‘Imitation Is the Sincerest Form of’ ... Cultural Evolution, or Is It?

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Abstract

Culture and cultural transmission is underpinned by social learning, allowing an individual to adopt the traditions of one's cultural group by interacting with others. Here I describe studies which demonstrate the role of imitation, the copying of methods and outcomes of behaviour, on cultural sustainability and innovation. Through diffusion studies with children using artificial fruits, the transmission of behaviour within and across groups was investigated. The results show that children are faithful to the methods and outcomes they witness, including copying irrelevant actions. Children in open diffusion studies acquired more than one solution, but sub-groups were established, conforming to a solution with other solutions being held in one's repertoire. Imitation is a critical skill underpinning the adoption and transmission of culture, with other mechanisms, such as asocial learning, teaching and emulation playing a less pertinent role.

Keywords

social learning – culture – cultural evolution – imitation – emulation – diffusion

Culture and cultural evolution have allowed humans to inhabit all corners of the globe, and beyond. Yet many questions remain to be answered about these phenomena. Culture is represented by our selection (conscious or unconscious), adoption and reproduction of behaviours, including, words spoken, tools used, clothes worn and bodily gestures made. There are rules within cultures around how these behaviours are used, such as what one should wear to
a wedding or a job interview. These rules are often unspoken, not demanded, or explicitly signalled, instead they are passed on from generation to generation. Indeed, it has been said that, ‘Traditions are just peer pressure from dead people’ (Greenwood, 2019). To be ‘culture’ these behaviours must not be solely dictated by the ecological demands of the environment in which a group lives, but must be a stable homogeneous behaviour that could be one of a variety of alternatives, such as eating with a knife and fork versus with one’s hands or chopsticks. Cultural evolution is the production, adoption and transmission of innovation at a group level; it underpins change of cultural norms.

Cultural traditions provide a stable environment in which to function, allowing speedy knowledge acquisition, and smoothing social interactions. We do not need to invent each behaviour from scratch or learn the rules of interaction with each stranger. Beyond the individual to individual level, norms and traditions allow societies to function effectively. Such functioning is so implicit that it is only when these norms are broken (imagine all drivers not following the agreed rules of the road) or when we are placed in a culture that is unfamiliar to us, that we see the power of these silent cultural norms.

Despite the power of these silent codes of behaviour, if we remain bounded by them then no innovations will occur. Yet, cultural evolution is all around us, especially in rapid technological advances. Cultural evolution requires the interaction of two key, but dichotomous, processes: stability (demonstrated in the implicit rules of groups, i.e. culture) and change (demonstrated by innovations). Alongside the stability of our traditions, innovations introduce new behaviours that can allow adaptation to a changing environment at a group level. My work has addressed how innovations enter an established repertoire of behaviour; that is how and why does an individual step away from the status quo and introduce new behaviours into a group (Carr, Kendal & Flynn, 2015; Flynn, Turner & Giraldeau, 2018). Here, I concentrate on the equally important issue of how stability within cultures is created and transmitted.

Examining the stability of cultural evolution may not appear as exciting as the innovation, yet it is critical. Traditions allow for the passing of large amounts of information in a very efficient manner regarding what is safe to eat, how to solve a novel technological problem with an already created tool, and how to communicate both of these things simply by listening to, or watching, others. I will disappoint some readers by stating early in this article that I do not believe that there is a single mechanism that underpins the stability of behaviour transmission within humans, or indeed a single mechanism that underpins innovation. Instead, humans are adept at using multiple mechanisms within their repertoires, such as watching, reading, inventing, and in fact they often desire to adopt more methods of acquiring information, such as
learning new languages or travelling to have new experiences. However, there may be some mechanisms that allow a more efficient and effective transmission of, and stability to, behaviour across groups and generations, and if so, this mechanism should be prevalent in our day-to-day interactions. Here I present one such mechanism, imitation.

Imitation sits under the ‘observational learning’ umbrella. Tomasello, Kruger, and Ratner (1993) distinguished different forms of observational learning, including mimicry, where the actions of another individual are copied with little thought to the resulting outcome, and, in contrast, imitation, where an individual reproduces the outcome as well as the actions that led to the outcome. In emulation an observer focuses on the mechanics of a scene, potentially learning about the affordances of the objects concerned, for example, that an object can be moved in a certain manner (object movement reenactment; Custance, Whiten, & Fredman, 1999) or that a certain goal can be achieved (goal emulation; Whiten & Ham, 1992). Here, for simplicity, I follow the definition of Whiten and Ham, (1992, p250) that “B learns some aspect(s) of the intrinsic form of an act from A’ but will touch on the role of intentional- ity and causal understanding later.

