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ARTICLE

Do children imitate even when it is costly? New insights from a novel task

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Abstract

Children have a proclivity to learn through faithful imitation, but the extent to which this applies under significant cost remains unclear. To address this, we investigated whether 4- to 6-year-old children ($N = 97$) would stop imitating to forego a desirable food reward. We presented participants with a task involving arranging marshmallows and craft sticks, with the goal being either to collect marshmallows or build a tower. Children replicated the demonstrated actions with high fidelity regardless of the goal, but retrieved rewards differently. Children either copied the specific actions needed to build a tower, prioritizing tower completion over reward; or adopted a novel convention of stacking materials before collecting marshmallows, and developed their own method to achieve better outcomes. These results suggest children's social learning decisions are flexible and context-dependent, yet that when framed by an ostensive goal, children imitated in adherence to the goal despite incurring significant material costs.

KEYWORDS

children, cost, flexible imitation, goals, high-fidelity imitation, social learning

BACKGROUND

Humans acquire a considerable portion of their knowledge and skills from each other via high-fidelity imitation (Legare, 2019; Legare & Nielsen, 2015). This process of social learning is thought to help lay the foundations of what is known as cumulative culture, whereby humans not only learn by copying others but also build on and improve their toolkit and pass it on to the next generation (Tomasello

et al., 1993). After multiple generations of progress, we accordingly possess a remarkable body of complex languages, cultural artefacts, rituals, advanced technology, and scientific knowledge that no individual could come up with on their own (Mesoudi & Thornton, 2018). Although there is evidence of cumulative culture in other animals, there is nothing that mirrors the depths and complexities of its expression in us (Whiten, 2019, 2022).

Imitation may be particularly critical for children, given the wealth of human repertoires they need to acquire to become competent adults and be integrated into their cultural in-group. By approximately 6 months of age, infants will copy simple, novel object-directed actions they have observed others performing to achieve an intended outcome (Barr et al., 1996; Meltzoff, 1988). By around 2 years of age, children's inclination to imitate reaches a striking level, where even perceivably causally unnecessary actions may be replicated (Hoehl et al., 2019; Nielsen, 2006). This particular form of high-fidelity copying, known as *over-imitation* (Lyons et al., 2007), has been widely documented and appears to be human-specific. In a now classic study by Horner and Whiten (2005), an adult human model demonstrated a means of reward retrieval on a novel apparatus. The model used a stick to reveal two openings in the apparatus and inserted the stick into each in turn. The reward could be retrieved only through the second opening, rendering as redundant all actions on the first opening. This redundancy, however, could be seen only when the apparatus was transparent, compared with a version where it was opaque. While chimpanzees omitted the redundant actions when the apparatus was transparent, human children imitated with high levels of fidelity irrespective of the transparency of the apparatus. This, alongside other studies (Clay & Tennie, 2018; Clegg & Legare, 2016a; McGuigan et al., 2007; Nielsen et al., 2014; Wilks et al., 2019), shows that children's proclivity to learn by faithfully replicating the 'process' of a behaviour at the expense of more effective means is distinct from even our closest living primate relatives (Byrne, 2009; Dean et al., 2012; Tomasello, 2019).

A sound reason for this initially puzzling proclivity could be that a process-oriented, high-fidelity form of learning is hugely beneficial over the long term. Copying what others do with objects is a powerful strategy, which helps avoid potentially costly individual trial-and-error learning, especially in a human cultural landscape furnished with complex artefacts (Laland, 2004). Such strategy also allows for the propagation of cultural traditions and rituals, which may be equally functionally opaque but are important for children for the purpose of group cohesion and society formation (Nielsen, 2018; Norenzayan et al., 2016; Over, 2020). By imitating faithfully, children build up affiliation and rapport with others, enhancing group living and supporting individual survival (van Baaren et al., 2004; Watson-Jones & Legare, 2016). In line with this, Whiten et al. (2005) suggested that imitation is a pragmatic 'rule of thumb' in children's social learning, helping them acquire the massive human cultural knowledge and skill reservoir.

Past research has indicated that children opt for high-fidelity imitation particularly when the primary learning purpose is social/conventional, but focus more on achieving an instrumental goal optimally and imitating with less fidelity (Clegg & Legare, 2016b; Herrmann et al., 2013; Legare et al., 2015; Williamson et al., 2008). Nonetheless, the scope and limits of children's drive to imitate faithfully remain unclear. More specifically, will children prefer to act out an action sequence they have seen someone else model if it entails abandoning a desirable, material reward?

One obfuscating factor in answering this question is that in almost all imitation studies published to date, there may be only a minimal cost to copying. Children are typically offered an opportunity to retrieve a reward or an object from a puzzle box, or they are given a chance to play with some materials after watching a model interact with them. Replicating the model's actions faithfully leads to the same material outcome for children as does ignoring most or all of the modelled actions. Consequently, other than to save a little time and energy when performing the task, there may be little reason to not imitate faithfully.

To the best of our knowledge, only a few studies have explored scenarios where imitations are made costly (Burdett et al., 2022; Carr et al., 2015; DiYanni et al., 2011; Evans et al., 2021; Keupp et al., 2016; Lyons et al., 2011; Vale et al., 2017). Several of these studies featured no tangible material cost to the child. These non-material costs varied in nature and were challenging to compare directly: the copied

Statement of contribution

What is already known on this subject?

- Children have a tendency to learn through faithful imitation, even replicating causally unnecessary actions.
- However, past imitation studies rarely involved costly actions.

What the present study adds?

- The present study utilized a novel simple task where material rewards were pitted against imitation.
- Children's social learning decisions are flexible and context-dependent; and can be driven by the process or the end-goal of the demonstration.
- Depending on the ostensive task goal and the level of social pressure, children's social learning behaviour can come at a significant material cost.

actions lead to someone else's belongings being destroyed (Keupp et al., 2016), losing in a competition (Lyons et al., 2011), or failing to complete a task (DiYanni et al., 2011). In studies that included a loss of material rewards, two involved copying only a single action of choosing an object (Burdett et al., 2022; Vale et al., 2017), leaving open the question of how children would adjust their level of imitative fidelity when faced with longer action sequences that require more advanced cause–effect understanding and intent interpretation, alongside balancing complex instrumental and social functions.

Among the studies that did involve copying action sequences (Carr et al., 2015; Evans et al., 2021; Lyons et al., 2011), rewards were placed inside unfamiliar puzzle boxes, adding to the novelty and complexity of the task. This, in turn, may have restricted children's causal understanding thereby increasing their imitative tendencies (Flynn & Whiten, 2008; Gardiner et al., 2012; Marsh et al., 2019; Wood et al., 2016). These studies also yielded mixed findings with young children either imitating less faithfully (Burdett et al., 2022; DiYanni et al., 2011; Evans et al., 2021; Keupp et al., 2016; Vale et al., 2017) or continuing to overimitate (Carr et al., 2015; Lyons et al., 2011). As a result, a study that involves desirable material rewards but does not rely on puzzle boxes is needed to better understand the impact of cost on children's faithful imitation of action sequences.

The current study thus set out to investigate whether, after witnessing a simple novel task performed, children would refrain from imitating what they saw if it meant forsaking a desirable food reward. Food rewards were implemented as they serve as naturally rewarding tokens, especially palatable and caloric foods are closely linked to the brain's reward pathways and can reinforce associated behaviours (de Araujo et al., 2020; Neary & Batterham, 2010). Children are particularly responsive to the rewarding properties of such foods (Rollins et al., 2014). Moreover, the present task was designed such that faithful replication of all modelled actions would lead to only a small proportion of the possible rewards available being collected. If children were to copy faithfully, they would only gain one marshmallow instead of all five (across two trials this effectively meant collecting two marshmallows instead of ten). Given the strong motivational drive of marshmallows, it was expected that the trade-off between imitation and reward would push children to evaluate and adjust their imitative decisions. Additionally, the unique action sequence of constructing a platform and collecting marshmallows involved concepts and skills familiar to children. Children were given the freedom to do whatever they wanted with the materials and were reassured any marshmallows they collected could be taken home. Four- to 6-year-old children were recruited as children of this age have previously been established as strong imitators (Kenward, 2012; Lyons et al., 2007; Nielsen & Tomaselli, 2010) yet also capable of selective imitation (Evans et al., 2018; Hoehl et al., 2014; Nielsen & Blank, 2011).

