Original Article

Investigating the Mechanisms of Cultural Acquisition

How Pervasive is Overimitation in Adults?

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Abstract. High-fidelity copying is critical to the acquisition of culture. However, young children's high-fidelity imitation can result in *overimitation*, the copying of instrumentally irrelevant actions. We present a series of studies investigating whether adults too overimitate. Experiment 1 found that adults do overimitate, even when evaluation pressures were reduced (Experiment 2) and when participants were faced with a time pressure involving a monetary reward (Experiment 3). Only when participants were presented with a demonstration by someone they believed to be a fellow participant (Experiment 4) did less than half of them overimitate. Thus, overimitation appears to be a robust, adaptive process allowing the acquisition of new information in unfamiliar settings.

Keywords: social learning, overimitation, imitation, cultural evolution, observational learning

While many cultural practices can be explained by ecological conditions, such as wearing climate-appropriate clothing, often cultural behaviors are opaque; the original ecological cause, if indeed there was one, may no longer be relevant. Humans demonstrate an incredible ability to acquire these opaque cultural behaviors, including language and social norms. Some of the most distinctive elements of the human behavioral repertoire, such as sophisticated technologies, highly developed sciences, elaborate religious rituals and complex language, are products of *cumulative cultural evolution*: Each generation builds on the achievements of their predecessors in a gradual, approximately monotonic ratcheting-up of complexity and functionality (Tomasello, 1999). Central to this cultural ratchet, along with innovation, is the high-fidelity transmission provided by imitation, as it is only by acquiring the "evolved" behaviors of previous generations that one can then improve them (Boyd & Richerson, 1985; Plotkin, 2003; Richerson & Boyd, 2005; Tomasello, 1999). Yet, faithful imitation does have a downside: Individuals sometimes reproduce the instrumentally nonfunctional behaviors they observe others performing, a phenomenon coined "overimitation" (Lyons, Young, & Keil, 2007, p. 19751). Copying behaviors that appear to be to instrumentally irrelevant to an outcome is costly in terms of time and energy, as well as the embarrassment of copying unintended actions (Gergely & Csibra, 2006). Yet copying such actions allows an individual to acquire the idiosyncratic, noninstrumental behaviors that are true of so many cultural rituals.

One of the first studies to illustrate overimitation was Horner and Whiten (2005), who presented young children and chimpanzees with an artificial fruit task, the Glass Ceiling Box (GCB; Figure 1), a puzzle box that contained a reward. Each participant, either a 3-year-old child or a chimpanzee, was initially presented with a demonstration by an adult model, who retrieved the reward from the GCB via a sequence of actions that included both relevant (directed to retrieving the reward) and irrelevant (causally unrelated to retrieving the reward) actions. There were two versions of the GCB: a transparent version (Figure 1A) in which the physical irrelevance of the actions was visible; and an opaque version (Figure 1B) in which the physical irrelevance of the actions was less obvious. While the chimpanzees showed an understanding of the causal relations of the task, as they only copied the task-relevant actions when initially presented with the transparent GCB but also copied the task-irrelevant actions when initially presented with the opaque GCB, the children copied all actions across both GCBs. With a larger sample of 3- and 5-year-olds, McGuigan, Whiten, Flynn, and Horner (2007) again found that, when witnessing a live demonstration as in Horner and Whiten (2005), children reliably imitated the full demonstration, including the irrelevant actions. Indeed, young children copy irrelevant actions under many conditions including when being trained to identify irrelevant actions performed by an experimenter, when they believe the experiment is over and they are under a time constraint

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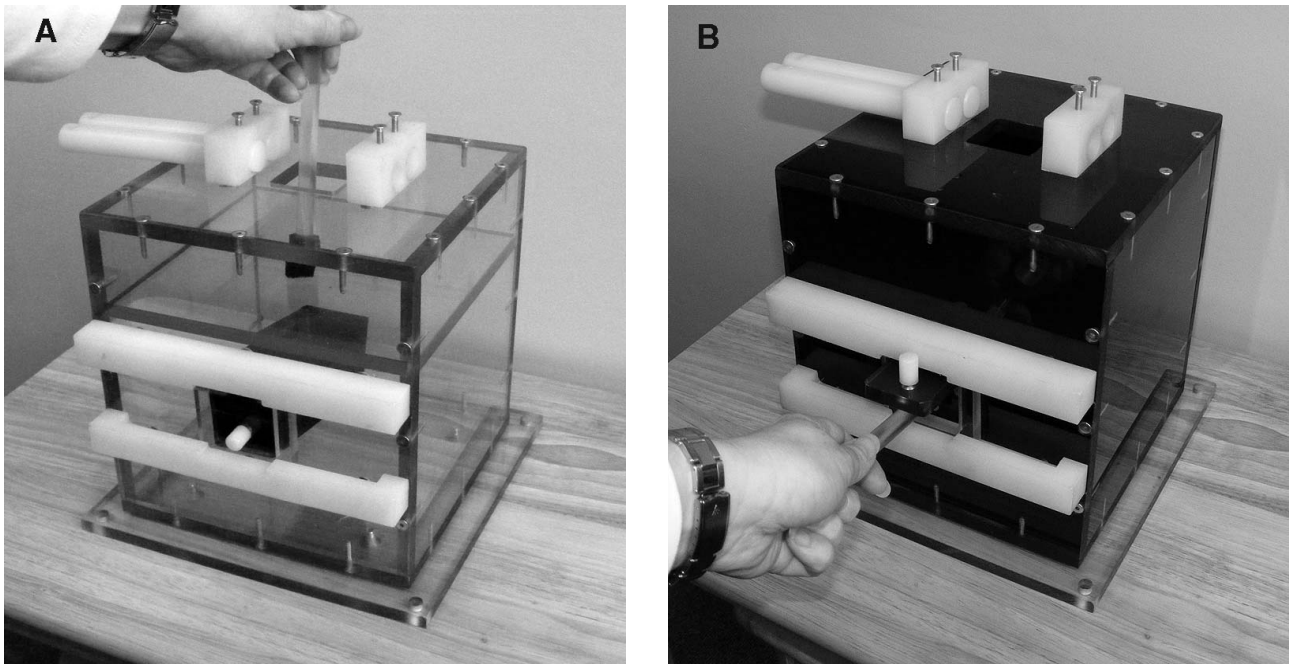