Imitation refers to a faithful form of copying including methods, outcomes and intentions, yet it should be noted that imitation brings with it an element of change even for those who wish to copy with exact precision. Adoption of a behaviour that one has witnessed has critical differences to the original performance. First, it occurs at a different time, even if the replication is temporally close. Second, it is undertaken by a different body even if that body has shared characteristics, such as age, species, gender. And finally, it will have nuances of change in the action sequence that may be intentional or unintentional that can be adopted by future imitators, moving further away from the original manifestation. This latter characteristic is critical for the examination of the mechanisms of transmission; it allows the examination of what is retained and what is lost or changed. This is not a new idea: in 522 BC Heraclitus stated, ‘No man ever steps in the same river twice, for it’s not the same river and he’s not the same man’.

Typically, imitation has been examined in dyadic settings: an observer witnesses a behaviour by a model and the observer’s behaviour is then examined to identify if any, and if so which, elements are reproduced. We know that humans will replicate causally-irrelevant actions, while chimpanzees will not (Horner & Whiten, 2005). Also, when presented with complex sequences of actions that cannot be held in memory, we see that children are able to parse actions within the sequence and extract high-level ordered information that they replicate, allowing them to achieve a goal without having to
reproduce all non-essential elements within the observed behaviour (Flynn & Whiten, 2008b).

To examine observational learning, cultural transmission and evolution, the paradigm I have used is artificial fruits. These are novel Perspex puzzle boxes that contain a reward (typically a piece of food for non-human primates, or stickers for children) which can only be retrieved once a series of defences has been removed, see Figure 1. Such tasks were first introduced by Dawson and Foss (1965) and are based on the foraging activity of non-human primates to acquire food from within protective material. Artificial fruits have been extremely ‘fruitful’. First, they require little verbal explanation so can be used across species. Second, to extract a reward a series of observable behaviours must be completed, which can be documented allowing the transmission, or not, of behaviour to be recorded. Third, the artificial fruits can be designed to address specific theoretical questions: for example, how the level of difficulty of a task affects the process of transmission; whether the use of a separate tool to the main body of the task influences behaviour; or how actions that are irrelevant to the acquisition on the reward are treated during the transmission?

A critical feature of artificial fruits is that they have multiple methods by which a reward can be extracted, for example, a door can be slid to the side or

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**Figure 1** Examples of artificial fruits
lifted; linking into the roots of culture, a group’s consistent use of one behaviour from a variety of possibilities. These multiple methods are critical because they allow us to infer whether a specific method is being adopted (imitation), alongside the outcome (emulation). For example, when a group of observers have witnessed method A to achieve outcome X, while another group have witnessed method B to achieve outcome X, we can only infer imitation if the members of each group replicate the distinct method that they have observed, i.e. method A is used by those that have witnessed it and method B is similarly reproduced by those that have witnessed ‘B’. If the use of the different methods is indiscriminately used across the groups then a single cultural behaviour is not clear, and we can infer either emulation, which is the adoption of the outcome and not the specific method, or asocial learning, the learning through one’s own endeavour. The behaviour of a third, control group, who are presented with the task but with no demonstration allows the examination of asocial learning. If the children who have witnessed a demonstration are more successful on the task than children in the control condition, then we can infer that social learning has had an effect on behaviour, with emulation being the mechanism if we do not see fidelity to the method, while imitation is inferred if we do see fidelity to the method witnessed. Both methods are typically arbitrary, i.e., they both lead to the same outcome, such as eating with chopsticks or a knife and fork, but their adoption has been influenced by the demonstration.