To further investigate whether children's imitative fidelity would vary when the cost of the actions was marginalized or stressed, we framed the goals of the task as either to 'build a tower' or to 'collect marshmallows'. We cued these alternative task goals verbally as this can effectively manipulate children's task interpretation without altering the demonstrated actions (Clay et al., 2018; Clegg & Legare, 2016b; Herrmann et al., 2013; Legare et al., 2015; Moraru et al., 2016). Children tend to imitate faithfully when the actions themselves are interpreted as the task goal (Carpenter et al., 2005), but are less likely to do so when the actions inhibit goal attainment (Meltzoff, 1995). We therefore expected children to focus on the process and imitate more faithfully when the goal was to 'build a tower' compared with when it was to 'collect marshmallows'. Because the goal was distinguished from the rewards per se, we also expected children to collect fewer marshmallows in the tower building condition.

The social side of imitation was also tapped by manipulating the degree of social pressure embedded in the demonstrations. Children were shown two types of demonstrations, one with a single model and the other with three adults standing behind the model nodding and smiling when the model was demonstrating. Past research shows that children are sensitive to shared judgement among individuals (Carpenter et al., 2005; Haun et al., 2012; Nielsen & Tomaselli, 2010; Wilks et al., 2015) and are more likely to imitate faithfully the actions demonstrated by a model being supported by multiple individuals (Evans et al., 2021; Fusaro & Harris, 2008). Thus, children were predicted to imitate with higher fidelity after seeing the demonstration with a group of adults, compared with when shown the demonstration of a single adult. Taken together, these conditions evaluated the interplay between different instrumental and social factors, affording novel insights into children's adaptability and flexibility toward diverse social learning contexts. A summary of the conditions can be seen in Table 1.

METHOD

Participants

Ninety-seven 4- to 6-year-old children ($M = 5.36$ years, $SD = 0.90$, 49 girls) were included in the final sample. This sample size allowed us to detect a large effect size (calculated with G*Power, $f = 0.40$, power over 90%, $\alpha = .05$). Data were collected from July 2021 to April 2022, when participants were tested in a university lab located within a large western metropolitan city. Consent was obtained from the children's guardians prior to their participation. Most guardians reported education background (91%) and ethnicity (97%); of those who reported, 94% of the families had at least one guardian with a university degree (73% of whom had a higher university degree). Participants were mostly Oceanians (51%), 29% were from multiple ethnic backgrounds, 12% Asian, and 7% European. An additional 13 children were excluded from analysis due to experimenter error ($n = 2$), condition assigning issues ($n = 8$), and failure to complete the task ($n = 3$). Children were tested in quiet rooms and received a small gift for participation. This study was approved following the ethical review processes of the University's Health and Behavioural Sciences Review Committee (Project no. 2021/HE000731).

TABLE 1 Summary of within group conditions and between group demonstration type.

Tower building	Marshmallow collecting	Control
Same demonstration		No demonstration
Two trials: a single model + a group consensus (sequence counterbalanced)		
Goal: to build a tower	Goal: to collect marshmallows	No goal

Design and materials

Children observed an adult model construct a small tower using marshmallows and craft-sticks, and then collected the marshmallow they had placed on top of the tower. We employed a mixed experimental design with condition as the between-subject variable: A third of the participants ($n = 35$) were told that the goal of the task was to 'build a tower' (Tower Building condition), and a third ($n = 32$) were told that it was to 'collect marshmallows' (Marshmallow Collecting condition). The remaining participants ($n = 30$) received no demonstration in order to examine children's spontaneous responses toward the test materials. Within each condition, there were two consecutive trials in which children either watched a video of a lone model or a video of the same model observed by three additional adults (two levels: single or consensus, sequence counterbalanced). This was set as a within-subject variable for more cost-effective sampling and to investigate whether children would adjust their strategies after viewing a less or more normative demonstration.

As shown in Figure 1, the initial setup in each trial entailed five Marshmallows (placed in a 17 cm × 11.5 cm × 5 cm container) and eight 15 cm × 9 cm craft-sticks placed on the table. An A4 paper sheet with four circles on it marking the locations of the marshmallows was placed in the centre of the table. A zip-lock bag was provided to store the marshmallows children collected. Additionally, a wooden box (19.05 cm × 12.05 cm × 6 cm) was used in the warm-up phase to introduce the process of marshmallow retrieval. A child-friendly, smiley-face Likert scale was displayed on a sheet of paper (21 cm × 6 cm) to record children's preferences for marshmallows at the end of each testing session (ranged from 1 = *Don't Like Very Much* to 5 = *Like Very Much*).

Demonstration videos

The task demonstrations were pre-recorded (see Figure 2). There were two types of video demonstrations. The 'single' video featured either a lone adult male or female model demonstrating the task; the 'consensus' video involved three additional adults standing behind the same model, nodding and smiling while the model was performing the actions. These models wore matching clothes to enhance

FIGURE 1 Materials used and experimental set-up. The smiley-face Likert scale was coloured as follows (from left to right): red, orange, yellow, light green and dark green.

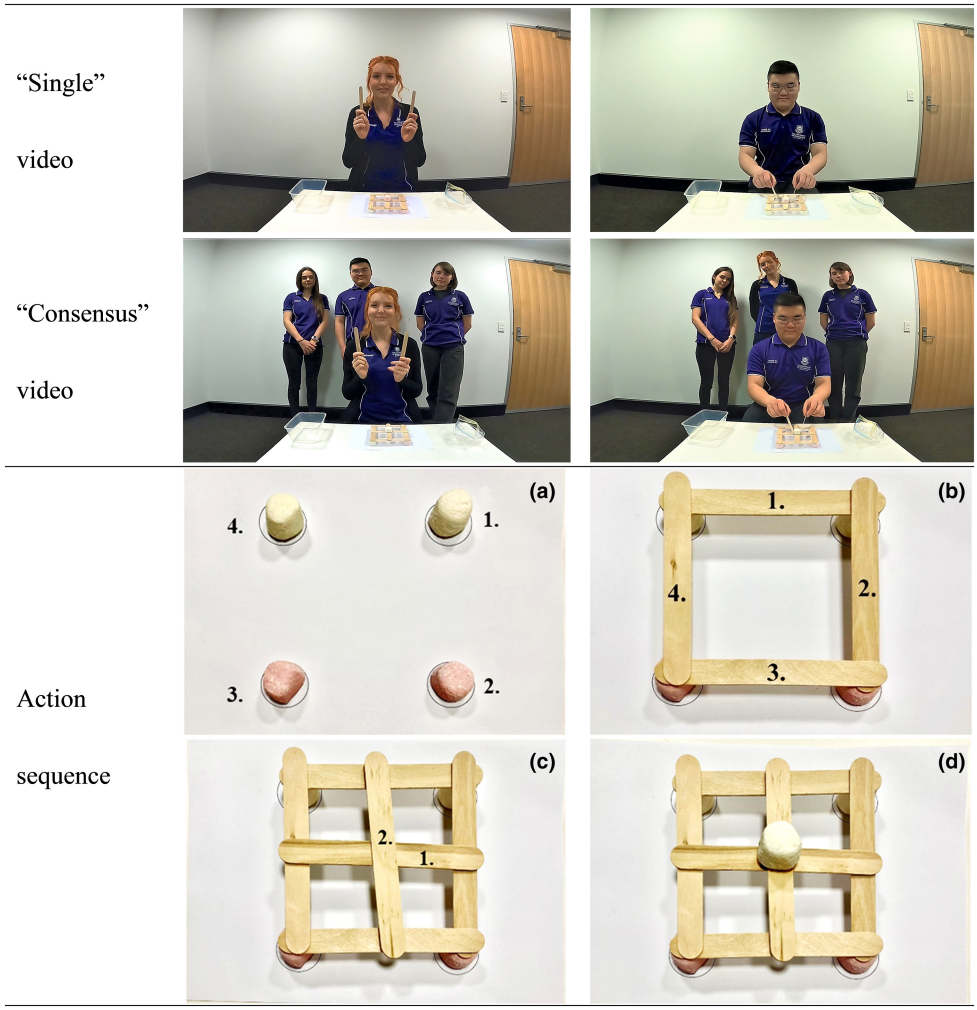

FIGURE 2 Screenshots of the video demonstrations and the sequence of the actions. The positioning sequence of the materials was as numbered.

shared group membership. Each video included the model first putting four marshmallows in a square on the A4 paper provided. The model then placed a stick on top from one marshmallow to the next. After making a square, two additional sticks were put across the midpoints of the four sticks. After that, the model picked up a final marshmallow using two new sticks and placed it in the middle of the crossed sticks. This marshmallow was then picked up again using the sticks and placed in the zip lock bag. Model sex was balanced, with half the children watching a same sex model, and the remaining half watching an opposite sex model.

