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## Is the tendency to conform influenced by the age of the majority?

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1 **Title**

2 'Is the tendency to conform influenced by the age of the majority?'

3

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21 **Abstract**

22 The aim of the current study was to explore the influence that the age, and the familiarity, of  
23 a group majority has upon copying fidelity in 4- to 6-year-old children. In Experiment 1  
24 participants ( $N = 120$ ,  $M$  age = 68 months) viewed 5 child models, all of whom were either  
25 younger, the same age, or older than themselves open a puzzle box using an inefficient (4  
26 models), or an efficient technique (1 model). In Experiment 2 ( $N = 82$ ,  $M$  age = 71 months)  
27 the identical task was presented by groups of unfamiliar models. In both Experiments 1 and 2  
28 a group of control participants saw an equal number of inefficient and efficient models.  
29 Results showed that the participants displayed conformity irrespective of the age, or the  
30 familiarity, of the individuals comprising the majority. However, the participants varied in  
31 their level of imitative fidelity depending on the identity of the group majority, with  
32 majorities that were either the same age, or considerably older, than the participants eliciting  
33 the highest levels of over-imitation. In contrast groups comprising individuals who were  
34 younger than the participants elicited a significantly lower level of over-imitation to that  
35 elicited by the same aged and older majorities. We suggest that these findings demonstrate an  
36 interplay between conformist and model-based transmission biases.

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## 43 **Introduction**

44 If we were to glance around our everyday environments, we would likely see ample evidence  
45 of the human disposition to adopt the behaviors and attitudes of those surrounding them. This  
46 conformist tendency was demonstrated experimentally by Solomon Asch in the 1950's where  
47 a substantial proportion of adult participants were shown to agree with a majority response in  
48 a perceptual judgment task despite the majority view being clearly incorrect (Asch, 1955;  
49 1956). This bias to conform- here defined as the propensity to display a behavior as it is the  
50 most frequent displayed in others (Claidière & Whiten, 2012)- seems somewhat surprising as  
51 it would appear to have the potential to lead individuals, at least on some occasions, to adopt  
52 ineffectual responses. However, evolutionary biologists have shown that rather than  
53 conformity being a limitation of our species, our bias towards conformity most likely serves  
54 key social functions by promoting ingroup cohesion and defining ingroup/outgroup  
55 boundaries (Boyd & Richerson, 1988; 2009; Henrich & Boyd, 1998). The potential  
56 importance of conformity, both theoretically and behaviorally, has led to recent explorations  
57 of the phylogenetic (Haun, Rekers, & Tomasello, 2012), and ontogenetic roots of this  
58 conformist disposition (Corriveau & Harris, 2010; Haun & Tomasello, 2011).

59         Studies that have adapted the Asch paradigm for use with preschool children have  
60 shown that 3/4-year-old children conform at similar levels to their adult counterparts when  
61 faced with a majority (of adults or peers) making an incorrect perceptual judgement  
62 (Corriveau & Harris, 2010; Haun & Tomasello, 2011). Similarly, studies from the trust in  
63 testimony literature have shown children's readiness to conform to the label used by the  
64 majority even when this label is incorrect (Chen, Corriveau, & Harris, 2012; Fusaro & Harris,  
65 2008, 2013; Seston & Kelemen, 2013). More recently, the study of conformity within the  
66 preschool period has been extended to the domain of action copying, with studies asking  
67 whether individuals will copy the actions displayed by a majority over an alternative action

68 displayed by a minority. In one such study 2-year-old humans, orangutans and chimpanzees  
69 were allowed to observe a majority of same species models each place a ball in the same  
70 container (from a choice of three), whilst a single individual (the minority) was seen to place  
71 their ball in a different container (Haun, Rekers & Tomasello, 2012). The results showed that  
72 two of the three species were influenced by the majority, with 56% of the children and 72%  
73 of the chimpanzees placing their ball in the same container as the majority despite there being  
74 no rationale for doing so. The orangutans by contrast responded randomly. Conformity to the  
75 actions displayed by the majority has also been demonstrated in slightly older children, with  
76 3- to 6-year-olds more readily performing the technique used to remove pegs from a  
77 pegboard by two models, than the same technique performed by a single model (Herrmann,  
78 Legare, Harris, & Whitehouse, 2013).