My work typically examines the development of the acquisition, transmission and evolution of culture, with groups of children being the primary focus. Children provide an extremely informative group. First, they are exceptionally physically competent and have had years of experience of manipulating, often novel, artefacts, so presenting them with a new artefact is not unusual. Second, children are typically surrounded by other people, engaging with them on new tasks, whether at playgroups, nurseries or in families and wider communities. Childhood is a time of cultural magnetism; children are not born with a culture, but are born within a culture. Finally, social and cognitive development are closely intertwined, and childhood provides a period of development in which questions about the antecedents and inter-relatedness of different abilities can be examined, as there may be differing profiles and competences over-time and ages which allows the interrelatedness to be distilled.

We know that imitation is prevalent from a young age, and has important implications throughout the life span. Children choose to learn from others rather than alone when given a direct choice (Flynn, Turner & Giraldeau, 2016). Children's imitation also provides a fertile mechanism for social affiliation alongside learning, with children signalling a preference for people who
Imitate them over those who don’t (Over & Carpenter, 2012). Even into adulthood we see the influence of faithful replication of behaviour: when waitresses repeat customers’ orders verbatim, they received larger tips than when they merely acknowledged or paraphrased the orders (van Baaren, 2005).

While imitation clearly has important implications for learning, and beyond, within dyadic settings, we must not forget that culture is a group-level phenomenon, allowing consistency beyond dyads to communities of individuals across generations. While a dyadic analysis of imitation provides much information about what is transmitted between two individuals (as outlined in Charbonneau & Strachan, 2022), it does not provide information about the processes and transmission that occurs at a group level. Analysis of historical archaeological records, anthropological observations of past and current cultural practices, and computational simulations have allowed us to explore culture at a group level. To do this in my own research I have utilised diffusion methods, including diffusion chains and open diffusion; such methods allow me to undertake an examination of the psychological and behavioural features of cultural transmission and evolution across multiple dyadic interactions overtime. Diffusion studies are an analogy of culture, similar to simulation studies, and as a result suffer from shortcomings such as not working on the same time frame, or within the same complexity of culture. But, as with many forms of method across different disciplines, they add information to our understanding of cultural acquisition, transmission and evolution, and help us to address some of the questions that are more difficult to answer from typical dyadic or observational methods.

In the diffusion chain method, one observes dyadic interactions, but does so across a sequence of dyadic interactions and thus the changes in transmission within dyads gets amplified and is a proxy for cultural change across generations. Specifically, individual A observes a model perform a seeded behaviour, and is then presented with the same task while observed interacting with the task by individual B, who then is presented with the task while observed interacting with it by individual C and so on along a chain of dyadic interactions. Critically, I do not give specific instructions to each demonstrating individual about how s/he should interact with the observer; there is no instruction to ‘show’, ‘teach’, or ‘tell’. The observer is simply in her/his presence while s/he interacts with a task. Similarly, I do not control what behaviour a child performs on a task. S/he may reproduce the observed behaviour, s/he may adapt it, or s/he may try something completely new; the degrees of freedom of the potential behaviour of the children are extensive and so regression is as possible as accumulation. Thus, there is a great opportunity for free-form behaviour and no explicit directive to replicate, mirroring how many cultural practices is transmitted.
Diffusion chain studies have shown that children are exceptionally faithful to the extraction method that is seeded at the beginning of their chain (Flynn & Whiten, 2008a; Hopper, et al. 2010). The level of fidelity to the observed behaviour is extremely strong, even when an alternative method appears to be more intuitive as it occurs more frequently within a no-model control condition. Children replicate the method of extraction and not simply the end-state of the extraction, as would occur through emulation. For example, in Flynn & Whiten (2008a) one 3-year-old girl (of 68 children in the chains, 1.4%) attempted an alternative method during her own attempt (when the next child in the chain was not present) but when she was not successful with that method she returned to the ‘observed’ method which had facilitated success during the demonstrations. Her innovation hints that, occasionally, children may break away from the canalization process that characterizes most children’s approaches, and it is this which could initiate some cultural change. All the other 67 children in the study replicated the method they had witnessed across all of their four attempts with the task. The fact that each method was transmitted down their respective series of chains shows that this was not due to the method being a predisposition for a particular task, as the two different methods were imitated equally despite one of them being significantly more prevalent within the no-model control condition. Thus, it is imitation that appears to be a driver of behaviour and not either a focus on only the outcome of a behaviour or asocial learning.

