation) serving informational versus social-integrative functions (Deutsch & Gerard, 1955). For example in a field experiment with wild vervet monkeys, van de Waal, Borgeaud, and Whiten (2013) found that 9/10 maturing males who had lived in groups that had learned to eat just one of two coloured provisioned foods quickly conformed to the opposite preference they witnessed on migrating to a new group. An informational function might be that the local monkeys know the best local choices so they should be copied; an alternative socio-integrative hypothesis is that by acting like the locals, incomers will be accepted the sooner. Experiments have shown that a person who imitates a monkey is later likely to elicit more affiliative responses than another who does not imitate it (Paukner, Suomi, Visalberghi, & Ferrari, 2009). That the one vervet male who did not conform had quickly dominated their adopted group is consistent with the social function hypothesis, because he did not need to ingratiate himself (see also van de Waal, van Schaik, & Whiten, 2017).

Another narrowness in the approach of Jagiello is advocating a dichotomy between "technological innovation" and "non-instrumental learning," linking in Box 1 with a dichotomy between "instrumental stance" and "ritual stance." I question whether this dichotomy accommodates all human and nonhuman cultural phenomena. Where, for example, do human languages fit – or indeed other forms of cultural communication such as bird and whale song? Birdsong can include elements that are stable over decades ("recurrent fidelity" in Heyes' (2018) terms) plus other elements that evolve across years (Whiten, 2019b; Williams, Levin, Norris, Newman, & Wheelwright, 2013). Humpback whale songs evolve greater complexity over several years, but may then be replaced by new songs, to which all whales in the population conform, with this new song then being transmitted to populations across ocean basin scales (Allen, Garland, Dunlop, & Noad, 2018).

Linked questions concern the scope of "convention" (Box 1): Presumably our linguistic lexicons are prime examples of conventions – so what then of bird and whale songs, given that both express local arbitrary dialects that function in the population concerned ("coordination devices," Box 1), but not in others, where they can, for example, prevent interbreeding because they lack requisite meaning for the females there (Grant & Grant, 2002). Going beyond vocal communication, van Leeuwen, Cronin, and Haun (2014) reported that a female chimpanzee's innovation of arranging a grass leaf in one ear was adopted by most of her group. Where (if at all) might such phenomena fit in the schemes (e.g., Fig. 3) of Jagiello et al.?

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Is there a need to distinguish instrumental copying behavior from traditions?

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Abstract

The authors make a distinction between instrumental copying behavior in which there is a clear reward for the copying behavior and social copying (traditions) in which the rewards for copying are less clear. However, I see no reason to distinguish between the two. We are social animals, for whom copying traditions have important rewards, those of affiliation.

Bifocal stance theory (BTS) makes a distinction between instrumental copying behavior, in which the goal is for the behavior copied to have some independent value, and the copying of traditions involving the faithful copying of what one might consider causally irrelevant action. However, there is no need to distinguish between the two. We are social animals, for whom copying traditions have important instrumental rewards, those of affiliation. BTS recognizes that traditions are sensitive to social cues, indicating that modeled behavior is conventional, normative, and otherwise relevant to group alignment, and therefore the motivation to copy such behavior is affiliative in nature. But why is this not instrumental? For humans, there are great advantages to being a member of a group. The authors say, "practices that are ineffective in producing environmental outcomes, result from a non-instrumental, affiliative motivation" (target article, sect. 2, para. 4). Why is affiliative motivation non-instrumental?

Of course, affiliation is a different kind of instrumental behavior from the rewards often used with animals (food) in experimental studies, but so are short cartoon clips (e.g., Alessandri, Darcheville, & Zentall, 2008), colorful stickers (e.g., Roberts, Alexander, & Knapp, 1990), and social praise (Fefer, DeMagistris, & Shuttleton, 2016) in experiments with children.

As the authors note, unlike chimpanzees, children often over-imitate, copying parts of the behavior demonstrated that are clearly not needed to attain the instrumental goal (Horner & Whiten, 2005). It may be, however, that the *instrumental* goal of over-imitation is to demonstrate (to others) that the observer has learned, with considerable fidelity, what the demonstrator has done (Over & Carpenter, 2015). In addition, although over-imitation may not appear to be instrumentally motivated, children have often been socially rewarded in the past for imitating behavior that has no apparent instrumental value. In fact, when children over-imitate they may be well aware that the over-imitation is not necessary to obtain a physical reward (Nielsen, Kapitány, & Elkins, 2015). By over-imitating, however, they may be demonstrating that they understand and remember what the model did, an instrumental goal in itself. Furthermore, as the authors recognize, the instrumental rewards of over-imitation may be opaque at the time of observation, but a child could have learned that it might be wise to copy the behavior because the opaque behavior may have some future instrumental value. For example, learning how to make sparks by hitting a piece of metal against a piece of flint may not be useful at the time of observation, but in the future it may be useful to build a fire. Interestingly, Japanese quail and pigeons, much like chimpanzees, show evidence of imitation (Akins & Zentall, 1996; Zentall, Sutton, & Sherburne, 1996), yet unlike children, they appear to be sensitive to the consequences of the demonstrated behavior. That is, if the demonstrated behavior is not rewarded, Japanese quail shows little tendency to imitate the behavior (Akins & Zentall, 1998).

Perhaps a more clear-cut example of imitation for purely social rewards is the children's game, "follow the leader." In this game the sole goal of the children who follow the leader is to copy the leader's behavior. It is a social game that likely has the act of copying as an instrumental reward, as it may demonstrate that one can remember and replicate the behavior.

There is a way in which ritualistic behavior that is associated with a social group may appear to differ from typical instrumental behavior. Rituals often occur even when the individual is alone, that is the affiliative reinforcers are not directly present. But some instrumental behaviors also become habitual even when separated from their consequences. For example, stopping at a red light late at night in the absence of traffic or law enforcement.