Procedure

All children were tested individually in a quiet room. The experimenter sat opposite the child at a small table. Before the testing session began, guardians were asked whether they commonly had marshmallows in their house (*Yes* or *No*), and how frequently their children ate marshmallows (on a five-point Likert scale ranging from 1 = *Never* to 5 = *Always*).

Familiarization

The testing session started with a warm-up phase to familiarize children with the premise that: (1) they were allowed to take any marshmallows home by putting them into a zip-lock bag and (2) to practise the use of the smiley-face Likert scale. Children were presented with a wooden box with a marshmallow placed inside. Once children opened the box, they were told that if they wanted this marshmallow, they could put it in the zip-lock bag to 'bring it home'. To ensure adherence to ethical guidelines, children were instructed to store the marshmallows in the bag instead of eating them straight away to make sure consumption was at their guardian's discretion. After that, the experimenter took out the smiley-face Likert scale, explained the meaning of each face (for example: 'the green happy face means you love something'), and asked children to indicate how much they liked the wooden box by pointing at one of the faces [similar to Roberto et al., 2010)]. Children were then randomly assigned to one of the following three conditions which are discussed in the following sections.

Condition 1: Tower building

After the warm-up phase, the experimenter introduced children to the task by saying 'now I'm going to show you some videos, and then you can play with some fun stuff' (full script can be seen in Appendix). The video was introduced by saying 'now let's watch my friend building a tower'. The video demonstration was played on a 10.9-inch screen tablet. After watching the video twice, children were given the materials and told to 'do whatever you want'. The same procedures were repeated for the second trial. Each trial ended when children indicated they were done or finished, or when children were unwilling to interact with the materials further. Non-directive verbal encouragement was given if a child was reluctant or shy; otherwise, the experimenter did not interact with children or react to their actions during the trials.

Condition 2: Marshmallow collecting

Procedures in this condition were the same as in the Tower Building condition with only one difference: the videos were introduced by saying 'now let's watch my friend collecting marshmallows'.

Condition 3: Control

In this condition, the experimenter introduced children to the materials by saying 'now I have some fun stuff here, and you can do whatever you want with them'. The same was repeated in the second trial.

In all these three conditions, children were reminded again before they interacted with the materials that if they wanted any marshmallows, they could place them in the zip-lock bag to take home.

After both trials, children were asked to indicate how much they like marshmallows by pointing to a face on the smiley-face Likert scale.

Coding

Children were scored on two measures for each test trial and in total: (1) the number of marshmallows collected (children could score from 0 to 5 in each trial; instances where a few children ate marshmallows immediately were coded as being equivalent to collecting marshmallows), and (2) the cumulative number of target actions produced. Breakdown of the target actions measure included

the following: (a) same placement of each marshmallow as the experimenter (five scores in total), (b) same placement of each stick (six scores in total), and (c) same usage of two additional sticks in picking up the fifth marshmallow (one score). Coding was based on the location of the objects, not the sequence, given the sequence for placing the four marshmallows or the six sticks were trivial with respect to the action outcome. Hence, a child could score from 0 to 12 on this measure in each trial, and from 0 to 24 in total.

A second coder who was blind to the hypotheses of the present study and the conditions to which children were assigned coded 15% of the videotapes independently. Intraclass correlation coefficients (Shrout & Fleiss, 1979) indicated very good agreement between the two coders on the total number of actions imitated ($r = .99$) and the total number of marshmallows collected ($r = .99$). The current study was pre-registered and can be accessed here: https://osf.io/7qcfn/?view_only=d3737d415b67473887c6c99bb0e2eab4. Processed data and video demonstrations can be accessed here: https://osf.io/k45f6/?view_only=a91dd1cdd28e46759ea86e49910389b6.

RESULTS

As a snapshot of participants' preferences, 82% of the children tested reported liking marshmallows Very Much (five out of five on the Likert scale), 54% of children did not commonly have marshmallows in their house, and the overwhelming majority either rarely (41%) or sometimes (53%) ate marshmallows. This suggests the rewards were highly desirable yet not frequently available.

Marshmallow collection and imitation scores were treated separately. Preliminary analyses showed no effect of sex, preference for marshmallows, whether children commonly had marshmallows at home or not, and how often children ate marshmallows, therefore these variables were not considered further.

Marshmallows collected

A mixed-factorial analysis of co-variance (ANCOVA) examined how video type (single vs. consensus) and condition (Tower Building vs. Marshmallow Collecting) affected the total number of marshmallows collected by children with age as a covariate (see Figure 3). There was a significant interaction effect of video type on condition (F [1, 64] = 4.59, $p = .036$, $\eta_p^2 = 0.07$), indicating that video type elicited more difference between conditions when observing a single model compared with when observing a group consensus (interpretation based on model estimated marginal means and 95% confidence intervals as shown in Figure 4, see Garofalo et al., 2022). There was no significant main effect of video type (F [1, 64] = 0.36, $p = .552$) or condition (F [1, 64] = 0.53, $p = .469$), nor a significant effect of age (F [1, 64] = 1.63, $p = .206$). This finding suggests that video type had a differential impact on the two conditions. Furthermore, the reward retrieval of children across all age groups was contingent on whether they had observed a single model or a group consensus.

A breakdown of reward retrieval in the Control condition suggests that around half of the children spontaneously collected all the marshmallows, with the rest collecting none or only a few (see Figure 5). The number of children who collected all marshmallows was compared among conditions (see Table 2). A Pearson's χ^2 test of independence showed a significant main effect of condition, $\chi^2(2) = 6.56$, $p = .038$, *Cramer's* $V = 0.26$. Follow up pair-wise comparisons using Bonferroni-adjusted a levels of .025 per test (.05/2) showed a significant difference between the Tower Building and the Control condition, $\chi^2(1) = 5.53$, $p = .019$. There was no significant difference between the Marshmallow Collecting and the Control conditions, $\chi^2(1) = 3.39$, $p = .065$. Thus, significantly fewer children chose to maximize their reward in the Tower Building condition than that in the Control. In contrast, a similar proportion of children maximized their gain in the Marshmallow Collecting condition.