The role of imitation on social learning and cultural transmission is further enhanced by the fact that children replicate irrelevant information that the demonstrator has produced. Therefore, we can conclude that in dyadic settings, even along chains of dyadic interactions, imitation appears to be a key mechanism in learning and transmission. Imitation is a robust phenomenon, as it occurs even against circumstances that should impede it. For example, the imitation of irrelevant actions occurs after a reward has been retrieved (Lyons, Young & Keil, 2007), when there is a time pressure to extract a reward quickly (Lyons, Damrosch, Lin, Macris, & Keil, 2011), and when the observed method is less effective than alternatives (DiYanni, Clegg & Corriveau, 2021). Equally when given a choice about whether a child wishes to solve a task him-or herself or to watch another person solve the task first, the vast majority of 3- and 5-year-old children want to watch others first before attempting the task (Flynn, Turner & Giraldeau, 2016). Thus, not only are children good imitators, but they also seek social information rather than attempting asocial learning.

Diffusion chains are useful as they allow hypotheses to be examined regarding the fidelity of transmission based on the characteristics of the chains. For example, is information transmitted more faithfully with age and are there
differences according to gender (Flynn & Whiten, 2008a) or across species (Horner, Whiten, Flynn & de Waal, 2006)? However, it could be argued that diffusion chains are artificial as children do not live in predefined sequences of interactions. Instead, interactions in the 'real world' ebb and flow, with the community from whom one can draw information changing as a day progresses. Open diffusion is a method that allows a more natural flow of information to be examined. Open diffusion designs occur in natural communities involving real group dynamics of friendship, familiarity of people and place, as well as the underpinning norms and traditions of the group. For my research I used established playgroups, in which a new behaviour is seeded using an artificial fruit, and then the group is observed to examine how the information is transmitted from child to child across the group over time. Questions arise regarding how children learn the behaviour, and how the behaviour changes over time?

Here, I focus on two open diffusion studies. In Whiten & Flynn (2010) I worked with 4 playgroups with a total of 88 children participating. In these playgroups I introduced an artificial fruit, the panpipes (Figure 2), from which a reward could be extracted using either lift or poke methods. In two of these playgroups, I ran an open diffusion design in which I seeded in each group

![Figure 2](https://example.com/fig2.png)

**FIGURE 2** The “panpipes”
Diagrammatic cross-sections illustrating (A) the lift method; (B) the poke method; (C) the T-bar method; and (D) the panpipes within the plastic box, simulating the problem earlier confronting chimpanzees, with the lift method being demonstrated.
one of the two methods, lift or poke, by training a child from that group to be a proficient user of the method and then introducing the task to the whole group. From this introduction of a proficient model and the task I was able to track the method children used to extract the reward from the panpipes, and thus could infer whether children were replicating the same method, or using a variety of methods that showed no affinity with what they had previously witnessed and thus would suggest asocial learning, or was a modification of what had been learnt and so was a mixture of asocial and social learning. To do this each child’s interaction with the panpipes was coded, along with information about which children were watching the interaction. I also coded what verbal instructions or requests were made about the panpipes, such as explicit instructions or requests for information about how to extract the reward, providing the rich level of behavioural analysis suggested by Charbonneau and Strachan (2022). In the other two playgroups, I ran a no-model control condition in which 28 children were presented with the panpipes and allowed to explore them to see whether they were able to solve the panpipes and, if so, which method they used. Such a condition allowed an assessment of how easy the task was with no demonstration, and also whether there was a predisposition for one of the seeded methods over the other. If one method did appear easily in the no model condition then it is not possible to infer social learning in the open diffusion if the pre-disposed method appears to dominate the behaviour, as it may be learnt individually and not from others.

In Whiten and Flynn (2010), in the no model control condition only five children (18%) successfully gained the reward, with the lift technique never appearing. This compared to 66% of children in the open diffusion conditions (83% of those who attempted the task) being successful. Thus, it was clear that children in the open diffusion conditions were being influenced by what they had seen. There were 1322 attempts at the task within the Open Diffusion. Observational learning was the overwhelming method of transmission: with 64% of attempts being underpinned by observational learning; 5% by instruction alone; 14% by observation alongside instruction and 17% resulting from asocial learning. There were 64 instances of children using a method they hadn’t used before: 66% in their first attempts, while 34% were changes in the method they had initially used, showing that in the open diffusion context, unlike the diffusion chain results, some children were able to produce new methods to those that they had witnessed others use. The prevalence of observational learning in the open diffusion conditions showed that each child’s turn was witnessed by up to 8 other children on average, and children who attempted the task watched a mean of 44 turns, ranging from 0 to 179. Thus again we see that observational learning plays a significant role in
children's lives whether intentional or because they are in an environment in which they are surrounded by, and thus able to witness, the behaviour of others. Observational learning was the overwhelming mechanism, with imitation showing that methods of extraction were being adopted and then adapted. Microcultures appeared across and within the playgroups, and this was supported by imitation as the majority mechanism, alongside teaching.