As the authors recognize, maintaining the duality between instrumental and ritualistic behavior is difficult because "the ritual and instrumental stances are intimately interwoven in many human pursuits" (target article, sect. 2.1, para. 4). Thus, is the duality necessary or is affiliation just another kind of instrumental behavior?

Magical thinking, a clearly ritualistic behavior supported by group affiliation, often has the effect of giving the individual a sense of instrumental control, especially when actual instrumental control may not be available. Furthermore, magical thinking can sometimes have instrumental effects, especially if the belief is strong enough (e.g., voodoo, Lachman, 1983).

Dietary restrictions mandated by certain religious groups, at one time may have been instituted for health reasons (although it may well be that such an instrumental attribution was suggested after the fact to give the ritual more credibility). Yet the practice remains even though the reasoning may no longer be relevant. Its persistence is surely reinforced by group cohesion, a strong instrumental reinforcer. Furthermore, it may have the added consequence of insulating the group from other groups because dietary customs reduce the likelihood of interacting (eating together) with groups that do not have similar dietary customs (Lewis, 1985) thus reducing the possibility of group fragmentation.

Instrumental behaviors sometimes result in nonsocial approach–avoidance conflicts (Miller & Kraeling, 1952) and very often similar conflicts occur between nonsocial and affiliative reinforcers (or punishers). As environments change, social rituals are often slow to change. Individual innovation, typically controlled by nonsocial rewards, may conflict with slow-to-change social rituals. Many individuals sustain the group's rituals to avoid social ostracization, but others may be willing to take a risk for the attraction of nonsocial rewards. Thus, there is the tension between the two instrumental forces, instrumental innovation and instrumental group cohesion.

Although acceptance by a social group may not be as quantifiable as other instrumental outcomes, that does not make group acceptance any less instrumental and certainly not different in kind.

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Authors' Response

Bifocal stance theory: An effort to broaden, extend, and clarify

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Abstract

The bifocal stance theory (BST) of cultural evolution has prompted a wide-ranging discussion with broadly three aims: to apply the theory to novel contexts; to extend the conceptual framework; to offer critical feedback on various aspects of the theory. We first discuss BST's relevance to the diverse range of topics which emerged from the commentaries, followed by a consideration of how our framework can be supplemented by and compared to other theories. Lastly, the criticisms that were raised by a subset of commentaries allow us to clarify parts of our theory.

R1. Introduction

The bifocal stance theory (BST) has stimulated a rich set of commentaries, bearing testimony to the productivity of our framework in advancing our understanding of human learning behaviour and cultural evolution. Many commentaries argued that BST has a broader range of applications than even we envisaged, for example applying to topics as diverse as language, music, education, pedagogy, psychopathology, and nonhuman animals. Many also suggested additional factors to be considered in the theory, or compared it to a competing framework thus generating testable predictions for future research. Our account of BST has also led to some criticisms that we seek to address. Our response is thus divided into three main parts dealing respectively with broadening the application of our theory, extending it, and responding to critique (Table R1).

R2. Broadening the applications of BST

First and foremost, BST is a theory of social learning and hence it concerns every aspect of human life in which individuals acquire information through interaction with others. As the commentaries make clear, the explanatory value of our framework spans a vast range of different fields of enquiry, giving insight into the psychological mechanisms, evolutionary origins, and meta-contributions of BST.

R2.1. Underlying cognition

Campbell & Fonagy argue that some symptoms in psychopathology could result from failure to read social cues correctly, producing too much or too little trust in social interactions, impairing the ability to switch flexibly between stances during learning interactions. This is a potentially fruitful idea to explore although it is important to remember that our framework proposes that the stances "lie in the eye of the beholder" and so, at least in principle, there is no "right" or "wrong" interpretation of any given action sequence. Nevertheless, we agree that deviation from normal patterns of stance adoption in a group could impair communication and learning observed across many different conditions. Most importantly, Campbell & Fonagy propose that non-standard adoption of ritual or instrumental stances may be because of deficits in mentalizing abilities. Our article has explored different types of cognitive structures underlying BST and remains open to this possibility. Nonetheless, in its simplest form, we propose that instrumental and ritual stances operate on domain-general processes of attention, motivation, and learning. Rather than appealing to domain-specific mechanism, abnormal stance switching could be because of inadequate input in early development. This would be consistent with the looking glass paradigm we propose (see sect. 5 in the target article), in which instrumental learning may reap social rewards while cues that are indicative of conventional learning are paired with inanimate rewards. A reversal of reward structure or complete lack of consistency in the way rewards are obtained may cause individuals to routinely adopt "the wrong" stance during ontogeny. Future research will be able to disentangle the contributions of rich, specialized processes, such as mentalizing, from those of leaner, domain-general processes.

An important step in that direction has been taken by **Leibo, Köster, Vezhnevets, Guzmán, Agapiou, & Sunehag (Leibo et al.)**, who consider how an agent-based modelling approach to BST could help clarify the various ways in which patterns of stability and innovation in social learning may be generated based on domain-general and non-deliberative cognitive processes. This approach marks a particularly exciting new direction for our framework, which to date has mainly focused on empirical research while leaving untapped the range of possibilities that agent-based models are capable of generating. They propose a domain-general learning model in which agents develop the

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Table R1. Overview of commentaries based on their general aim to provide applications, extensions, or critiques of BST