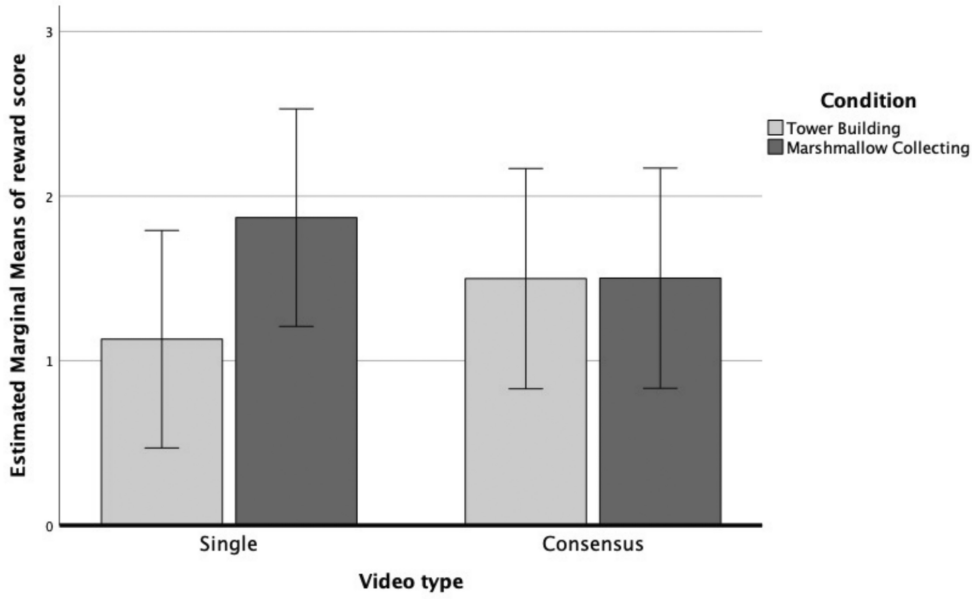

FIGURE 3 The number of marshmallows collected in both conditions by video type. Error bars represent plus or minus two SEs from the mean.

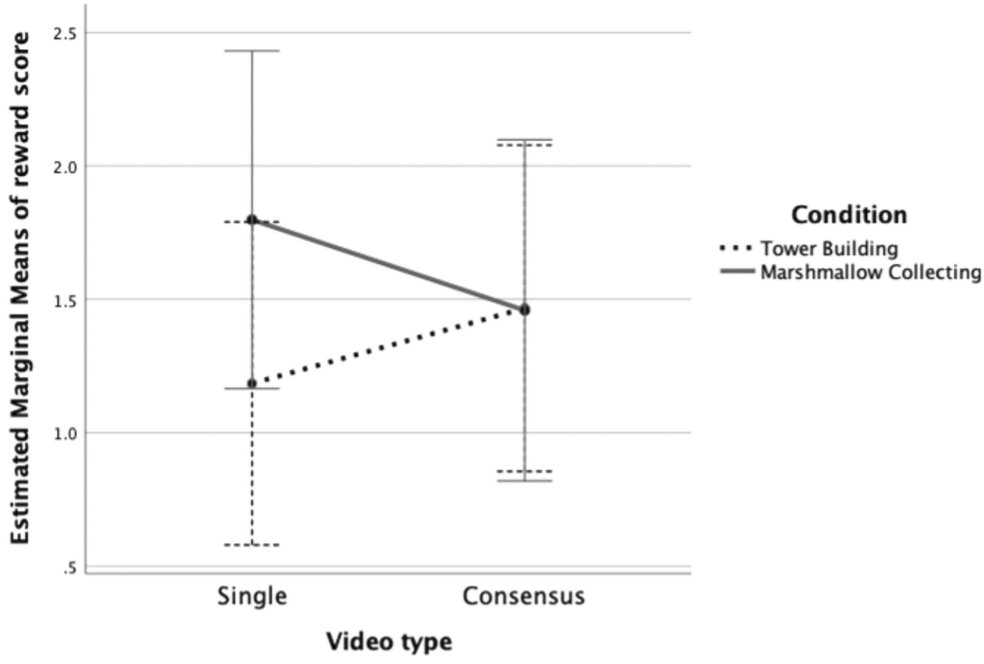

FIGURE 4 Interaction effect between video type and condition. Error bars represent 95% confidence intervals of the mean.

Imitative fidelity

A mixed-factorial analysis of variance (ANOVA) examined how video type (single vs. consensus) and demonstration condition (Tower Building vs. Marshmallow Collecting) affected the total number of

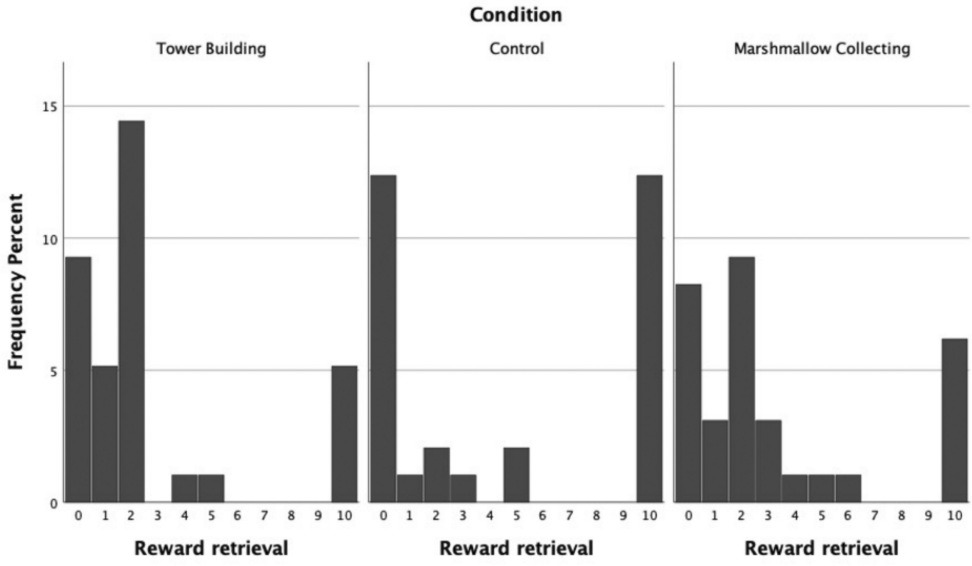

FIGURE 5 Distribution of the number of marshmallows collected in the three conditions across both trials.

TABLE 2 Descriptives of the number of marshmallows collected in all conditions across both trials.

Condition	Mean	SE	Mean 95% CI [LL, UL]	Percentage of collecting 10	Of those collecting less than 10			
					Mean	SE	Min.	Max.
TB	2.63	0.55	[1.51, 3.75]	14	1.40	0.22	0	5
MC	3.28	0.63	[1.99, 4.57]	19	1.73	0.32	0	6
Control	4.60	0.85	[2.86, 6.34]	40	1.00	0.40	0	5

Note: LL and UL represent the lower limit and upper limit of the mean confidence interval, respectively. TB and MC represent the Tower Building and the Marshmallow Collecting conditions, respectively.

actions replicated by children (see Figure 6). There was no significant main effect of age, video type and condition, $F(1, 57) = 0.02$, $p = .892$; $F(1, 57) = 0.01$, $p = .928$; $F(1, 57) = 0.20$, $p = .658$, respectively. Additionally, there was no significant interaction effect. This suggests that regardless of the framing of the task, children displayed equivalently high levels of imitative fidelity. Also, the added social pressure did not elicit different imitative behaviour.

A breakdown of the specific actions copied in both experimental conditions indicates that on average children replicated most of the marshmallow positioning actions ($M = 86\%$, $SD = 28\%$) and the stick-positioning actions ($M = 70\%$, $SD = 35\%$). Children collected marshmallows in the same way as the model (using two sticks; $M = 53\%$, $SD = 48\%$) and correctly positioned the fifth marshmallow on top ($M = 49\%$, $SD = 43\%$) around half of the time. There was no significant difference in children's imitation of each category of the action sequence between the two demonstration conditions. A one-way ANOVA indicated a significant main effect of condition on imitative fidelity, $F(2, 96) = 59.80$, $p < .001$, $\eta^2 = 0.56$. Post-hoc comparison using Turkey's HSD revealed children in the Control condition ($M = 2.90$. $SD = 4.09$) produced significantly fewer target actions compared with those in the Tower Building ($M = 18.00$. $SD = 6.51$, $p < .001$) or the Marshmallow Collecting conditions ($M = 17.23$. $SD = 6.76$, no difference from the Tower Building, $p = .999$). This suggests that the designed action sequence is unlikely to be produced by children spontaneously without observing the demonstration.