Figure 1. The two GCBs: (A) the transparent GCB with the tool being tapped on the glass ceiling, (B) the opaque GCB with the door in the lift position and the tool inserted into the opaque tube which contains the reward.

to prepare for the next participant, and even when given direct instructions to ignore any unnecessary actions (Lyons et al., 2007). More recently, Lyons, Damrosch, Lin, Macris, and Keil (2011) found that the copying of irrelevant actions occurred when there was a competitive cost and Nielsen and Tomaselli (2010) showed that children in the remote Bushman communities of southern Africa also overimitate, suggesting that it may be a universal phenomenon.

Such findings suggest that children are blanket copiers, indiscriminately copying all actions presented to them. Yet, much work has shown that children can be selective copiers, choosing to copy only certain elements of what they have witnessed (DiYanni & Kelemen, 2008; Flynn & Whiten, 2008; Gergely, Bekkering & Király, 2002; Schwier, van Maanen, Carpenter, & Tomasello, 2006). In keeping with this flexibility, overimitation has been shown to be surmounted by a number of factors, including when the demonstrator's irrelevant actions break the "contact principle," that is, the rule that mechanical interactions cannot occur at a distance (Lyons et al., 2007), when 3-year-old children watch a video demonstration of a model's hands completing the task, in contrast to a live demonstration (McGuigan et al., 2007), and when the irrelevant actions appear to be unintentional (Lyons et al., 2011). Finally, Flynn (2008) found that irrelevant behaviors were not transmitted along diffusion chains of 2- and 3-year-old children, suggesting that, although young children copy the irrelevant actions performed by an adult model, they are able to eliminate irrelevant actions demonstrated by a peer (see also McGuigan, Makinson, & Whiten, 2011; Wood, Kendal, & Flynn, in press).

As outlined above, most empirical evidence for overimitation comes from young children. It could be argued that, while the tendency of children to overimitate is intriguing, it is a consequence of some aspect of their youthful naivety – perhaps a lack of access to behavioral alternatives, the inability to assess the merits of alternatives, or a disproportionate faith in the functionality of adult behaviors. Evidence for the fidelity of adults' imitation in general has been mixed. Horowitz (2003) found that adult participants did not faithfully imitate the actions of a model, concluding that adults show less faithful imitation because they possess "other problem solving and learning algorithms" (p. 334). Yet, Custance, Prato-Previde, Spiezio, Rigamonti, and Poli (2006) found that adults imitated with high fidelity, copying not only a general method but also the finger used by the model. However, at later trials, in keeping with Horowitz (2003), adults began to discover more efficient methods, suggesting that high-fidelity copying may be an initial strategy when an individual is unsure of a task, but as their knowledge increases they adopt idiosyncratic methods.

More recently, McGuigan et al. (2011) explicitly demonstrated the tendency of adults to overimitate using the GCB. In their study adults were presented with a video demonstration of either a child or an adult completing the sequence of irrelevant and relevant actions on the transparent version of the GCB. They found that adults overimitated, concluding that, "rather than growing out of such a tendency, adults continued to copy in an unselective fashion, adopting irrelevant actions with an even higher level of fidelity than the children" (p. 11).

Mimicry of others' behaviors in adults has been shown

to be extremely important in social relations (Chartrand, Maddux, & Lakin, 2005), ultimately benefiting the imitator (Chartrand & Bargh, 1999; Lakin & Chartrand, 2003; Lakin, Chartrand, & Arkin, 2008). Thus, while overimitation may be not be instrumentally functional, copying others increases the likelihood of being liked (Chartrand & Bargh, 1999) and helped (van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Indeed, if a waitress mimics customers by repeating their orders verbatim she receives significantly larger tips than if she paraphrases the order (van Baaren, Holland, Steenaert, & van Knippenberg, 2003). Such immediate benefits have been shown to be transferred not only to the mimicker but also to individuals not involved in the mimicry situation (van Baaren et al., 2004). This facilitation of positive interactions through high-fidelity copying of behaviors may also result in longer term benefits, by underpinning the social glue (Lakin, Jefferis, Cheng, & Chartrand, 2003; van Baaren et al., 2004), which allows groups of individuals to function as a cultural unit (Over & Carpenter, 2011).