	Contribution	Commentator
Broadening the applications of BST	BST in nonhuman animals	Whiten
	BST in music research	Loui & Margulis
	BST in science and education	Watve & Watve
	Evolutionary origins of BST	Veit & Browning
	BST and psychopathology	Campbell & Fonagy
	BST and Confucian philosophy	Lai & Stapleton
	BST and child-led teaching	Bazhydai & Karadag
	Agent-based models of BST	Leibo, Köster, Vezhnevets, Guzmán, Agapiou, & Sunehag
	BST in language evolution	Scharinger & Erfurth
	BST and threat sensitivity	Samore & Fessler
Extending BST	The role of culture in shaping BST	Fong, Nielsen, & Legare
		Clegg, Wen, & Rawlings
	BST, within-culture variability and developmental milestones	Puttre & Corriveau
	BST and construal level theory (CLT)	Kalkstein & Trope
	BST and social relationships	Thomas, Radkani, & Hung
	BST and the specificity, riskiness, and complexity of goal-directed action	Brown & Pain
	Cost–benefit calculations in BST	Vélez, Wu, & Cushman
	Repetition, goals, and habits in BST	Perez
Addressing the critics	Social learning is more complex than BST	Packer & Cole
	All rewards are instrumental	Zentall
	Extrapolation from single learning instances	Buskell & Charbonneau
	Environmental scaffolds drive social learning	Nonaka
	Most of culture is learned via the instrumental stance	Dubourg, Fitouchi, & Baumard
	Most of magic is instrumental	Hong
	Relevance explains social learning	Altınok, Tatone, Király, Heintz, & Gergely
	Arbitrary action is instrumental	Fong, Nielsen, & Legare

tendency to punish norm deviations. Explaining the emergence of such a norm-punishing property is straightforward once the relevant scaffolding of promoting punishing behaviour is in place, but a pressing question would be to determine the origins of such a scaffold: How did the first generation of norm-punishers come into being? Applying BST to agent-based modelling addresses not only how the stances can emerge independently, but also potentially pinpoints the factors that promote generic learners to switch between them in a dynamic fashion. The successful implementation of such a model would thus weaken the case for a purely deliberative account of BST, shedding light on plausible candidate mechanisms mediating differential learning modes, as well as discussing the range of factors that may have given rise to ritual and instrumental stances in the first place.

R2.2. Evolutionary origins and human uniqueness

Veit & Browning propose a feedback loop including cooperative foraging and reliance on others as origin of the stances. This however raises the question of why other species that also rely on group membership for improved survival have not developed a similar propensity to engage in ritual copying. Additionally, other factors could have played a pivotal role in the inception of this co-evolutionary interplay between the stances. It could be that the advent of hunting tools (such as spears and projectiles) increased costs of inter-group conflict which necessitated stronger social cohesion and improved group delineation via ritual learning. The link between war and ritual has been established in previous research (Sosis, Kress, & Boster, 2007; Whitehouse, 2021) and human warfare likely scaled up with instrumental learning, refining the weaponry involved in conflict, which in turn increases the importance of cementing group membership via accurate ritual transmission. Such a feedback loop is analogous to what Veit & Browning have suggested, but perhaps points to a different driver.

Indeed, a similar explanation is explored by **Samore & Fessler**, who discuss the link between adherence to tradition (via the ritual stance) to improved outcomes in threat situations (caused by environmental hazards, like pathogens or outgroup violence) through increased group cohesion. We agree with the authors

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that our framework is informative and possesses explanatory potential in elucidating the role of tradition in coping strategies in response to threat. To further investigate this link, future cross-cultural research might employ a combination of threat priming scenarios (e.g., risk of contamination, outgroup hostility, natural disaster, etc.) together with a subsequent learning phase in which subjects are asked to imitate actions from members of their own group. Would elevated threat salience promote the adoption of a ritual stance during subsequent learning episodes?

Whiten highlights another way of addressing the question of origins by considering an alternative possibility – that the ritual stance is not uniquely human but could be phylogenetically more ancient than previously assumed. We agree with his suggestion that our initial formulation of BST – proposing that it mainly explains cultural patterns seen in humans – is not quite ambitious enough, as our framework might come with implications for explaining learning more widely within the tree of life. As Whiten astutely observes, this raises the question as to whether the observed conformism is produced by the motivation to fit into the new social environment or whether it hinges on the implicit assumption that other group members possess an informational advantage – in which case the copying behaviour is designed to achieve the best instrumental outcome. One way to probe this question might be to observe how ostracism affects these learning strategies. A particularly efficient proxy for social concern might be the individual's rank within the group. If nonhuman primates make use of bifocal stances in the way they copy actions from others, then a low ranking or peripheral individual should act to secure group membership via conformism.

R2.3. BST beyond the action domain

We equally agree with **Whiten** that BST should be applied to a wider range of human and nonhuman cultural phenomena, such as language and song. Comparative research that is mindful of the different types of perceived action (Fig. 3 in the target article) will be needed to provide clarity as to how these phenomena fit into our framework. Even though songs may be attributed to an attainable goal, the means by which this end state is achieved is causally opaque in irremediable ways. From the perspective of natural causation, there is no physical reason as to why specific sounds should be arranged in any particular way to create music. We therefore expect musical practices to persist with high accuracy and we find it particularly intriguing that bird and whale songs have not only been found to serve as coordination devices within specific populations, but also to exhibit remarkable stability over time, both characteristics which are in line with the predictions of BST.

Indeed, music, song, and language are topics that lend themselves to further investigation in light of BST, as demonstrated by **Loui & Margulis**, who apply BST to the domain of music by proposing an experimental design which aims to disambiguate the different pathways proposed by our cultural action framework, while also discussing how our framework can account for the evolution of music more generally. We find their argument that the innovative spirit of music composers comes from an instrumental stance, while other more socially focused uses of music activate the ritual stance, intriguing. Nonetheless, as we note within the context of quasi-instrumental practices as well as in our response in section R4.1, the presence of an end goal does not automatically result in the adoption of an instrumental stance.

Like **Loui & Margulis**, **Scharinger & Erfurth** apply BST's core arguments about the fidelity of imitated action to a non-action domain, proposing that the instrumental stance could drive language innovation while a speaker's motivation to affiliate with their group could promote linguistic stability via the ritual stance. BST is primarily a theory which attempts to explain imitated action, therefore we generally approach its applications outside of the action domain with some caution. For instance, the assumption that regular past tense forms accomplish their communicative goals via knowable causal pathways (hence prompting an instrumental stance) while irregular forms are causally opaque in irresolvable ways (because they do not undergo the rule application of the *-ed* suffix, hence prompting a ritual stance), is currently beyond the scope of our theoretical framework. Neither regular nor irregular verb forms can be potentially explained via natural causation in the way they reach their communicative goals. Nonetheless we agree that this is an interesting new angle which invites novel ways of theorizing.