79         That the children in the studies described above readily adopted the same actions as  
80 the majority suggests that the domain of action copying may provide a fruitful, and as of yet  
81 relatively untapped, avenue with which to explore conformist behavior. Traditional action  
82 copying (social learning) studies are most often dyadic (one model and one observer), and  
83 precise fidelity to the task is assessed using a two-action design where half of the participants  
84 see a single model operate an object using technique A, with the remaining half viewing a  
85 single model operate the same object using an equally effective technique B (e.g., Whiten,  
86 Custance, Gomez, Teixidor, & Bard, 1996). Studies have shown that children frequently  
87 copy the technique witnessed with high levels of fidelity (e.g., Hopper, Lambeth, Schapiro &  
88 Whiten, 2008; Whiten et al., 1996), however we currently know little of how children will  
89 respond when viewing a group of models, the majority of whom perform a task using a  
90 different technique to a minority. Will children conform to the technique performed by the  
91 majority even if there is no need to do so in order to succeed in the task? A tentative answer  
92 to this question can be extrapolated from the findings of recent studies that have used an open

93 diffusion approach to explore the cultural transmission of tool use in preschool children  
94 (Flynn & Whiten, 2012; Whiten & Flynn, 2010). In these open diffusion studies an individual  
95 who was pre-trained to retrieve a reward from inside a puzzle box, using one of two different,  
96 but equally effective, techniques, was allowed to perform the task within their naïve peer  
97 group. Typically, the technique seeded spread, with the majority of individuals adopting the  
98 technique performed by the pre-trained individual, providing suggestive evidence that  
99 preschool children will conform to the most common behavioral variant witnessed. More  
100 recent studies that have provided a more direct test of conformity in the context of action  
101 copying have shown that children prefer to copy the actions used by a majority (of adult  
102 models) than a minority when both solutions are equally successful (Wilks, Collier-Baker, &  
103 Nielsen, 2015). A majority preference that occurs independently of emotional reactions to the  
104 behavior (Turner, Nielsen, Collier-Baker, 2014). The preference to copy to an adult majority  
105 has also been demonstrated in the context of tool selection, where children frequently  
106 selected the same inefficient tool chosen by an adult majority rather than an efficient tool  
107 chosen by a minority (DiYanni, Corriveau, Kurkul, Nasrini, & Nini, 2015).

108         The current study aimed to build on previous conformity studies by detailing not only  
109 whether the behavior of the majority influences the propensity of 4- to 6-year-old children to  
110 conform, but also asks for the first time whether the age of the group majority relative to the  
111 observer impacts on this tendency. Previous studies have used either adult models or same  
112 aged peers, thus we know little of the relative influence that individuals of different ages have  
113 on conformist behavior. This leaves open the question of whether some individuals who are  
114 present in an observer's day-to-day environment have a greater influence on copying  
115 behavior than others. The task used was the Glass Ceiling Box, first designed for use in a  
116 comparative project (Horner & Whiten; 2005), and subsequently adopted by many  
117 researchers to explore what has become known as 'over-imitation', or 'over-copying' in both

118 the preschool period and beyond (e.g., Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons,  
119 Young, & Keil, 2007; McGuigan, Gladstone, & Cook, 2012; McGuigan, 2012; 2013;  
120 Moraru, Gomez, & McGuigan, 2016; Nielsen & Blank, 2011). In contrast to the traditional  
121 two-action design tasks described above, where the model operates the task using only  
122 actions that are causally necessary (e.g., removing an obstruction to obtain a reward), the  
123 Glass Ceiling Box is modelled using actions that are both causally unnecessary (the lack of  
124 causality is evident as the box is transparent) and causally necessary to retrieve a reward.  
125 Modelling the task in this way allows observers to approach the task efficiently by retrieving  
126 the reward by opening a small door on the front face of a box and inserting a stick tool inside  
127 (the efficient task variant). Alternatively observers could over-imitate by performing a  
128 number of causally irrelevant actions on the top of the box (e.g., tapping the box with the  
129 tool) before reward retrieval occurs (the inefficient task variant).