In Flynn and Whiten (2010), I asked, do children continue to use previously acquired personal information to solve a task when faced with social information from multiple sources in a natural, open-diffusion setting, or do they switch to alternative, socially acquired solutions? Twenty-two children aged 3–4 years participated. The study had two stages: an initial asocial-learning stage, in which children were presented individually with an artificial fruit (the serial box, SB) with no model present and no goal-directed instruction. This phase allowed the children to acquire information about the task, such as how to extract the reward or what would not allow extraction of the reward. It also established whether one of the two methods to extract the reward was more salient. After this asocial-learning phase, the SB was placed into the children's usual playgroup for a period of time during which it was free for all the children to access it. During the open-diffusion phase, we videotaped and later coded which children were manipulating the SB, whether they were successful at extracting the reward, and, if so, what method they used. This provided an ordered sequential record of all the children's attempts and successes at the task, as well as which children witnessed these attempts and successes, as well as what was said during these interactions (in line with Charbonneau and Strachan, 2022).

During the initial asocial learning phase 50% (11 children) were successful, 6 (55% of the successful children) using Method A and 4 (36% of the successful children) using Method B. One child completed both methods before she pushed open the reward door. This shows that the two methods were roughly equivalent in their likelihood of spontaneous discovery, with Method A having a slight advantage.

One key finding across the two days was that during the first day of open diffusion children used a mixture of methods to achieve their successes similar to the asocial learning phase, however, by the second day, all the children's successes were achieved using the same method, B. This convergence suggests some degree of social conformity, through imitation, since the initial, asocial-learning phase showed that the two methods were within the group's repertoire at similar levels (method A was, in fact, slightly more common than method B). Indeed, the swing to the Method B monoculture on Day 2 was to the method that had been most commonly seen (67% of cases) on Day 1; a form
of social learning was at play which facilitates the copying of outcomes and methods, that is imitation.

The different approach in this study, that of introducing an asocial phase, meant that there was the variation in behaviour during the initial open diffusion phase within the group. For example, 11 children learned asocially, but 11 did not. Then 5 of those who learned asocially initially also learned socially adopting a method that they had witnessed, whereas 6 did not. Equally, five children who learned asocially did not try again with the task, whereas 1 did and kept the same method. Five others chose to change method from that learned through asocial learning to that witnessed during the open-diffusion phase. Whether a clearer pattern would have emerged with a larger sample or more time is unknown, but the data here suggest that cultural learning in such an everyday context can be both flexible and varied in terms of whether one wishes to participate or not. What we do see at the end of day 2 though is a conformity of the participating children to a single method.

The group differences found in these open diffusion studies are consistent with our prior diffusion chain studies in which alternative techniques were passed along a chain of young children. In the diffusion chain studies fidelity was high with no crossover infidelity in the two chains. In the two open diffusion studies we do see a settling of groups, whether whole groups or monocultures, on a single method for a group. In the open diffusion studies we see more variation in the methods used, which means that children have access to a variety of methods, yet through social learning groups become faithful to a particular method. It is likely, as both method and outcome are replicated, that imitation is the key mechanism in this adoption of behaviour.