An analogous approach would be to consider BST's role in the wider context of religion (Whitehouse, 2011, 2012). For instance, do minimally counterintuitive concepts (MCI; Boyer, 2002; Nyhof & Barrett, 2001) serve a similar affiliative function as action sequences that are perceived as irretrievably opaque? Future research might establish whether socially and goal-driven motivations modulate the fidelity with which certain story elements and narratives are retold, thus further exploring the reach of BST's explanatory potential.

Lai & Stapleton's literary and philosophical approach makes use of the *Analects* (a historical text describing the lives of early Confucians) as a case study for BST, finding many parallels between our framework and the Confucian approach to ethico-social learning. This also prompts novel questions about the role of tailoring – the ability to enact a tradition accurately but with slight deviations as to accommodate the context in which it takes place – and about the relationship between the stances. We do sympathize with the authors' aim of drawing attention to the importance of tailoring, which places goal-focus in the context of ritual practice. Tailoring is a concept which aligns well with the quasi-instrumental practices we discuss in our article. We propose that learners switch flexibly between ritual and instrumental stances based on the weighing of cues, so while the presence of a goal might render an instrumental stance more likely (resulting in relatively more deviations during ritual enactment) we maintain that given the importance of other cues in stance adoption, the presence of a goal does not deterministically send a learner into an instrumental learning mode (as discussed in sect. R4.1). Moreover, we applaud the author's application of BST to this case study as it further underlines our framework's versatility and reach in accounting for a wide variety of cultural phenomena.

Although we anticipate considerable flexibility in the interplay of the stances, we are inclined to resist **Lai & Stapleton's** suggestion that a varifocal lens would be a better metaphor than a bifocal lens. It may well be that flexible, culturally shaped deployment of the ritual and instrumental stances yields a continuum of copying fidelity; the area between highly innovative and highly conventional behaviour may be thickly populated with intermediate cases. However, the hypothesis that this output continuum is generated by two distinct clusters of psychological properties – two stances in a bifocal relationship – has the virtue of coherence with existing evidence and of testability in future work. By contrast, it is hard to see how a varifocal account of BST could be adequately tested because any result that fails to conform to the predicted patterns of social learning associated with ritual and instrumental stances could simply be "explained away" by being assigned to an intermediate middle ground.

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R2.4. BST in education

Watve & Watve's discussion of how our framework could lead to a better understanding, and ultimately optimization, of the practices and norms in academia and education harmonizes well with Whitehouse's (2021) argument that BST can help us better understand and address the general divide between the sciences and humanities (the "two cultures problem"). Here, the instrumental stance appears to motivate fields dominated by scientific thinking, focusing on causal transparency and attainable end goals, while the ritual stance is more pervasive in the arts and humanities, which place greater emphasis on irremediably opaque discourse, inviting exegetical interpretation in much the same ways as rituals and artworks. We are equally intrigued by the prospect of investigating how the two stances may be adopted *within* a field, where for instance some aspects of science might place emphasis on faithful replication to preserve the current state of knowledge, which in turn could impede rates of innovation. Fostering an instrumental stance in the classroom via focus on end states might be an exciting new objective to explore within the context of academia and education.

R3. Extending BST

R3.1. Competing hypotheses

Thomas, Radkani, & Hung (Thomas et al.) argue that non-instrumental actions communicate social relationships rather than delineating group membership. For example, they argue that bowing or kissing is a poor marker of group identity because they are so ubiquitous. We are unconvinced, however, by the examples chosen. Cross-cultural research indicates great variability in how different groups kiss, with some cultures not engaging in the practice at all (Jankowiak, Volsche, & Garcia, 2015). Variations in kissing behaviour appear to be among the stereotypes used to delineate group identities, for example differentiating British, French, and Italian styles of greeting or taking leave.

Further, as the authors note, their examples describe behaviour that is asymmetric. This marks an important departure from BST as our framework aims to explain differences in copying fidelity in intergenerational and historical transmission of cultural practices. In other words, when a social learner observes a model and is prompted to replicate a cultural practice, why do they imitate some aspects more accurately than others? It appears that behaviours which do not inspire imitation as a direct consequence of observation, such as the mentioned example of bowing, are less relevant to BST. For instance, there is evidence that kissing serves important signalling purposes in sexual selection (Hughes, Harrison, & Gallup, 2007) and we agree that it is unlikely to be a behaviour that requires a ritual stance in order to persist as it is anchored in biological proximate mechanisms – in much the same way as other forms of intimacy would not require ritual learning even though their immediate purpose may not be accessible to the actor or recipient of the action.

Accordingly, BST does not claim to account for all observed human behaviours but rather attempts to account for the psychological motivations that mediate instances of social learning within the cultural domain. The question then as to how social learners decide whether a non-instrumental action is about either rituals or relationships may have a rather simple answer: If the social learner is in a social situation that encourages or requires the replication of non-instrumental action, they may readily adopt the ritual stance based on detecting conventional cues. If the situation is not about learning but simply observing or online coordination of action, they may draw a plethora of different inferences based on the nature of the interaction, including assumptions about relationships such as described in this commentary. Moreover, this basic distinction in how a situation is framed can be investigated empirically by manipulating the contexts in which actions are observed as well as the implicit expectations that are directed at the observing party in the social interaction. Do social learners copy rituals more accurately even if they did not expect to be asked to do so?