130         The majority of the previous studies that have used the Glass Ceiling Box have  
131 utilized a single adult model who always demonstrated the task inefficiently (e.g., McGuigan  
132 & Whiten, 2009; McGuigan, Whiten, Flynn & Horner, 2007; Whiten, Allan, Devlin, Kseib,  
133 Raw, & McGuigan, 2016). Typically children in the age period 3-5 years over-imitate by  
134 copying the causally irrelevant actions performed by the adult model with extremely high  
135 levels of fidelity (e.g., Lyons et al., 2007; Nielsen & Tomaselli, 2010). The high levels of  
136 over-imitation witnessed following task demonstration by an adult model contrast with the  
137 findings of studies that have shown that a child model tends to elicit much lower levels of  
138 irrelevant action fidelity (Flynn, 2008; McGuigan & Graham, 2010; McGuigan, Makinson, &  
139 Whiten, 2011; Wood, Kendal, & Flynn, 2012). However, the results of a recent study suggest  
140 that task demonstration by multiple inefficient peers can lead to increased levels of over-  
141 imitation (McGuigan & Robertson, 2015). McGuigan and Robertson (2015) asked whether 4-  
142 year-old children would switch from their initially efficient approach to the task if the number

143 of inefficient models were incrementally increased. In an initial phase the children saw two  
144 familiar peers perform the task, one efficiently and one inefficiently, before one of the models  
145 left the testing room leaving the participant to perform the task in the presence of the  
146 remaining model. The results showed that the children always performed the task efficiently  
147 irrespective of which model was present during their reproduction. However, in a second  
148 phase of the study the same participants became increasingly likely to include the irrelevant  
149 actions in their reproductions as the number of familiar peers performing the task  
150 inefficiently increased (from 1 to 4 inefficient individuals). The highest levels of over-  
151 imitation were witnessed after viewing a 4:1 ratio of inefficient to efficient models, although  
152 even a small inefficient majority (2:1) was enough to significantly increase the levels of over-  
153 imitation witnessed after viewing one efficient and one inefficient model at baseline.  
154 Intriguingly, in a final phase of the study where the task was presented to the children outside  
155 of the experimental context the level of over-imitation reduced dramatically suggesting that  
156 the participants' causal understanding of the task remained intact, and that social influences  
157 lay behind their tendency to over-imitate.

158         The paradigm used by McGuigan and Robertson (2015) was adapted in the current  
159 study in order to determine whether the levels of over-imitation witnessed would vary  
160 according to the age of the models comprising the group majority. In McGuigan and  
161 Robertson (2015), the group majority comprised familiar individuals who were the same age  
162 as the observers, leaving open the question of whether or models who are either younger, or  
163 older, than the participants would elicit varying levels of over-imitation. Previous dyadic  
164 studies (e.g., Koenig & Harris, 2005; Koenig, Clément, & Harris, 2004) have pointed to the  
165 existence of age related copying biases (e.g., prestige bias; expertise bias), where children  
166 show a preference for learning from older informants, and conversely show a distrust of  
167 information provided by younger informants (i.e., younger individuals are viewed as less



168 knowledgeable and less esteemed than older individuals). However, it has yet to be  
169 determined whether these biases are evident outside of dyadic contexts.

170 In order to explore the influence that the age of the majority has on copying fidelity,  
171 4- to 6-year-old participants in Experiment 1 were presented with task solutions by a group of  
172 five models (4 inefficient models and 1 efficient model) who were either all younger than the  
173 participants, all the same age as the participants, or all older than the participants (as in  
174 McGuigan & Robertson 2015 the models (with the exception of the oldest models) attended  
175 the same elementary school as the participants). In a second experiment, we explored the  
176 influence of model familiarity by presenting the identical task to that used in Experiment 1 to  
177 a second group of participants who were unfamiliar with the models. In both Experiments 1  
178 and 2 we included a further test of conformity by allowing each participant to perform the  
179 task in a ‘post-experiment’ trial in which they were led to believe that the experiment was  
180 complete, thereby removing the social pressure to conform. We predicted that irrespective of  
181 model familiarity the children would be least likely to reproduce the causally irrelevant  
182 actions when faced with an inefficient majority younger than themselves, with the tendency  
183 towards over-imitation increasing as the age of the models comprising the group majority  
184 increased.