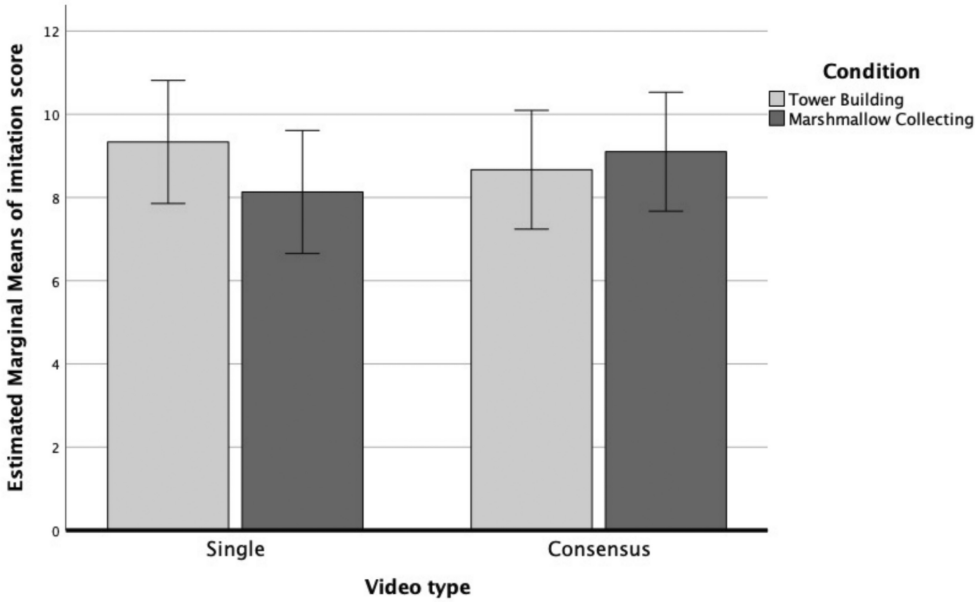

FIGURE 6 The number of actions replicated in both conditions by video type. Error bars represent plus or minus two SEs from the mean.

Overall, there was a negative correlation between imitation score and the number of rewards collected by children ($r = -.20$, $p = 0.046$), this is in line with our study design to pit imitative fidelity against reward retrieval. Children who collected all marshmallows imitated to a similarly high extent ($P_{TB} = 14\%$, $P_{MC} = 19\%$, $M = 16.45$, $SD = 8.73$) as those who collected fewer marshmallows in both experimental conditions ($M = 17.86$, $SD = 6.42$, $t\,[65] = 0.62$, $p = .535$, $d = 0.21$), there being no difference between conditions ($t\,[9] = -.84$, $p = .778$). Given marshmallows were used as building blocks in the tower construction actions, this finding suggests that children prioritized imitation and collected the rewards afterwards by taking the tower apart.

DISCUSSION

Research into children's imitative flexibility has yielded many novel insights into the social and cognitive proclivities of developing children, and by extension the evolution of some of the core traits of our species (Hoehl et al., 2019; Legare & Nielsen, 2015). However, most of this work has utilized protocols that involve opening puzzle boxes, and tasks that involve little incentive for learners to deviate from a modelled action sequence. This constrains our knowledge of children's developing social learning tendencies. To begin addressing this gap, we designed a novel task in which replication of modelled actions was pitted against retrieval of an easily accessible, desirable food reward. Our primary finding was that despite comparable imitative fidelity in the two demonstration conditions, children were more likely to deviate from the modelled actions of collecting the top marshmallow only and seek greater reward when the goal was to 'collect marshmallows', especially when the social pressure to conform was weaker. In contrast, when the supposed intended outcome did not involve accessing the available food rewards (i.e., to 'build a tower'), children elected not to retrieve them. This highlights how ostensive goals and social pressure guide children's social learning behaviours, and imitation can be directed by different motivations, even in ways that are costly.

That children in the Marshmallow Collecting condition were equivalently likely to re-enact the demonstrated actions with high fidelity as those in the Tower Building Condition is somewhat surprising. In the Marshmallow Collecting condition, the demonstrated building actions were not only unnecessary to the stated goal of collecting marshmallows but also seemingly impeded this. Past research has shown that providing a clear purpose for an instrumental task induces selective imitation where children are inclined toward the most efficient means of completing a task (Fong et al., 2021; Gergely et al., 2002; Williamson & Markman, 2006; Wohlschläger et al., 2003). Children also exhibit payoff-biased social learning and are less likely to adopt the model's solution when this limits their reward gain (Burdett et al., 2022; Vale et al., 2017). This predicts children would have copied less when the actions were contradicting the goal of collecting marshmallows, but they did not. A potential explanation for this finding may be that the tower-building actions lacked an underlying reason for their execution when the goal was to collect the rewards. Arbitrary actions like these could have signalled conventionality, priming children to imitate more faithfully than they otherwise might (Boyer & Liénard, 2006; Legare et al., 2015; Nielsen et al., 2018). This finding thus highlights the importance of detailing the motivations underpinning children's social learning responses in any given task and for identifying when action sequences and their associated goals are treated as instrumental versus when they are treated as conventional. Furthermore, being presented with a novel task by an unfamiliar adult in an unfamiliar experimental setting may have triggered children to want to 'do well', potentially creating a sense of obligation to follow through with the observed actions (Hoehl et al., 2019). Future studies would benefit from reducing situational expectations by utilizing more naturalistic settings.

Although children in the two demonstration conditions imitated with comparable fidelity, those in the Tower Building condition tended to replicate what the model had done and stop at completion, maintaining the integrity of the tower, whereas those in the Marshmallow Collecting condition tended to copy the modelled sequence but then break parts or all of the tower to collect more treats. Specifically, when the purpose of the task was to 'build a tower', significantly fewer children collected the maximum number of marshmallows available compared with the Control condition. This highlights how children's inclination to follow through with the intended goal detailed by others can be so strong that it will pull them away from an attractive reward to complete a largely useless task. This was especially the case when children were observing only a single model, thereby receiving minimum social pressure to conform and copy all of the actions demonstrated, including the collection of one marshmallow that had no bearing on the task goal of building a tower. Such findings point to the potential costliness of imitation when the task goal is directed towards something other than, or even contradictory to, the child's own interest.

Children who were told the aim was to collect marshmallows ultimately retrieved all marshmallows at rates similar to those in the no demonstration condition. This is consistent with studies showing that, under certain circumstances, children will deviate from a demonstrated outcome, developing their own solutions to achieve better outcomes (Fong et al., 2021; Keupp et al., 2016; Schulz et al., 2008). That is, when the model's approach aligns with the child's objective, children are able to flexibly adapt the observed method to eliminate the potential cost of imitating. Nevertheless, there is perhaps some possibility that children may not have fully understood or remembered the task goal, which was stated only once before showing the video demonstrations. Future studies could reiterate the goals multiple times and include a post-experiment test evaluating children's recall of the task goal.

Children's social learning flexibility was also illustrated by their responses to different levels of social pressure. When observing a single model, children's reward retrieval aligned more with the stated task goal: children collected more rewards when told the goal was to do so, but collected fewer rewards and thus focused more on the building process when told the goal was to build a tower. However, when watching a group consensus, the difference between the two conditions disappeared as children tended to copy closely what the model did, therefore restricting reward retrieval in the Marshmallow Collecting condition but increasing reward gain in the Tower Building condition. This pattern corresponds with previous studies examining the impact of group consensus on children's conformity, where young children were found to show a tendency for adopting the behaviours or choices endorsed by a group

(Corriveau et al., 2009; Fusaro & Harris, 2008). Taken together, the disparate outcomes of reward retrieval between the two experimental conditions highlight the adaptable and context-sensitive nature of children's imitative responses, which depend on both task goals and the level of social pressure exerted upon them.

Despite marshmallows being considered a highly rewarding food item, the current paradigm may have restricted the expected impact of this incentive. While nearly all children reported liking marshmallows very much and were happy to take all the marshmallows home when asked at the end of the experiment, only half of those in the Control condition collected all marshmallows. A potential explanation was that marshmallows were indeed an attractive reward, however, given the settings of the study, children may have been hesitant to take them. Children in Western cultures are generally taught by their caregivers to be mindful of their sugar intake and to treat food with care (Eck et al., 2018; Prada et al., 2021). This could have led children to refrain from taking marshmallows, especially when they were accompanied by their parents during the experiments. Therefore, it would be valuable to evaluate how children respond if their access to treats in any form is rare, be that due to cultural or economic constraints. Additionally, as an ethical consideration aimed at reducing potential caregiver fears about sugar consumption, we elected to have the marshmallows be rewards children could take home and not be consumed immediately. It is possible this impacted their reactions as young children tend to discount the value of a delayed reward (Green et al., 1994; Lee et al., 2013). Children may respond differently if they can eat any treats straight away rather than being forced to wait, especially if a timer is imposed whereby any treats not retrieved are forsaken.