A theory which more closely competes with BST within the domain of social learning is construal level theory (CLT) as discussed by **Kalkstein & Trope**. They propose that the higher the psychological closeness to a model, the greater the motivation to copy observed actions with higher fidelity. Conversely, greater psychological distance promotes focus on a goal and thus higher abstraction of the steps that lead up to it. This model is rooted in the assumption that higher distance increases processing load, thus prompting goal orientation as a means of coping. Arguably, however, psychological closeness and motivation to affiliate might be hard to disentangle, as psychologically close models are probably also targets of affiliative motivations. That said, experimental designs that tease apart these two factors may open up exciting new avenues for research. As the ritual stance has important implications for group cohesion and boundary marking, paradigms in which closeness and group membership are manipulated may prove particularly insightful as a way of probing the questions set out by Kalkstein & Trope. BST would predict that, under conditions of social concern, a learner would copy irresolvably causally opaque actions more accurately from a distant in-group model as opposed to a close out-group model. Investigating these questions empirically could help to disentangle the underlying motivations and cognitive constraints that regulate copying fidelity in cultural transmission.

R3.2. Role of culture

Fong, Nielsen, & Legare (Fong et al.), as well as **Clegg, Wen, & Rawlings (Clegg et al.)**, focused on the role of culture in shaping the stances during development. The research they review suggests that the tendency to engage in one stance over the other varies across cultures. We agree that "culture is an optometrist" (Clegg et al.) and that cultural scaffolds and teaching norms encourage young learners to adopt one stance or the other. However, cross-cultural research is often correlational in nature – there are more differences between cultural groups than for example the degree to which they resort to observational learning. In order to test the impact of cultural teaching differences more directly, Western participants in an experiment may be exposed to observational learning methods for extended periods of time, while Ni-Vanuatu learners may be assigned a condition in which they receive direct instructions. Will this manipulation reverse the observed preferences or are there more cultural factors that will keep the current lens prescriptions intact? Given that the impact of culture on copying fidelity is in line with the "cognitive gadget" account that we propose, teasing apart which cultural variables mediate stance adoption is among the most pressing questions of the BST framework. More generally, these commentaries draw attention to the bi-directional nature of the mind–culture interaction, and it is important to recognize that minds not only give rise to culture via their abilities to process, store, and transmit, but that culture itself also shapes minds and the way they interact with cultural representations.

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Similarly, **Puttre & Corriveau** draw attention to the role of within-culture variability, specifically the distinction between minority and majority groups in BST. They review research showing how recent immigration, being part of a religious minority as well as differing degrees of familial authoritarianism can modulate stance adoption and thus copying fidelity. Further, they propose that cultural identity may interact with developmental milestones, giving rise to different stance propensities. These points constitute valuable additions to our framework and we wholeheartedly agree with their suggestion that future BST research needs to consider the interaction between these factors. On questions relating to social identity, we further note that BST might be particularly useful in investigating stance preferences on an even finer-grained level, namely that of individual differences. Are personality traits predictive of a social learner's propensity to adopt one stance over the other? For instance, as discussed by **Samore & Fessler**, an individual's tendency towards threat detection may push them towards adopting a ritual stance more readily for purposes of buffering against external risks by cleaving more closely to the group via conformism.

R3.3. Costs of goal-directed action

Brown & Pain propose another set of factors that might affect stance adoption – namely specificity, riskiness, and complexity of goal-directed action. They argue that the higher these properties, the smaller the margin of error, which would render copying via the ritual stance more adaptive. This is in line with many of the core assumptions of BST. For instance, we propose that the ritual or instrumental nature of an action lies in the eye of the beholder. If a sufficient amount of conventionality cues push a learner towards adopting the ritual stance when copying a food processing procedure (where mistakes are costly due to the risk of poisoning), then a high level of fidelity can be maintained even when the procedure is seen as instrumental from an outsider's perspective (to obtain food). Adherence to local traditions via social motivations could be crucial to guarantee that particularly specific, risky, or complex instrumental sequences are preserved via faithful transmission. Past research has similarly found that ritualization in moderation may enhance the memorability of a goal-directed action (Kapitány, Kavanagh, Whitehouse, & Nielsen, 2018). But despite the applicability of BST in the domain of complex goal-directed action, it is important to emphasize that our framework does not claim that the instrumental stance results in overall low-fidelity learning. Rather, as elaborated further below, we argue that while high levels of fidelity can be maintained, an instrumental stance produces *relatively* lower-fidelity learning compared with behaviour copied via the ritual stance.

Vélez, Wu, & Cushman (Vélez et al.) draw attention to the cognitive costs of figuring out a model's intentions. They propose that if the costs of inferring intentions are not sufficiently offset by the knowledge that is gained as a result, then unquestioning and faithful copying becomes adaptive. Much like in **Brown & Pain's** commentary, this line of reasoning seeks to explain cases where instrumental action is imitated with high fidelity (where the cost of inferring model intentions is too high), while also attempting to account for low-fidelity copying within the ritual domain (whereas the intentions of the model are inferred, increasing the learner's flexibility in attaining the inferred goal by substituting steps in the sequence). As before, the interaction between social concerns and costs of inference can be investigated empirically by applying our cultural action framework (Fig. 3 in the target article). BST would predict that ostracized learners copy an action sequence with an inferred end goal more accurately if it is assumed to be irresolvable (the action–outcome link cannot be explained via natural causation) as opposed to resolvable (via the implicit assumption that there is a physical–causal explanation for how the goal is achieved). Nonetheless, Vélez et al. would predict that an action sequence with an irresolvably opaque structure but with a salient end goal is copied less accurately than an opaque sequence without inferred end goal, as the presence of an inferred goal might increase the willingness of learners to innovate. In short, exploring the cost–benefit tradeoffs of model inference and goal salience can provide further nuance and insight into the cognitive processes underlying the stances.