Here, we present a series of studies specifically designed to explore whether adults overimitate. As with previous studies outlined above, we adopt the GCB task to assess overimitation and investigate conditions similar to those addressed in previous studies with children, including increasing the salience of the actions (Lyons et al., 2007), increasing the motivation to extract the reward in the GCB as quickly as possible (Lyons et al., 2007, 2011), and changing the identity of the model (McGuigan et al., 2011; Nielsen & Blank, 2011; Wood et al., 2012).

Experiment 1

Do adults overimitate with a live demonstration? And if so, how faithful is their imitation and does access to the causal mechanisms within the apparatus affect the level of fidelity?

In the first of our experiments we extend the work of McGuigan et al. (2011) by presenting the demonstration using a live model (as opposed to a video demonstration) and by presenting the participants with both GCBs, transparent and opaque. To date adult overimitation has not been assessed on the opaque GCB. As in Horner and Whiten (2005) all of the participants in the experimental conditions in the current study received two attempts at removing the reward, one on the opaque and one on the transparent GCB. Horner and Whiten (2005) found that children overimitated across both GCBs and McGuigan et al. (2011) found that adults overimitate across all trials with the transparent GCB, so we predicted that adults would overimitate across both the transparent and opaque GCB. Finally, we examined whether adults would be "supercopiers" (Custance et al., 2006) across both GCBs by assessing whether they would copy the exact number of irrelevant actions they witnessed.

Participants

A group of 60 participants was recruited, their mean age being 34 years with a range of 25 to 60 years. In an attempt to use a population outside the university body, we recruited staff from a local secondary school. This recruitment was reflected in the ratio of 6 males and 54 females; however, as no effect of sex has been reported for children's or adults' overimitation, so we did not believe that this split significantly influenced our data – and indeed we show in Experiments 2 and 4 that rates of overimitation do not differ between males and females.

Design

There were six conditions in a mixed design: In four of the conditions (the observational learning conditions) participants witnessed a demonstration of a series of actions on the GCB featured in Figure 1. All the participants witnessed the same demonstration on the opaque and the transparent GCB, but 20 participants witnessed this demonstration on the opaque box first and 20 on the transparent box first. Furthermore, half of the participants in each of these groups witnessed three repetitions of the irrelevant tapping action into the upper compartment of the GCB and half witnessed the same action performed only once. Thus the four experimental conditions were as follows:

1. one tap performed, opaque then transparent GCB,
2. one tap performed, transparent then opaque GCB,
3. three taps performed, opaque then transparent GCB,
4. three taps performed, transparent then opaque GCB.

Two no demonstration control conditions were also included, one with the opaque box (n = 10) and one with the transparent box (n = 10), in which participants were presented with the GCB with no demonstration. These no demonstration control conditions were included to provide a baseline for the level of successful retrieval of the reward from the GCBs through asocial learning.

Materials

Two GCBs were used, differing only in their transparency (as described above and pictured in Figure 1). Each box has a hole on the roof, covered by a two-bolt defense, and a second hole on the front face of the box covered by a door defense. Behind the front hole is a sloping tube, opaque in both boxes, which contains a reward (a Velcro-backed sticker). In order to retrieve the reward the door in the front of the box must be opened (either by sliding or lifting). A tool (a 22 cm long rod with Velcro on the end) can then be inserted into the tube and used to pull out the reward. Actions directed to the front of the box are causally necessary to retrieve the reward, whereas actions directed to the top of the box are not: the reward cannot be accessed through the top hole.

Procedure

Initially, the experimenter invited the participant into a quiet room in his/her school. In the observational learning conditions the participant was positioned facing the GCB. The experimenter said "I'm going to have a go, then it'll be your turn" and then performed a series of actions on the GCB. First, the experimenter used the tool to drag the bolts away from the top hole. The tool was then inserted into the top hole and used to tap on to the glass ceiling below, either once or three times depending on the experimental condition. The experimenter then lifted the front door, inserted the tool and retrieved the reward. Only the last two actions (lift door and insert tool) were necessary to obtain the reward. After the initial demonstration the GCB was reassembled and the participant was told "Now it's your turn."

In keeping with previous work (Horner & Whiten, 2005; McGuigan et al., 2007), the goal of retrieving the Velcro-backed sticker was never explicitly stated. The trial ended when the participant had retrieved the reward or wished to stop. Once the initial trial had ended, the original GCB was removed and the alternative GCB (transparent to opaque or opaque to transparent) was presented. The procedure was then repeated, with a second demonstration from the experimenter preceding the participant's second attempt.

In the no demonstration control condition, participants were brought into the room and presented with the GCB and tool and told "Just do whatever you want. You can stop whenever you like."

Testing ended if a participant successfully retrieved the sticker, refused to continue, or after 4 minutes had elapsed.

Coding and Interrater Reliability

Each participant's performance was scored on three variables:

1. whether s/he removed the bolts;
2. whether s/he tapped in the top of the GCB, and if so, how many times and
3. whether s/he opened the door and inserted the tool to remove the sticker.

An independent observer, blind to the rationale of the study, coded 25% of the sample. All Cohen's κ were .93 or above, showing a good level of reliability. The same coder coded 25% of the data in Experiments 2–4 and all Cohen's κ were above .91.