Taken together, our results show that when told the goal was to build a tower, children focused on doing so as shown, even though this meant forsaking considerable portions of a treat they themselves identified as desirable. Though they still copied what the model did, if told the aim was to collect marshmallows, the children extended what was shown and developed their own methods, thereby gaining rewards in the process. These findings are in line with notions that children's social learning approaches are built on shared intentionality and goals (Carpenter, 2006; Tomasello et al., 2005), and highlight that children's drive to imitate in adherence to shared goals can outweigh their personal gain. Our findings are also consistent with a view of children's social learning as dynamic, driven by their understanding of multiple aspects of the task (Keupp et al., 2018).

Taking account of both children's learning of the intended method and reward retrieval separately affords important insights into children's social learning behaviour. By attending to children's learning of the method, we note that the motivations underlying their high-fidelity copying of the demonstrated process across two conditions may be different—one as faithful re-enactment of steps to construct a tower, another as faithful replication of a new convention to collect marshmallows. On the other hand, children behaved differently in terms of the material outcome according to different task goals and levels of social pressure to conform. These findings illustrate children's high flexibility in adjusting their social learning responses according to particular task demands and in consideration of both action processes and task end-goal. This is a hallmark of the evolution of cumulative culture, one of the defining features of our species, and one that we see here in place relatively early in development.

AUTHOR CONTRIBUTIONS

Mingxuan Zhao: Conceptualization; writing – original draft; investigation; methodology; validation; visualization; writing – review and editing; software; formal analysis; project administration; data curation. **Frankie T. K. Fong:** Conceptualization; investigation; supervision; methodology; writing – review and editing; resources. **Andrew Whiten:** Writing – review and editing; funding acquisition. **Mark Nielsen:** Supervision; conceptualization; investigation; funding acquisition; writing – review and editing; methodology; resources.

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CONFLICT OF INTEREST STATEMENT

There are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

DATA AVAILABILITY STATEMENT

The current study was pre-registered and can be accessed here: https://osf.io/7qcfn/?view_only=d3737d415b67473887c6c99bb0e2eab4. Processed data and video demonstrations can be accessed here: https://osf.io/k45f6/?view_only=a91dd1cdd28e46759ea86e49910389b6.

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REFERENCES

Barr, R., Dowden, A., & Hayne, H. (1996). Developmental changes in deferred imitation by 6- to 24-month-old infants. *Infant Behavior and Development*, *19*(2), 159–170. https://doi.org/10.1016/S0163-6383(96)90015-6

Boyer, P., & Liénard, P. (2006). Precaution systems and ritualized behavior. *Behavioral and Brain Sciences*, *29*(6), 635–641. https://doi.org/10.1017/S0140525X06009575

Burdett, E. R. R., Whiten, A., & McGuigan, N. (2022). The ontogeny of selective social learning: Young children flexibly adopt majority- or payoff-based biases depending on task uncertainty. *Journal of Experimental Child Psychology*, *214*, 105307. https://doi.org/10.1016/j.jecp.2021.105307

Byrne, R. W. (2009). Animal imitation. *Current Biology*, *19*(3), R111–R114. https://doi.org/10.1016/j.cub.2008.11.027

Carpenter, M. (2006). Instrumental, social, and shared goals and intentions in imitation. In *Imitation and the social mind: Autism and typical development* (pp. 48–70). Guilford Press.

Carpenter, M., Call, J., & Tomasello, M. (2005). Twelve- and 18-month-olds copy actions in terms of goals. *Developmental Science*, *8*(1), F13–F20. https://doi.org/10.1111/j.1467-7687.2004.00385.x

Carr, K., Kendal, R. L., & Flynn, E. G. (2015). Imitate or innovate? Children's innovation is influenced by the efficacy of observed behaviour. *Cognition*, *142*, 322–332. https://doi.org/10.1016/j.cognition.2015.05.005

Clay, Z., Over, H., & Tennie, C. (2018). What drives young children to over-imitate? Investigating the effects of age, context, action type, and transitivity. *Journal of Experimental Child Psychology*, *166*, 520–534. https://doi.org/10.1016/j.jecp.2017.09.008

Clay, Z., & Tennie, C. (2018). Is overimitation a uniquely human phenomenon? Insights from human children as compared to bonobos. *Child Development*, *89*(5), 1535–1544. https://doi.org/10.1111/cdev.12857

Clegg, J. M., & Legare, C. H. (2016a). A cross-cultural comparison of children's imitative flexibility. *Developmental Psychology*, *52*(9), 1435–1444. https://doi.org/10.1037/dev0000131

Clegg, J. M., & Legare, C. H. (2016b). Instrumental and conventional interpretations of behavior are associated with distinct outcomes in early childhood. *Child Development*, *87*(2), 527–542. https://doi.org/10.1111/cdev.12472

Corriveau, K. H., Fusaro, M., & Harris, P. L. (2009). Going with the flow: Preschoolers prefer nondissenters as informants. *Psychological Science*, *20*(3), 372–377. https://doi.org/10.1111/j.1467-9280.2009.02291.x

de Araujo, I. E., Schatzker, M., & Small, D. M. (2020). Rethinking food reward. *Annual Review of Psychology*, *71*(1), 139–164. https://doi.org/10.1146/annurev-psych-122216-011643

Dean, L. G., Kendal, R. L., Schapiro, S. J., Thierry, B., & Laland, K. N. (2012). Identification of the social and cognitive processes underlying human cumulative culture. *Science*, *335*(6072), 1114–1118. https://doi.org/10.1126/science.1213969

DiYanni, C., Nini, D., & Rheel, W. (2011). Looking good versus doing good: Which factors take precedence when children learn about new tools? *Journal of Experimental Child Psychology*, *110*(4), 575–591. https://doi.org/10.1016/j.jecp.2011.06.002

Eck, K. M., Dinesen, A., Garcia, E., Delaney, C. L., Famodu, O. A., Olfert, M. D., Byrd-Bredbenner, C., & Shelnutt, K. P. (2018). "Your body feels better when you drink water": Parent and school-age children's sugar-sweetened beverage cognitions. *Nutrients*, *10*(1232), Article 9. https://doi.org/10.3390/nu10091232

Evans, C. L., Burdett, E. R. R., Murray, K., & Carpenter, M. (2021). When does it pay to follow the crowd? Children optimize imitation of causally irrelevant actions performed by a majority. *Journal of Experimental Child Psychology*, *212*, Article 105229. https://doi.org/10.1016/j.jecp.2021.105229

Evans, C. L., Laland, K. N., Carpenter, M., & Kendal, R. L. (2018). Selective copying of the majority suggests children are broadly "optimal-" rather than "over-" imitators. *Developmental Science*, *21*(5), Article e12637. https://doi.org/10.1111/desc.12637

Flynn, E., & Whiten, A. (2008). Imitation of hierarchical structure versus component details of complex actions by 3- and 5-year-olds. *Journal of Experimental Child Psychology*, *101*(4), 228–240. https://doi.org/10.1016/j.jecp.2008.05.009

Fong, F. T. K., Imuta, K., Redshaw, J., & Nielsen, M. (2021). When efficiency attenuates imitation in preschool children. *British Journal of Developmental Psychology*, *39*(2), 330–337. https://doi.org/10.1111/bjdp.12366

Fusaro, M., & Harris, P. L. (2008). Children assess informant reliability using bystanders' non-verbal cues. *Developmental Science*, *11*(5), 771–777. https://doi.org/10.1111/j.1467-7687.2008.00728.x