Open diffusion studies are important as they offer a richer and more realistic portrayal of cultural diffusion dynamics. However, Flynn and Whiten (2010)’s exploration of the role of personal versus social information in subsequent behaviours did not provide a robust analysis due to the small sample of children. Therefore I, along with colleagues, ran a larger dyadic study to establish whether previous experience would influence children’s predisposition to learn from others about a task. The design of the study drew on real life dynamics as comparisons were made across groups of children who had differing levels of experience with a task and input from others. In Wood, Kendal and Flynn (2012) 167 5-year-olds were spilt across a number of conditions which had two phases: one in which children either were presented with a demonstration of how to open an artificial fruit, or where they were presented with the artificial fruit and were allowed to discover a method of extracting the reward for themselves, so social versus personal experience respectively. Following this they were presented with a demonstration that either used the same method
from the first phase or used an alternative method. The question of interest was whether children would stick to the method they initially experienced or whether they would swap to a newly demonstrated method, and whether the source of the initial information (social or personal) influenced whether they adopted the new method. Children were also given multiple trials during the second phase to see if they switched between methods, or remained with an already acquired method. If children are more likely to stick to a method they have acquired through social rather than personal learning, then it illustrates the power of imitation. Whereas if both groups show a similar level of later fidelity (or not) over trials then it shows that both social and personal learning have equal influence on behaviour.

Children who saw the same method demonstrated across the two phases, whether the initial discovery was made socially or personally, were unlikely to discover any other methods during their attempts. When children were presented with a new (second) solution they incorporated this new solution into their repertoire, but this new method did not become dominant and children switched between the two methods across multiple later trials. Adopting further strategies when one already has a successful strategy allows resilience if an original strategy fails, increases one’s overall knowledge of the task and provides generalisable knowledge regarding the properties of each strategy and the task at hand and a motivation to acquire additional knowledge enables modifications over time.

Together this work demonstrates that information is often acquired through social learning. Imitation is critical in this process as we see individuals adopting both the methods, which are applied to a task, as well as achieving the outcome. Further, irrelevant actions are also transmitted along the chains, showing that imitation is critical to cultural transmission of functionally relevant and also less immediately functionally relevant information, showing how normative, non-causally essential behaviours can be adopted and transmitted. Imitation is, however, not the only game in town with other mechanisms, such as teaching, taking an important but less prevalent role (for example, we see the role of other learning mechanisms in diffusion chains with adults, Caldwell & Millen, 2008). It should also be noted that all of these studies draw from WEIRD societies: Western, Education, Industrialized, Rich and Democratic, in which specific forms of information transmission, such as schooling, occur at a very early age. Thus, the generalisability of the role of imitation in cultural acquisition remains questionable. Table 1 presents a list of areas rich for future exploration, based on the results reflected on here. Is imitation the sincerest form of cultural evolution? It is clearly a key contender, with much evidence in these studies showing compelling evidence for its significant role.
<table>
<thead>
<tr>
<th>Area for fruitful future exploration</th>
<th>Expansion</th>
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<tbody>
<tr>
<td>The role of intentionality</td>
<td>Imitation differs from mimicry through the level of intentionality to replicate. The verbal exchanges of the children, not discussed here due to space constraints, suggest that the children were intending to copy. Yet, intentionality remains an elusive aspect within imitation research due to the difficulty of ‘proving’ a mental state.</td>
</tr>
<tr>
<td>The role of social motivations and affiliations</td>
<td>Imitation occurred for irrelevant actions when it was clear that there was no causal rationale for their production, as a reward was already acquired. Thus, children imitate behaviours that have no immediate benefit. Cultural gestures signal one’s identity, and imitation produces strong affiliations between individuals. What remains unclear is how much of children’s imitation is driven by explicit reward acquisition, and how much is driven by social motivations such as cultural belonging, or social affiliation?</td>
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<tr>
<td>Interplay between social learning strategies and social learning</td>
<td>Within a cultural setting there are many dynamics at play: the setting in which the learning takes place and the characteristics of the task or the model. These dynamics interplay with social learning strategies. It seems likely that one is more likely to imitation when uncertain, when seeing an expert other, or when one sees success by others. All of these strategies are discussed directly in Flynn and Whiten (2010).</td>
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<tr>
<td>The role of verbal communication</td>
<td>Here I have presented mostly observational data, yet children are verbal creatures. I witnessed instances of verbal teaching, negotiation, collaboration in the open diffusion studies. The interplay between different transmission mechanisms is ripe for exploration, as suggested by Charbonneau and Strachan (2022).</td>
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<tr>
<td>What springs one out of normative behaviour?</td>
<td>Children kick against the norm; remember the single girl who attempted something new in one of her attempts. What is special about the dynamics at play at that point: is it something about her, or something about the relationship between the model, observer and task? Such a question underpins the ‘change’ aspect of cultural evolution.</td>
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References