R3.4. Role of repetition

Perez proposes that the continuous performance of an action sequence may play a fundamental role in stance selection, in that it shifts the learner's attention away from the end point rendering the steps that lead up to it more salient. We agree that repetition is likely to be a crucial factor in stance selection and advocate for its inclusion in our framework. For instance, religious practices that are part of the doctrinal mode of religion, serving as identity markers of large imagined communities (Whitehouse, 2018), often become fixated through processes of repetition, which are likely to promote the adoption of a ritual stance and hence minimize the likelihood of deviations (Whitehouse, 2004). Further, we welcome the author's efforts to connect BST to a broader range of research in psychology and neuroscience by mapping it onto the distinction between goal-directed and habitual behaviour. We feel that the mapping is not quite as neat as Perez suggests. When stance selection is automatic, it would not involve ascription of intentions to the model, and when it is deliberative, gestural or intrinsic goals may be ascribed – for example, the intention to enact a certain sequence of body movements rather than to have a certain effect on the world. However, we regard the lessons that Perez derives from the literature on actions and habits as very valuable indeed. The temporal features of observed action, frequency of repetition, and variability of enactment may well play significant roles in stance selection.

R4. Addressing the critics

Several commentaries follow a common pattern, suggesting that some aspects of our theory are more contentious than others or were articulated insufficiently in the first place. In particular, several commentaries took the position that all cultural learning is instrumental and that BST fails to acknowledge the complexity of social learning. This has led some to conclude that a bifocal stance arrangement might be a less relevant feature of social learning than proposed in our article. We respectfully disagree with this conclusion and the arguments leading to it but we are grateful for this opportunity to clarify our position.

R4.1. Culture and social learning is not always instrumental

Even though some commentaries seek to formulate accounts that are more parsimonious than BST, the simplicity of these frameworks is achieved at the cost of either ignoring certain key issues or underestimating the mechanisms involved in cultural transmission. Most commentaries that fall prey to these problems propose

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some variant of the assumption that all cultural practices are viewed through the instrumental stance by default. For instance, **Zentall** claims that there is no need to distinguish between instrumental and affiliative copying behaviour, because affiliative rewards are instrumental (in fact, he proposes that all types of rewards, without exception, are instrumental). He makes the argument that food, cartoons, stickers, and social praise in developmental research are all instances of the same thing, namely instrumental rewards. We find this to be, at best, a point about semantics – an insistence that the term "instrumental" should always and only be used as it is in the literature on animal learning – and, at worst, an argument which conflates very different phenomena. What we mean by instrumentality, as specified in our article, is the achievement of a goal via physical–causal pathways. Instrumentality refers to the attainment of technical rewards which we argue are different from social rewards, which are less tangible and require a different degree of copying fidelity to be obtained. We assume that an adaptive organism would modulate its behaviour whenever possible based on the nature of the reward that is expected. We do not deny that the desire to affiliate is technically a goal, but we do argue that different goals (social and asocial, animate and inanimate) are reached in different ways.

Zentall offers a cognitively complex interpretation of overimitation in which the social learner is motivated to signal to the model that they are capable of accurately reproducing an observed action sequence. In fact, as we point out in our article, it is an open empirical question to what extent overimitation involves this kind of mentalizing and conceptual grasp of social norms, rather than learned associations between slavish copying and social rewards. Moreover, Zentall leaves the question unaddressed as to when and why learners decide to "impress" a model via accurate copying. If instrumental learning underlies all cultural learning then how can the historical, as well as empirical (e.g., Watson-Jones, Whitehouse, & Legare, 2016) patterns of differential transmission be explained? It seems that, rather than offering improved conceptual tightness, Zentall's account is based on using the term "instrumental" as a linguistic catch-all term for heterogeneous phenomena.

The critique presented by **Dubourg, Fitouchi, & Baumard** also assumes that instrumental copying alone can account for conventional stability and technological innovation but does not explain how. This commentary describes examples of how sports games and social etiquette have been changed in order to satisfy non-affiliative goals, leading them to the conclusion that a bifocal theory of cultural evolution is unwarranted. There are several problems with this view. First, the examples of deliberately changing rules and etiquettes do not serve as suitable cases of social learning. Sitting on a committee responsible for changing the "off-side rule" in football to make the sport more enjoyable does not capture well the features of cultural learning environments that BST seeks to investigate.

Further, as we explore in the article, deliberate reasoning about the purpose of a rule in sport may entail a focus on instrumental goals, but these attributed purposes may significantly depart from the practice's evolved function. An imagistic ritual, for example, may be ascribed a variety of purposes by its practitioners (e.g., appeasing the gods, turning a boy into a man, etc.), but its evolutionary function is to create a sense of oneness among the members of localized groups (Whitehouse, 2018). Thus, practices are preserved as they are part of the cultural repertoire that marks the learner's group identity and deviating from them may achieve the same instrumental results, such as producing a soothing effect or demonstrating physical skill, but will eventually lead to weaker delineation of group membership.

Packer & Cole make a similar argument by claiming that institutional ceremonies are more than mere ritual because they are attributed to a consciously formulated goal (e.g., conferring rank). Again, we disagree that any procedure with an end goal must be instrumental. We argue that in the case of some actions that are attributed to salient end goals, the causal opacity is assumed to be irresolvable and we refer to these as magical or "quasi-instrumental" rituals, arguing that they are viewed through the lens of the ritual stance (see Whitehouse, 2011, 2021). Accordingly, while magic relies on the presence of instrumental aims, such as warding off misfortune, it is not the same as purely instrumental action as our cultural action framework makes clear. More broadly, however, Packer & Cole argue that we do not pay enough heed to the cognitive mechanisms involved in social learning and imitation. One of us has devoted decades to studying these mechanisms (e.g., Heyes, 1994; 2012, 2021), but they are not a focus of the current article because stances are not reducible to social learning and imitation. Stances depend on motivational, attentional, and (possibly) executive processes that differentially recruit mechanisms of social learning and imitation. This is made clear in sections 2 and 5 of the target article.