Gardiner, A. K., Bjorklund, D. F., Greif, M. L., & Gray, S. K. (2012). Choosing and using tools: Prior experience and task difficulty influence preschoolers' tool-use strategies. *Cognitive Development*, *27*(3), 240–254. https://doi.org/10.1016/j.cogdev.2012.05.001

Garofalo, S., Giovagnoli, S., Orsoni, M., Starita, F., & Benassi, M. (2022). Interaction effect: Are you doing the right thing? *PLoS One*, *17*(7), e0271668. https://doi.org/10.1371/journal.pone.0271668

Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature*, *415*(6873), 755. https://doi.org/10.1038/415755a

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science*, *5*(1), 33–36. https://doi.org/10.1111/j.1467-9280.1994.tb00610.x

Haun, D. B., Rekers, Y., & Tomasello, M. (2012). Majority-biased transmission in chimpanzees and human children, but not orangutans. *Current Biology*, *22*(8), 727–731. https://doi.org/10.1016/j.cub.2012.03.006

Herrmann, P. A., Legare, C. H., Harris, P. L., & Whitehouse, H. (2013). Stick to the script: The effect of witnessing multiple actors on children's imitation. *Cognition*, *129*(3), 536–543. https://doi.org/10.1016/j.cognition.2013.08.010

Hoehl, S., Keupp, S., Schleihauf, H., McGuigan, N., Buttelmann, D., & Whiten, A. (2019). 'Over-imitation': A review and appraisal of a decade of research. *Developmental Review*, *51*, 90–108. https://doi.org/10.1016/j.dr.2018.12.002

Hoehl, S., Zettersten, M., Schleihauf, H., Grätz, S., & Pauen, S. (2014). The role of social interaction and pedagogical cues for eliciting and reducing overimitation in preschoolers. *Journal of Experimental Child Psychology*, *122*, 122–133. https://doi.org/10.1016/j.jecp.2013.12.012

Horner, V., & Whiten, A. (2005). Causal knowledge and imitation/emulation switching in chimpanzees (pan troglodytes) and children (*Homo sapiens*). *Animal Cognition*, *8*(3), 164–181. https://doi.org/10.1007/s10071-004-0239-6

Kenward, B. (2012). Over-imitating preschoolers believe unnecessary actions are normative and enforce their performance by a third party. *Journal of Experimental Child Psychology*, *112*(2), 195–207. https://doi.org/10.1016/j.jecp.2012.02.006

Keupp, S., Bancken, C., Schillmöller, J., Rakoczy, H., & Behne, T. (2016). Rational over-imitation: Preschoolers consider material costs and copy causally irrelevant actions selectively. *Cognition*, *147*, 85–92. https://doi.org/10.1016/j.cognition.2015.11.007

Keupp, S., Behne, T., & Rakoczy, H. (2018). The rationality of (over)imitation. *Perspectives on Psychological Science*, *13*(6), 678–687. https://doi.org/10.1177/1745691618794921

Laland, K. N. (2004). Social learning strategies. *Animal Learning & Behavior*, *32*(1), 4–14. https://doi.org/10.3758/BF03196002

Lee, N., De Groot, R., Boschloo, A., Dekker, S., Krabbendam, L., & Jolles, J. (2013). Age and educational track influence adolescent discounting of delayed rewards. *Frontiers in Psychology*, *4*, 1–8. https://doi.org/10.3389/fpsyg.2013.00993

Legare, C. H. (2019). The development of cumulative cultural learning. *Annual Review of Developmental Psychology*, *1*(1), 30–147. https://doi.org/10.1146/annurev-devpsych-121318-084848

Legare, C. H., & Nielsen, M. (2015). Imitation and innovation: The dual engines of cultural learning. *Trends in Cognitive Sciences*, *19*(11), 688–699. https://doi.org/10.1016/j.tics.2015.08.005

Legare, C. H., Wen, N. J., Herrmann, P. A., & Whitehouse, H. (2015). Imitative flexibility and the development of cultural learning. *Cognition*, *142*, 351–361. https://doi.org/10.1016/j.cognition.2015.05.020

Lyons, D. E., Damrosch, D. H., Lin, J. K., Macris, D. M., & Keil, F. C. (2011). The scope and limits of overimitation in the transmission of artefact culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1567), 1158–1167. https://doi.org/10.1098/rstb.2010.0335

Lyons, D. E., Young, A. G., & Keil, F. C. (2007). The hidden structure of overimitation. *Proceedings of the National Academy of Sciences*, *104*(50), 19751–19756. https://doi.org/10.1073/pnas.0704452104

Marsh, L. E., Ropar, D., & Hamilton, A. F. (2019). Are you watching me? The role of audience and object novelty in overimitation. *Journal of Experimental Child Psychology*, *180*, 123–130. https://doi.org/10.1016/j.jecp.2018.12.010

McGuigan, N., Whiten, A., Flynn, E., & Horner, V. (2007). Imitation of causally opaque versus causally transparent tool use by 3- and 5-year-old children. *Cognitive Development*, *22*(3), 353–364. https://doi.org/10.1016/j.cogdev.2007.01.001

Meltzoff, A. N. (1988). Infant imitation and memory: Nine-month-olds in immediate and deferred tests. *Child Development*, *59*(1), 217–225.

Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology*, *31*(5), 838–850. https://doi.org/10.1037/0012-1649.31.5.838

Mesoudi, A., & Thornton, A. (2018). What is cumulative cultural evolution? *Proceedings of the Royal Society B: Biological Sciences*, *285*(1880), 1–8. https://doi.org/10.1098/rspb.2018.0712

Moraru, C.-A., Gomez, J.-C., & McGuigan, N. (2016). Developmental changes in the influence of conventional and instrumental cues on over-imitation in 3- to 6-year-old children. *Journal of Experimental Child Psychology*, *145*, 34–47. https://doi.org/10.1016/j.jecp.2015.11.017

Neary, M. T., & Batterham, R. L. (2010). Gaining new insights into food reward with functional neuroimaging. *Frontiers in Eating and Weight Regulation*, *63*, 152–163. https://doi.org/10.1159/000264403

Nielsen, M. (2006). Copying actions and copying outcomes: Social learning through the second year. *Developmental Psychology*, *42*(3), 555–565. https://doi.org/10.1037/0012-1649.42.3.555

Nielsen, M. (2018). The social glue of cumulative culture and ritual behavior. *Child Development Perspectives*, *12*(4), 264–268. https://doi.org/10.1111/cdep.12297

Nielsen, M., & Blank, C. (2011). Imitation in young children: When who gets copied is more important than what gets copied. *Developmental Psychology*, *47*(4), 1050–1053. https://doi.org/10.1037/a0023866

Nielsen, M., Mushin, I., Tomaselli, K., & Whiten, A. (2014). Where culture takes hold: "Overimitation" and its flexible deployment in western, aboriginal, and bushmen children. *Child Development*, *85*(6), 2169–2184. https://doi.org/10.1111/cdev.12265

Nielsen, M., & Tomaselli, K. (2010). Overimitation in Kalahari bushman children and the origins of human cultural cognition. *Psychological Science*, *21*(5), 729–736. https://doi.org/10.1177/0956797610368808

Nielsen, M., Tomaselli, K., & Kapitány, R. (2018). The influence of goal demotion on children's reproduction of ritual behavior. *Evolution and Human Behavior*, *39*(3), 343–348. https://doi.org/10.1016/j.evolhumbehav.2018.02.006

Norenzayan, A., Shariff, A. F., Gervais, W. M., Willard, A. K., McNamara, R. A., Slingerland, E., & Henrich, J. (2016). The cultural evolution of prosocial religions. *Behavioral and Brain Sciences*, *39*, e1. https://doi.org/10.1017/S0140525X14001356

Over, H. (2020). The social function of imitation in development. *Annual Review of Developmental Psychology*, *2*(1), 93–109. https://doi.org/10.1146/annurev-devpsych-033020-024051