Results and Discussion

The first analysis examined whether the opportunity for observational learning made a difference to success on the task, by examining the success rate of participants who witnessed a model undertake the task compared to participants who were simply presented with the task. Table 1 presents the rate of success for the two GCBs for the participants' first attempts in each condition. Taking the two GCB types separately: on the opaque GCB, significantly more participants retrieved the reward after having witnessed a demonstration (85%) than not (control group, 40%; $p < .05$, Fisher's exact test). In contrast, there was no significant difference in the rate of success for participants who witnessed a demonstration (80%) on the transparent GCB compared to those who did not witness a demonstration (50%; $p = .12$, Fisher's Exact test). However, it should be noted that the difference in the rate of success between the transparent and opaque GCB was small and not significant.

Table 1. Experiment 1: The rate of successful extraction of the reward for the participants' first attempt

	Opaque GCB		Transparent GCB	
	Failed	Succeeded	Failed	Succeeded
Experimental	3	17	4	16
No demonstration control	6	4	5	5

The second analysis examined whether the participants' behavior differed according to the availability of causal information. Overimitation was judged to have occurred if a participant produced *any* of the modeled irrelevant actions (a more fine-grained analysis of the copying of specific irrelevant actions is presented later). There was no difference in the reproduction of irrelevant actions according to the type of GCB the participants were presented with on their first attempts (see Table 2): The level of imitation was 100% on the opaque box and 98% on the transparent box ($p = 1.00$, Fisher's exact test) or their second attempts (the level of imitation was 98% on both GCBs, $p = 1.00$, Fisher's exact test). Similarly, there was no change in the rate of overimitation across trials. Combining across GCBs, the level of imitation was 98% on the first trial and 95% on the second trial (McNemar test, $N = 40$, $p = 1.00$). Participants applied an overimitation strategy regardless of whether they were interacting with the opaque or transparent GCB and irrespective of whether this was a first or second attempt. Producing only the relevant actions was extremely rare in the data set as a whole, with only three participants (8% of the sample, all female) removing the irrelevant actions across all 80 attempts, one at the first attempt, and two different individuals at the second.

Table 2. Experiment 1: The number of adults who copied, or not, the irrelevant actions on each GCB at each attempt

	First attempt copied irrelevant actions		Second attempt copied irrelevant actions	
	No	Yes	No	Yes
Opaque GCB	0	20	1	19
Transparent GCB	1	19	1	19

Further analyses investigated whether participants copied the number of taps they witnessed (1 versus 3). There was a significant difference in number of taps produced by these two groups for both trials (first, $t_{38} = 7.64$, $p < .01$; second, $t_{22.29} = 5.79$, $p < .01$). The mean number of taps produced for 1-tap trials was 0.95 ($SD = 0.45$), and for 3 taps was 2.80 ($SD = 1.16$). 88% of the participants copied the exact number of taps they witnessed on at least one trial. In summary, regardless of the causal information available on either the first or second trials, participants tended toward exact imitation. Therefore, when presented with the same conditions as children (Horner & Whiten, 2005; McGuigan et al., 2007), adults do overimitate. McGuigan et al. (2011) found high levels of overimitation on only the transparent GCB with a videoed model, and we extend these findings by showing a high level of overimitation across both GCBs with a live model. Further, this high-fidelity copying was seen also in the specifics of the irrelevant actions performed, in keeping with the findings of Custance et al. (2006).

Experiment 2

Do adults overimitate when social pressure is reduced? The high level of adults' overimitation seen in Experiment 1 might be due to the social pressure to imitate the model. The social element of observational learning has been of interest for some time (Užgiris, 1981), and recent theories and experimental evidence have highlighted the role of social pressure on the propensity to copy (Kenward, Karlsson, & Persson, 2010; Over & Carpenter, 2011). In Experiment 2 we manipulated the social pressure felt by a participant by varying the presence or absence of the model/experimenter. Such a manipulation has been used with children (Horner & Whiten, 2005; Lyons et al., 2007) and found to have little impact on their overimitation. However, Nielsen and Blank (2011) presented children with two models, one who demonstrated irrelevant actions in a sequence to retrieve a toy from a novel apparatus, and one who completed only necessary actions. After the demonstrations one of the models left the room, before the children's attempt. Children reproduced the irrelevant actions only when presented with the manipulated apparatus by the adult who had demonstrated them, even though a departed adult's actions had emphasized how unnecessary these redundant actions were.

Adults may also be influenced by social pressure. Thus, we predicted that, when the experimenter was not present and there was no overt evidence of recording equipment, participants would be less likely to reproduce the irrelevant actions than when the experimenter and camera were present. An additional modification, also designed to encourage the removal of the irrelevant actions, was to include a time pressure. Participants were told to complete the task "as quickly as possible," and it was predicted that they would be less likely to reproduce the irrelevant actions under these conditions compared to the participants in Experiment 1.

Participants

A group of 32 participants were recruited, all of whom were undergraduate students. The mean age was 21 years (range 18–39 years). There were 11 males and 21 females. Through an initial, informal question regarding the courses they had completed we ensured that all of the undergraduates who participated in Experiments 2–4 were not familiar with the rationale of the studies.