Hong advances a more measured critique in claiming that *most* magical practices are viewed through the lens of the instrumental rather than ritual stance. First, we think that the question of whether *most* practices classified as "magical" are seen as instrumental *most of the time* requires systematic quantitative investigation; it cannot be established by a few examples. Further, Hong also seems to base his argument on the assumption that the presence of an end goal (e.g., efforts to make it rain) will cause social learners, in quite deterministic fashion, to assume that the causal opacity of a practice is resolvable, prompting them to innovate and experiment with the sequence via an instrumental stance. However, as we point out in the target article, BST proposes that the resolvability of opacity also lies in the eyes of the beholder. This means that, as in the example of Sylvia's recipe in which cutting off both ends of a joint can be viewed either through an instrumental or ritual lens, an action sequence that is part of a rainmaking ceremony might be interpreted as either resolvable (instrumental and thus "technological") or irresolvable (ritualistic). Thus we do not strip magic of its instrumental properties as our cultural action framework is sensitive to both possibilities. In fact, a core principle of BST is the proposition that the learner's perception does not need to align with the objective reality of the action sequence that is copied. Magic can be perceived as technological and technology may be seen as magical. Accordingly, BST proposes that adopting a stance relies on a variety of factors, such as the properties of the action to be copied as well as the characteristics of the model (Fig. 1 in the target article). Assuming that an end goal always (or *mostly*) results in the adoption of an instrumental stance potentially underestimates the role and frequency of behaviour that is interpreted as irremediably opaque for purposes of generating social glue. Nonetheless, we find Hong's commentary, especially the cited research about rainmaking practices insightful as it clearly highlights the importance of discussing both emic and etic functions of cultural practices.

A similar issue is raised by the commentary from **Fong et al.** who seem to conflate arbitrariness with instrumental behaviour. It appears that from their point of view, twirling a stick before it is used to reach an object is *arbitrary* but causally transparent because there is an end goal, and only twirling

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the stick without using it to reach an out-of-bounds object can be seen as causally opaque. The claim that arbitrary actions with a salient end state are causally transparent would mean that social learners always parse action sequences at the highest level, clustering all the components together and interpreting the whole sequence as either categorically opaque or transparent. This neglects cases where an action sequence with an end state can be causally opaque in irresolvable ways, such as the case of magical practices.

Moreover, we do not follow **Fong et al.** in assuming an objective and sharp distinction between instrumental and ritual actions which are therefore always classified as such in a deterministic fashion. Such an *action-centric* rather than *learner-centric* view potentially neglects the distinctions between emic and etic functions and leaves unaddressed the level of deliberateness by which learners come to adopt either stance (one of the focal points of BST). We feel that these distinctions mark important departures from the perspective of Fong et al. (as well as previous work by Legare & Nielsen), despite the fact that we all use similar terminology owing in part to a shared history of collaboration between our lab groups. That said, we welcome Fong et al.'s review of evidence that cultural factors can influence the development of stance behaviour. Like the research highlighted by **Puttre & Corriveau**, and **Clegg et al.**, this evidence makes it plausible that stance psychology has been shaped predominantly by cultural evolution; that it is closer to the cognitive gadget than to the cognitive instinct end of the continuum.

R4.2. Cued relevance and pedagogy are compatible with BST

Altınok, Tatone, Király, Heintz, & Gergely (Altınok et al.) propose that copying fidelity is modulated by attention to ostensive behaviours, such as eye contact and child-directed speech. Within this framework, the presence of communicated relevance encourages children to form the expectation of acquiring important knowledge, thus increasing their copying efforts. However, a model can communicate different goals, such as instrumental and normative ones. For instance, as mentioned in our article, Clegg and Legare (2016) examined the effect of goal-focused versus conventional language cues on children's imitative fidelity of a necklace-making activity, finding that the latter instructions improve accuracy of transmission over the former. Thus, the use of goal-directed and normative language as a cue is recognized by our framework (see Fig. 1 in the target article). It is not surprising that, all things being equal, ostensive behaviour causes heightened copying fidelity as it captures the learner's attention.

Despite the importance of ostensive cuing in social learning, we find it difficult to reconcile the natural pedagogy theory (Csibra & Gergely, 2009) with findings showing that ostracism modulates the copying fidelity with which children reproduce an action sequence (Watson-Jones, Legare, Whitehouse, & Clegg, 2014; Watson-Jones et al., 2016). With communicated relevance being equal between conditions, what drives the differences in imitative fidelity if not exclusion from the ball passing activity? It is not clear to us that natural pedagogy can provide an answer to that question – nor why the two theories should be seen as mutually exclusive. The theory of natural pedagogy implies that infants use ostensive cues to make inferences about the model's communicative intentions. Thus, in BST terms, it is committed to the idea that, even in infancy, copying fidelity depends on highly deliberative, mentalistic processes. BST regards this as an outstanding empirical question. The work on "rational imitation," cited by **Altınok et al.** and by **Fong et al.**, has been challenged (e.g., Beisert et al., 2012; Heyes, 2016), but, as we indicate in section 5 of our target article, claims about the deliberativeness and innateness of stance behaviour are thoroughly testable. More precisely, BST would predict that a non-ostensive condition in which learners are ostracized will produce higher copying fidelity than an inclusive condition in which ostensive cues are present.

Moreover, we find that **Altınok et al.'s** account is related to an important question in BST: Do social learners copy ritual actions more accurately than instrumental actions during memory formation (because of heightened levels of attention for one over the other) or are both actions encoded equally but differences emerge at the retrieval stage, during which the individual accesses the memory? Addressing this question is crucial in mapping out the cognitive structure of the bifocals and we find that Altınok et al.'s commentary makes an important step into that direction by discussing attention-related processes such as ostensive cuing.