Prada, M., Saraiva, M., Godinho, C. A., Tourais, B., Cavalheiro, B. P., & Garrido, M. V. (2021). Parental perceptions and practices regarding sugar intake by school-aged children: A qualitative study with Portuguese parents. *Appetite*, *166*, 105471. https://doi.org/10.1016/j.appet.2021.105471

Roberto, C. A., Baik, J., Harris, J. L., & Brownell, K. D. (2010). Influence of licensed characters on Children's taste and snack preferences. *Pediatrics*, *126*(1), 88–93. https://doi.org/10.1542/peds.2009-3433

Rollins, B. Y., Loken, E., Savage, J. S., & Birch, L. L. (2014). Measurement of food reinforcement in preschool children. Associations with food intake, BMI, and reward sensitivity. *Appetite*, *72*, 21–27. https://doi.org/10.1016/j.appet.2013.09.018

Schulz, L. E., Hooppell, C., & Jenkins, A. C. (2008). Judicious imitation: Children differentially imitate deterministically and probabilistically effective actions. *Child Development*, *79*(2), 395–410. https://doi.org/10.1111/j.1467-8624.2007.01132.x

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin*, *86*(2), 420–428. https://doi.org/10.1037/0033-2909.86.2.420

Tomasello, M. (2019). *Becoming human: A theory of ontogeny*. The Belknap Press of Harvard University Press.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences*, *28*(5), 675–691. https://doi.org/10.1017/S0140525X05000129

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioral and Brain Sciences*, *16*(3), 495–511. https://doi.org/10.1017/S0140525X0003123X

Vale, G. L., Flynn, E. G., Kendal, J., Rawlings, B., Hopper, L. M., Schapiro, S. J., Lambeth, S. P., & Kendal, R. L. (2017). Testing differential use of payoff-biased social learning strategies in children and chimpanzees. *Proceedings of the Royal Society B: Biological Sciences*, *284*(1868), 1–9. https://doi.org/10.1098/rspb.2017.1751

van Baaren, R. B., Holland, R. W., Kawakami, K., & van Knippenberg, A. (2004). Mimicry and prosocial behavior. *Psychological Science*, *15*(1), 71–74. https://doi.org/10.1111/j.0963-7214.2004.01501012.x

Watson-Jones, R. E., & Legare, C. H. (2016). The social functions of group rituals. *Current Directions in Psychological Science*, *25*(1), 42–46. https://doi.org/10.1177/0963721415618486

Whiten, A. (2019). Cultural evolution in animals. *Annual Review of Ecology, Evolution, and Systematics*, *50*(1), 27–48. https://doi.org/10.1146/annurev-ecolsys-110218-025040

Whiten, A. (2022). Blind alleys and fruitful pathways in the comparative study of cultural cognition. *Physics of Life Reviews*, *43*, 211–238. https://doi.org/10.1016/j.plrev.2022.10.003

Whiten, A., Horner, V., & Marshall-Pescini, S. (2005). Selective imitation in child and chimpanzee: A window on the construal of others' actions. In S. Hurley & N. Chater (Eds.), *Perspectives on imitation: From neuroscience to social science* (Vol. *1*, pp. 263–283). MIT Press.

Wilks, M., Collier-Baker, E., & Nielsen, M. (2015). Preschool children favor copying a successful individual over an unsuccessful group. *Developmental Science*, *18*(6), 1014–1024. https://doi.org/10.1111/desc.12274

Wilks, M., Redshaw, J., Mushin, I., & Nielsen, M. (2019). A cross-cultural investigation of children's willingness to imitate prosocial and antisocial groups. *Journal of Experimental Child Psychology*, *185*, 164–175. https://doi.org/10.1016/j.jecp.2019.04.018

Williamson, R. A., & Markman, E. M. (2006). Precision of imitation as a function of preschoolers' understanding of the goal of the demonstration. *Developmental Psychology*, *42*(4), 723–731. https://doi.org/10.1037/0012-1649.42.4.723

Williamson, R. A., Meltzoff, A. N., & Markman, E. M. (2008). Prior experiences and perceived efficacy influence 3-year-olds' imitation. *Developmental Psychology*, *44*(1), 275–285. https://doi.org/10.1037/0012-1649.44.1.275

Wohlschläger, A., Gattis, M., & Bekkering, H. (2003). Action generation and action perception in imitation: An instance of the ideomotor principle. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *358*(1431), 501–515. https://doi.org/10.1098/rstb.2002.1257

Wood, L. A., Harrison, R. A., Lucas, A. J., McGuigan, N., Burdett, E. R. R., & Whiten, A. (2016). "Model age-based" and "copy when uncertain" biases in children's social learning of a novel task. *Journal of Experimental Child Psychology*, *150*, 272–284. https://doi.org/10.1016/j.jecp.2016.06.005

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APPENDIX
FULL SCRIPT OF THE TESTING PROCEDURE

Before the experiment begins, the experimenter explains briefly to the guardian(s) that this study is about studying children's social learning behaviour and what would they do when there's a cost to what's been shown to them.

The experimenter then asks the guardian(s) to not tell the child what to do during the game and hands the guardian(s) the demographics form.

Warm-up phase

The study begins with the child sitting across from the experimenter at the table.

Experimenter Look, I have a box here (*taking out the warm-up box and putting it on the table, facing the child*), would you like to open it for me?

The child proceeds to open the box with the experimenter offering assistance if needed.

Experimenter Look, what's inside? A yummy marshmallow! If you want it, you can put it in this bag (*takes out the zip-lock bag and opens the bag for the child*). This way, you can bring it home with you! Remember, you can't eat it now, but you can eat it later, and promise me you'll ask Mom/Dad/etc. before you eat, okay?

Ensure that the child acknowledges and responds to the instruction.

Experimenter Now the bag is yours! Let me put your bag here (*put it on the right side of the table*). If you want any marshmallows, you can always put them in here. Now, I've got some faces here (*taking out the smiley-face Likert scale*), the green happy face means you love something, this light green face means you like something, this yellow face means you are unsure, this orange sad face means you don't like it, and this red sad face means you hate it (*demonstrates each face while explaining*). Can you tell me how much you like this box by pointing to these faces?

The child points to one of the faces.

Testing phase

Experimenter Well done! Now I'm going to show you some videos, and after that, you can play with some fun stuff, okay?

Experimenter puts the box and the smiley-face scale away and takes out the iPad.

Experimenter Now let's watch my friend building a tower/ collecting marshmallows.

If the child doesn't pay attention while the video is playing, the experimenter instructs the child to watch carefully. After finishing watching the video once, the experimenter instructs "Let's watch her/him build a tower/collect marshmallows again" and play the video again, then,

Experimenter *skip to this step if it's the control condition* Well done! Now I've got some fun stuff here (*takes out the testing materials*), and you can do whatever you want with them. Remember, if you want any marshmallows, you can put them in this bag. Are you ready? Let's go!

If the child doesn't touch the materials within 10 s, the experimenter gives the prompt to start: "Why don't you try? It's your turn."

After the child indicates they are done or stops interacting with the materials for 20 s,

Experimenter Are you finished? Good job! Let's watch some videos and play with some fun stuff again, shall we (puts away the materials and takes out the iPad)? Let's watch my friend build a tower/collect marshmallows!

If the child doesn't pay attention while the video is playing, the experimenter instructs the child to watch carefully. After finishing watching the video once, the experimenter instructs "Let's watch her/him build a tower/collect marshmallows again" and play the video again, then,

Experimenter *skip to this step if it's the control condition* Well done! Now here's some more fun stuff, and you can do whatever you want with them. Remember, if you want any marshmallows, you can put them in this bag. Are you ready? Let's go!

If the child doesn't touch the materials within 10 s, the experimenter gives the prompt to start: 'Why don't you try? It's your turn.'

After the child indicates they are done or stops interacting with the materials for 20 s,

Experimenter Are you finished? You did so well! Now can you tell me how much you like marshmallows by pointing to these faces? The green happy face means you love something, this light green face means you like something, this yellow face means you are unsure, this orange sad face means you don't like it, and this red sad face means you hate it (*make face while explaining*). Can you tell me how much you like marshmallows by pointing to these faces? Good job! You are all finished!