Design and Procedure

Experiment 2 followed the same general procedure as Experiment 1, but with two major alterations: First, social pressure was reduced for half of the participants, as the experimenter was absent during their (single) attempt. Participants in this condition witnessed the demonstration, and then the experimenter left the room on the pretext of bringing in the next participant. Obscured recording equipment allowed the behavior of the participants to be noted. The second main change involved the addition of time pressures: The experimenter instructed all participants to, "have a go as quickly as you can" immediately before his/her attempt.

There were also a number of minor changes to streamline the procedure. First, as there was no difference in the behavior of the participants on the first and second trials in Experiment 1; participants were tested only once, on one of the two GCBs. Thus, there were four conditions based on the between-participant factors of experimenter (present or absent) and GCB (opaque or transparent). Second, as no demonstration control data had been collected in Experiment 1 this control was not repeated. Third, the two-action design was introduced (see Dawson & Foss 1965; Flynn, 2008; and Hopper, Flynn, Wood, & Whiten 2010); half of the participants in each condition saw the bolt defenses on the top opening dragged clear and then the door defense on the front opening slid away, and the other half saw the bolts pushed and the door lifted. By including the two-action design the extent of the participants' specific imitation of the demonstrated actions on the bolt and door defenses could be examined (following Horner & Whiten, 2005; McGuigan et al., 2007, 2011). Finally, because Experiment 1 showed that there was no difference in the level of imitation according to whether participants saw one or three taps, all the participants witnessed three taps.

Results and Discussion

In order to address whether participants were less likely to replicate the irrelevant actions when the experimenter was

absent a 2 × 2 analysis of variance was undertaken to compare the number of irrelevant actions performed (five irrelevant actions were presented: removal of two bolts and three taps). There was no effect on the number of irrelevant actions reproduced depending on whether they were presented with the opaque ($M = 4.13$, $SD = 1.63$) or transparent GCB ($M = 3.13$, $SD = 2.06$; $F(1, 32) = 2.22$, $p = .15$), or whether the experimenter was present ($M = 3.50$, $SD = 2.09$) or absent ($M = 3.75$, $SD = 1.73$; $F(1, 32) = 0.14$, $p = .71$). Nor was there a significant interaction ($F(1, 32) = 0.55$, $p = .46$). Therefore, it appears that participants copied a similar number of actions from the demonstration, irrespective of whether the experimenter was present or not and whether the actions were produced on the opaque or transparent GCB.

Experiment 2 also allowed an investigation of whether adults copied the *method* used to undertake the actions (both irrelevant and relevant). There were no significant effects of action type for copying fidelity (removing bolts by drag or push: $\chi^2_{1,28} = 1.19$, $p = .27$); opening door by lift or slide: $\chi^2_{1,32} = 0.83$, $p = .67$), so the following analysis collapsed across methods. When examining the twenty-eight participants who removed the bolts, there was overwhelming fidelity to the method they witnessed: 27/28 participants, 96%, copied the method they witnessed; $\chi^2_{1,28} = 24.14$, $p < .001$. Similarly, when the method used to open the door was examined, 25 of the 32 participants (78%) who opened the door used the same technique as their model, again showing strong fidelity: $\chi^2_{1,32} = 10.13$, $p < .001$. Such a finding supports Custance et al. (2006), who found that adults were high-fidelity imitators, and McGuigan et al. (2011), who found that adults copied the methods they witnessed.

Finally, as before, participants who copied one or more irrelevant actions were classified as overimitators. As seen in Table 3 only four of the 32 participants performed no irrelevant actions, producing an overall imitation rate of 88%, not significantly different from the first trials in the observational learning conditions in Experiment 1 ($p = .16$, Fisher's exact test), suggesting that overimitation is common across different groups of adults of different ages including school teachers and undergraduates. Further, the current study had more male participants and again produced high levels of overimitation, with three of the four participants not overimitating being female. Therefore, as has been seen in research with children's overimitation, this is not a solely female phenomenon. Three of the four individuals who did not reproduce the irrelevant actions undertook their attempt with the experimenter present, suggesting that even with a larger sample size, experimenter absence would not have facilitated removal of the irrelevant actions. Thus, even with the combined reduction in the social pressure to imitate and the addition of a time pressure, overimitation remained high.

Table 3. Experiment 2: The number of adults who copied (or not) the irrelevant actions for each GCB

	Demonstrator present copied irrelevant actions		Demonstrator absent copied irrelevant actions	
	No	Yes	No	Yes
Opaque box	0	8	1	7
Transparent box	3	5	0	8

Experiment 3

Can competition for a monetary reward reduce adults' overimitation? In Experiment 2 being told to act "as quickly as you can" may not have been a strong enough motivation to eliminate the irrelevant actions. In Experiment 3, all participants followed the experimenter-present procedure from Experiment 2, but were told that there was a £20 reward for the participant who was quickest at retrieving the reward. We predicted that a monetary reward would induce stronger time pressures, resulting in less overimitation.

Participants

A group of 32 participants were recruited, all of whom were undergraduate students. There mean age was 21 years (range 18–29 years). There were three males and 29 females.

Design and Procedure

Experiment 3 followed the same procedure as the experimenter-present condition in Experiment 2, except that participants were briefed that there was a prize of £20 for the individual who removed the reward from the box in the fastest time. Immediately prior to their trial participants were reminded to "get the object out as quickly as possible."