Nonaka, while in agreement with the basic premise that two distinct stances are adopted in social learning, disagrees that the stances are cued via the relative salience of end goals or causal structure in the actions themselves. Albeit less fully specified, Nonaka's argument resembles that proposed by **Altınok et al.** Nonaka proposes that if the goal salience of food intake prompts infants to adopt an instrumental stance then there would be no reason to use spoons instead of their fingers. There are some problems with this argument, however. First, the starting assumption that spoon use is perceived as less efficient than using fingers is questionable, as it should be possible to gauge that a spoon can fit more food and will cause less spillage, hence prompting an instrumental stance. Second, as elaborated at length in our account, stances are not only triggered by properties of the observed actions. Their activation can also rely on a number of other cues, such as the number of models, as well as the use of instructions and normative language (see Fig. 1 in the target article). In this context, we see Nonaka's commentary (along with those of Altınok et al., **Brown & Pain**, **Campbell & Fonagy**, **Fong et al.**, **Lai & Stapleton**, and **Vélez et al.**) as valuable in highlighting the many ways in which teaching, and cultural learning more generally, shapes the development of stance psychology.

R4.3. Social learning is complex and copying fidelity is relative

Both **Packer & Cole** and **Buskell & Charbonneau** claim that BST draws conclusions about cultural transmission from simple imitation paradigms, which either fail to take into account the intergenerational aspect of cultural evolution or neglect complex properties, such as teaching, as a core mechanism of social learning. Despite Packer & Cole's critique, our definition is mindful of the fact that social learning constitutes a complex process which transcends simple one-to-one copying. Indeed, as **Whiten** points out, one of us has written at length about the need for "faithful retention" and "recurrent fidelity" (Heyes, 2018). Teaching falls well within the process of "information acquisition through interaction with others" as we envisage it and we do not agree that the complexity of social learning is underrepresented in our framework. On the contrary, BST seeks to draw attention to many different aspects of a learning interaction that can inspire the adoption of either instrumental or ritual stances, including factors such as the number of models and their characteristics (see Fig. 1 in the target article).

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Further, the fruitfulness of our approach is evidenced by the wide range of topics and domains that BST has been applied to in the commentaries above. In fact, as observed by **Bazhydai & Karadag**, BST proves informative in not only accounting for selectivity during copying, but also during teaching. Their discussion of how children's use of normative language in teaching scenarios reflects a ritual stance is compelling because it opens up a host of new questions regarding the motivations of models in learning scenarios. Do demonstrators make increasing use of conventional cues whenever group cohesion is important? Rather than oversimplifying the process of social learning, BST actively encourages its application to novel areas of research.

Buskell & Charbonneau propose that BST bases its arguments about intergenerational transmission on single instances of learning. Our framework does not assume that cultural evolution operates on dyadic one-off transmission scenarios alone, but rather draws from a variety of developmental research paradigms. Moreover, the usefulness of Buskell & Charbonneau's toy example is limited as it is based on fixed learning profiles as well as an instrumental stance which only dispenses with causally opaque elements while replicating the instrumental parts perfectly. This constitutes a coarse-grained conceptualization of transmission accuracy, which does not capture the key predictions that BST is setting out to test. We argue that adopting an instrumental stance creates *relatively* greater openness to innovation than adopting a ritual stance. As such, when approaching an action sequence through the lens of the instrumental stance one increases the likelihood of fine-grained deviations, making improvements via error more likely. Thus, Buskell & Charbonneau's hypothetical thought experiment produces the same cultural stability for instrumental and ritual actions because it was constructed with unrealistic base parameters (equipping learners with inflexible learning profiles and assuming that instrumental learning means mere elimination of causally opaque elements).

We find the issue of granularity in comparing instrumental to non-instrumental action sequences intriguing and agree that future research needs to be mindful of the level at which actions are compared. Nonetheless, it is important to note that the findings we review in our article are based on experiments that already make use of carefully controlled lab conditions (which match the level of granularity with which actions are compared). Differences in copying fidelity as prompted by ostracism threat (Watson-Jones et al., 2016), for example, cannot be explained by "the grain at which traits are learned." In light of these points, we disagree with their notion that there is an explanatory gap between learning and copying fidelity in BST.

While we cannot agree with **Buskell & Charbonneau's** claims, we like their concept of a "heuristic explanatory strategy." From the perspective of a cognitive psychologist, accustomed to thinking of mechanisms as "the inner machinery of agents," nearly all constructs in research on social learning and cultural evolution – from "stimulus enhancement" and "shared intentionality" to "attractors" and "cultural cognitive causal chains" – could be characterized as heuristic explanatory strategies. What is distinctive about BST is that it is explicitly designed to facilitate experimental work, of the kind described in section 5 of our target article that will elucidate "the inner machinery of agents."

Moreover, BST is sufficiently versatile to account for patterns in vertical (intergenerational) and oblique teaching, as well as horizontal transmission, such as child-led teaching, as discussed by **Bazhydai & Karadag**.

R5. Conclusions and future directions

The commentaries on our target article amply demonstrate the relevance of BST to a great variety of domains, ranging across psychopathology (**Campbell & Fonagy**), music (**Loui & Margulis**), language (**Scharinger & Erfurth**), philosophy (**Lai & Stapleton**), and modelling (**Leibo et al.**). Collectively, the commentaries point to considerable potential for expanding our framework (**Brown & Pain**; **Vélez et al.**; **Perez**), for instance by allowing us to explore the bi-directional relationship between mind and culture (**Puttre & Corriveau**; **Clegg et al.**; **Fong et al.**), as well as to test our key arguments against those of competing accounts (**Altınok et al.**; **Thomas et al.**; **Kalkstein & Trope**). Given the capacity of BST to address the differential patterns of cultural evolution that bolster our species' success, the framework lends itself to theorizing about our evolutionary past as well as our uniqueness in the tree of life (**Veit & Browning**; **Samore & Fessler**; **Whiten**). Our framework is ripe with new research directions that could be explored via collaborations between authors in all the above fields. Lastly, some of the concerns raised have usefully allowed us to clarify aspects of our approach.

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