There were two experimental conditions, with half of the participants receiving their demonstration and trial on the opaque GCB and half receiving their demonstration and trial on the transparent GCB. Within each of these groups half of the participants witnessed the bolts being dragged and the door being lifted, while half witnessed the bolts being pushed and the door being slid to the side. It was predicted that participants who witnessed the actions modeled on the transparent GCB would be significantly more likely to leave out the irrelevant actions than participants who witnessed the demonstration on the opaque GCB.

Results and Discussion

There was no significant difference in the level of imitation according to whether the participants witnessed the demonstration on the opaque or transparent GCB ($p = .39$, Fish-

er's exact test, see Table 4) and no difference in the number of irrelevant actions produced according to GCB type (opaque $M = 2.56$, $SD = 2.06$; transparent $M = 2.44$, $SD = 2.36$; $t_{30} = 0.16$, $p = .87$). A total of 78% of participants overimitated, which was significantly lower than the proportion of participants who overimitated in their first attempt in Experiment 1 (98%; $p < .05$, Fisher's exact test) but did not significantly differ to the level of imitation in Experiment 2 (88%; $\chi^2_{1,64} = 0.99$, $p = .07$), although it approached significance. Of those who removed the irrelevant actions six were female and one was male.

Table 4. Experiment 3: The number of adults who copied (or not) the irrelevant actions for each GCB

	Copied irrelevant actions	
	No	Yes
Opaque box	2	14
Transparent box	5	11

The second analysis investigated whether adults copied the detail of the method used by the model. When examining the 25 participants who removed the bolts, there was fidelity to the method witnessed (19/25 copied the method they witnessed, $\chi^2_{1,25} = 6.76$, $p < .01$). Similarly, when the method used to open the door was examined, 24 of the 32 participants used the same technique as the model, showing strong fidelity ($\chi^2_{1,32} = 8.00$, $p < .01$).

In summary, it appears that, although adults are less likely to reproduce the irrelevant actions when they are under time pressures associated with a monetary reward (relative to the baseline provided by Experiment 1), this behavior is not affected by the availability of causal information: Participants produced as many irrelevant actions when presented with the opaque GCB as when present with the transparent GCB. Participants continued to imitate the observed techniques with high fidelity, copying the specifics of the model's method on the actions they chose to undertake.

Experiment 4

Does the identity of the demonstrator affect adults' overimitation? In Experiment 4 the participant's perception of the identity of the model was manipulated, so that the participant witnessed the sequence of actions demonstrated by a fellow participant (actually a confederate), in order to explore whether overimitation occurs when the demonstration is performed by an apparently naïve individual. Chartrand and Bargh (1999) observed that participants unconsciously copied the mannerisms of a confederate, even though the confederate and the participant were not acquainted. In line with this finding, our participants could copy the actions of another individual who performed a series of irrelevant actions on a novel artefact, even if they assumed that person had no knowledge of the task and lacked the authority of an experimenter-model. Alternatively, a participant's assumption about the lack of knowledge of the task and lack of authority of a "fellow participant" may reduce the number of irrelevant actions reproduced.

Notwithstanding the use of the confederate, the procedure for Experiment 4 was the same as for Experiment 3: Participants were again told to remove the reward from the box "as quickly as possible," and they were told there was a prize of £20 for the fastest retrieval. It was predicted that participants would be significantly less likely to reproduce the irrelevant actions when presented with the transparent GCB than when presented with the opaque GCB, when the demonstration was perceived to be presented by a fellow participant. Similarly, it was predicted that participants would be significantly less likely to copy the specific method used to move the bolts and the door when the demonstration was perceived to be presented by a fellow participant.

Participants

A group of 32 participants were recruited, all of whom were undergraduate students. They were aged between 18 and 21 years (mean 20 years); 16 were male and 16 were female.

Design and Procedure

As in Experiment 3, there were two conditions, with half of the participants being presented with the opaque GCB and half with the transparent GCB. Within each of these groups, half the participants witnessed the bolts being dragged from the upper opening and the door being slid away from the front opening, and half the participants witnessed the bolts being pushed and the door being lifted.

As each of the participants entered the room they were told a fellow participant was already there. This fellow participant was in fact a female experimenter pretending to be a participant, henceforth referred to as the confederate. The participants were told there was something in the box that they had to get out and told there was a prize for the fastest removal. Then, the experimenter said to the confederate, "As you've been here longer, would you like to go first?" To this the confederate nodded, and the experimenter added, "Okay, you may start when ready."

The confederate then followed a set script, where she performed the same set of actions (removing bolts, tapping in the upper compartment three times, removing the door, and sticking the rod into the hole to remove the reward) as had been carried out by the model in the previous experiments. At the end of the confederate's attempt the experimenter reminded the participant about the prize and then allowed the participant his/her attempt. Participants ap-

peared to believe that the confederate was a fellow participant; two even suggested that it was unfair to be in the room when the other participant (confederate) had her turn, as it would give them an unfair advantage to win the £20 reward.

Results and Discussion

The rate of overimitation among the participants was 44%, significantly lower than in Experiment 1 (98%; $\chi^2_{1,72} = 26.44$, $p < .001$), Experiment 2 (88%; $\chi^2_{1,64} = 13.58$, $p < .001$) and Experiment 3 (78%; $\chi^2_{1,64} = 7.94$, $p < .01$). As suggested by Table 5, there was a significant effect of GCB type, with participants presented with the transparent GCB being significantly less likely to overimitate (19%) than those participants presented with the opaque GCB (69%; $\chi^2_{1,32} = 8.13$, $p < .01$). Further, as the experiment had the same number of males and females, it was possible to show experimentally a similar levels of overimitation in males (50%) and females (63%, $\chi^2_{1,32} = 0.51$, $p = .48$).

Table 5. Experiment 4: The number of adults who copied (or not) the irrelevant actions for each GCB

	Copied irrelevant actions	
	No	Yes
Opaque box	5	11
Transparent box	13	3

The second set of analyses investigated whether adults imitated the methods used by the confederate. When examining the 14 participants who removed the bolts, there was fidelity to the method witnessed (12/14 (86%) copied the same method, $\chi^2_{1,14} = 7.14$, $p < .01$). In contrast, when the method used to open the door was examined, 12 of the 32 participants who opened the door used a different technique, showing a *lack* of fidelity ($\chi^2_{1,32} = 2.00$, $p = .57$). When the behavior on the door was examined according to GCB type and method was witnessed, fidelity to the method witnessed was found to exist for the participants working on the transparent GCB ($\chi^2_{1,16} = 4.00$, $p < .01$), as 8/8 copied the door lift and 8/8 participants copied the door slide. But participants who worked on the opaque GCB did not show fidelity to the method witnessed ($\chi^2_{1,16} = 0.01$, $p = 1.00$), this was particularly pertinent in the lift condition as only 3/8 participants copied lift, while 7/8 participants copied slide. Note that this is the opposite pattern to the imitation of irrelevant actions, where participants working with the opaque box were more likely to imitate. Descriptively, it appears that participants trade off faithfulness of imitation at various levels (although see Flynn & Whiten, 2008). So participants who are less faithful at the level of copying irrelevant actions are more faithful at copying the details of the method used. This may be a risk-management strategy and merits further study.

Overall Discussion

The main conclusion from this series of studies is that adults overimitate, and that this overimitation occurs across a variety of conditions. Experiment 1 extended McGuigan et al. (2011) to show that adult's overimitation occurred not only in a task in which the causal relevance of the actions is accessible (the transparent GCB), but also when it is not (the opaque GCB), and when the model presents a live demonstration. Experiments 2 and 3 show that overimitation occurred when social pressures were reduced and when overimitating was costly (in the form of not winning a monetary reward). Overimitation also occurs in different groups of adults, including those in different occupations, and of different ages and sex.

By examining these results in the light of evidence from social learning strategies (see Laland, 2004 for a review) we can see a number of possible explanations for why adults might consistently overimitate, and indeed why overimitation might generally be rational and/or adaptive. First, copying occurs when individual learning is costly (Boyd & Richerson, 1985, 1988; Feldman, Aoki, & Kumm, 1996). Costs can include energetic costs of searching or processing valuable resources, such as food, or the risk of acquiring unreliable information through individual learning. Thus, there is a tradeoff between accurate but costly information versus less accurate but relatively cheap information. In Experiments 1 and 2 participants chose to reproduce the less accurate, but cheap actions, thus producing the "low-cost" irrelevant actions. It is only in Experiments 3 and 4, where we introduce a financial incentive, that we see a significant reduction of copying of irrelevant actions compared to the baseline produced in Experiment 1. Thus the reproduction of these irrelevant actions is no longer low cost, since it reduces a participant's chance of winning the monetary reward. However, it should be noted that, in Experiment 3, 78% of participants continued to copy the irrelevant actions.

Taking part in a psychology experiment is an unusual situation, and so may cause participants to use a *copy when uncertain* heuristic (as demonstrated in the nonhuman animal literature, Kendal, Coolen, & Laland, 2004). In order to compare our findings with those of Horner and Whiten (2005) and McGuigan et al. (2007), we kept as close as possible to their original procedure: Participants in Experiment 1 and 2 were not provided with explicit instructions about the aim of the task. In Experiments 3 and 4, the participants were told to "get the object out as quickly as possible," though they were never told to use the most efficient method. Participants in Experiments 3 and 4 were more likely to leave out the irrelevant actions than participants in Experiment 1. This lack of explicit instruction may have added to the uncertainty of our participants. Indeed, a number of participants made comments indicative of a *copy when uncertain* heuristic, e.g., "I don't really see the point of this bit, but maybe it's some kind of magical device" and

"I thought I'd better just do what you did, was that right?" (participants in Experiment 1). These findings are in line with the Gricean principle that all interactions come with a guarantee of relevance (Sperber & Wilson, 1995), such that partners within an interaction assume that all actions or words within that interaction are meaningful (Grice, 1975). Thus, when the experimenter performs a series of irrelevant actions, the observing participant assumes that these actions, although causally irrelevant, are somehow meaningful and, therefore, copies them. Such effects are contingent on the interaction partner being competent and intentional. This would explain in part the findings in Experiment 4, where a "fellow participant," who is perceived to lack any task knowledge, models the behavior and the level of copying of irrelevant actions is significantly reduced. However, even within the context of such an explanation, it appears that adults do overimitate, as 44% of participants in Experiment 4 imitated the "fellow participant's" actions. As well as supporting a *copy when uncertain* learning strategy, these findings also support the unconscious mimicry seen in Chartrand and Bargh (1999). Thus, the overall implication is that overimitation is complex and unlikely to reduce to a single explanation. Thus, the dynamics between the model, observer, context, and task all play a significant role. Future work could address this question by exploring, among other things, the role of explicit instruction on adults' overimitation and/or by asking adults at the end of the experiment why they either copied or, indeed, did not copy the irrelevant actions (Kenward et al., 2010).

In Experiment 2 we attempted to manipulate the extent to which participants felt under external pressure to imitate, by having the demonstrator present or absent during the participant's attempt. When the evaluation pressures were reduced in this way, adults were just as likely to copy all the irrelevant actions on both GCBs. The effectiveness of this manipulation might be open to question, as it may be the case that our participants still believed they were being watched or evaluated. Further exploration of this manipulation is warranted. But these initial findings suggest that the cause of overimitation goes beyond factors such as impression formation (copying what the model has done while the model watches) and is a fairly deep-rooted default strategy that humans adopt when placed in an unusual setting.

As well as addressing when to copy, social learning strategies consider *who* is copied. One relevant strategy is to copy successful individuals. Across all the experiments the model was always successful, suggesting that the method the model had used was correct. In the current experimental setting there are also prestige biases, where individuals copy those who have more status (it seems logical to assume that in the setting of a psychology experiment, the experimenter has high prestige). Thus, Experiment 4 attempted to overcome this bias, as participants believed the demonstration was presented by a fellow participant, who did not appear to have any knowledge of the task or authority in the experimental setting. This manipulation had three significant effects. First, for the first time across the series of experiments, over half of the participants eliminated the irrelevant actions they witnessed. Second, the causal information that was available to the participants (based on whether the GCB was transparent or opaque) had an effect on the behavior of the participants: Participants who were presented with the transparent GCB were significantly more likely to eliminate these behaviors than those presented with the opaque GCB. Finally, in contrast to the behavior of the participants in the previous experiments, participants did not always copy the specific method they had witnessed during the demonstration. Although copying was sometimes strong, with 86% of participants who removed the bolts using the same method, and 63% of participants using the same method when opening the door.

In Experiment 4, 44% of the participants copied the irrelevant actions they had seen performed by a fellow "naïve" participant, 19% who were presented with the transparent GCB, 69% on the opaque GCB. This suggests strong individual differences in adults' tendency to overimitate, with some adults finding it extremely difficult to overcome the tendency. Such a finding undermines Lyons et al.'s theory that observers copy because they encode these behaviors as being causally necessary (Lyons et al., 2007, 2011). We see here that such encoding can be decreased by the identity of the model, and that adults will copy irrelevant actions even when performed by someone who appears to have no task knowledge. The participants' lack of fidelity in Experiment 4 must be due to the lack of authority of the model, and the apparent (lack of) confidence of the model in her actions because of her lack of knowledge of the task. When acquiring cultural practices it appears that "who" one learns from is extremely important: People copy high-ranking and successful individuals (Henrich & Gil-White, 2001) as well as individuals who are perceived as knowledgeable (Henrich & Broesch, 2011; Wood et al., 2012). The current study supports these findings and highlights that the interactions between factors such as task knowledge, confidence, and authority are ripe for further exploration.

Custance et al. (2006) found that while adults were high-fidelity imitators, they adapted their behavior across trials so that they were using the most efficient method on later trials, introducing behaviors that they had not witnessed the model perform. Social learners are expected to refine their own efforts through trial and error (Richerson & Boyd, 2005). Experiment 1 did not replicate this finding. Instead, adults continued to replicate all actions on their second trial. The lack of an effect for behavior over trials could be due to the slight change in task, participants were presented with the alternative GCB on their second trial. Future work could investigate the impact of behavior refinement by presenting participants with multiple demonstrations with different contents (irrelevant actions present or not) and multiple trials to see if and how participants refine behavior (similar work has been undertaken with children: Buchsbaum, Gopnik, Griffiths, & Shafto, 2011).

Finally, a note of caution. Our goal in this series of studies was to investigate whether the effects seen in children's overimitation is also true of adults. To this end, we remained close to the procedures of previous experiments with children and used similar sample sizes. Consequently, our experiments are sensitive only to the large effects seen in the child literature. There may be more subtle influences on adult overimitation missed as a result.

Conclusions

Adults overimitate, just like young children. Adults' overimitation is extremely robust, occurring under conditions that should reduce such a tendency, including when the threat of evaluation is reduced (Experiment 2), under time constraints that result in a monetary reward (Experiment 3) and, for some participants, when the demonstration is presented by someone who appears to be naïve to the task (Experiment 4). Only in the latter condition do we see over half of participants eliminating irrelevant actions from their task performance. Our difficulty in extinguishing adult overimitation suggests that adults are using a deeply embedded social learning strategy and possibly a (usually) useful adaptive mechanism employed to acquire new information. Overimitation appears to be extremely important for both adults and children, allowing cultural information, which may be opaque, to be acquired and thus underpinning the social glue that allows groups of individuals to function as a cultural unit.

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