185

## 186 **Experiment 1**

### 187 Method

#### 188 *Participants*

189 One hundred and twenty participants (60 males and 60 females) who ranged in age  
190 from 54 to 78 months ( $M = 68$  months,  $SD = 6$  months) took part in the study. The children

191 were allocated to one of 6 conditions each of which comprised 20 participants. In addition to  
192 the experimental participants the study required the participation of 32 (16 males and 16  
193 females) pre-trained child models who provided the task demonstrations in each condition.  
194 Children were predominantly Caucasian and came from mixed socioeconomic backgrounds.  
195 Informed consent was obtained from a parent or guardian of each child.

196

### 197 *Design*

198 The participants were randomly allocated to one of six conditions in a between  
199 participants design, and their responses videotaped for later analysis. In five ‘inefficient  
200 majority’ conditions the participants viewed a total of five task demonstrations (4 inefficient,  
201 1 efficient) presented by a group of five identically aged models (both male and female) who  
202 were either all younger (3-year-old models), all the same age (5-year-old models), or all older  
203 than the participants (8-year-old models, 11-year-old models or 13-year-old models).  
204 Irrespective of condition, four individuals performed the task inefficiently (the majority), and  
205 one individual performed a single efficient demonstration (the minority) with the gender of  
206 the efficient model, and the order in which the efficient model demonstrated (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>  
207 or 5<sup>th</sup>) fully counterbalanced.

208 In a ‘no-majority’ control condition participants viewed two task demonstrations, one  
209 performed by an efficient model and one by an inefficient model (both 5 years of age, one  
210 male and one female), with the gender and the order in which the efficient and inefficient  
211 models demonstrated fully counterbalanced. All of the models were recruited from the same  
212 elementary school (and adjoining Kindergarten class) as the participants with the exception of  
213 the 13-year-old models who had recently attended the same elementary school as the  
214 participants but were now attending a nearby Junior High School. The school environment

215 was one that allowed for interaction between the youngest and oldest children on a daily  
216 basis. However, in order to emphasize that the models were attending the participants' school  
217 (or the nearby Junior High) the models were filmed in full school uniform.

218

### 219 *Apparatus*

220 The apparatus used was a transparent puzzle box (20cm<sup>3</sup>) that was completely sealed  
221 with the exception of two small openings, one on the top of the box and one on the front face  
222 of the box. Each of the openings was covered by a defence, which comprised a small door in  
223 the case of the front opening, and two bolts in the case of the top opening. The opening on the  
224 front face of the box was connected to an opaque tube that held a reward (a small magnetic  
225 toy). In order to retrieve the reward the participant was required to slide open the door and  
226 insert a tool (22cm long) with a magnetic tip into the tube. In contrast, the reward could not  
227 be retrieved via the opening on top of the box, as a 'false ceiling' prevented the tool from  
228 making contact with the tube. Actions directed toward the box could therefore be divided into  
229 two distinct types: causally relevant actions (directed to the front face of the box) and  
230 causally irrelevant actions (directed to the top of the box).

231

### 232 *Procedure*

233 *Experimental Phase.* On entry to the testing room, the participant was asked to sit at a  
234 table directly facing the puzzle box. The experimenter then told the participant that: 'There is  
235 a toy inside the box, and I'm going to show you [the participant] a video of some other  
236 children getting the toy out' (the same toy was extracted from the box by all models). When  
237 the participant appeared comfortable, the box was moved out of direct sight and the video

238 was shown via a laptop display. The video comprised five segments, each interspersed with a  
239 blank screen that showed each of the five models performing the task individually. In order to  
240 ensure that the observer's experience, and subsequent performance, was as naturalistic as  
241 possible the experimenter never explicitly mentioned the age of the models.

242 In the 'inefficient-majority' conditions the participants viewed five different models  
243 retrieve the reward from inside the box. Of these models four (the majority) performed five  
244 causally irrelevant actions using an identical sequence (removing both bolts and tapping on  
245 the internal false ceiling three times) before reward retrieval, whereas one model (the  
246 minority) used only the causally necessary actions required to retrieve the toy (opening the  
247 door and using the tool to retrieve the reward). In the 'no-majority' control condition the  
248 video showed two models retrieve the reward from inside the box, one who performed the  
249 same sequence of causally irrelevant actions used in the 'inefficient majority' conditions, and  
250 one who used only the causally necessary actions required to retrieve the toy. On completion  
251 of the task demonstrations, the box was placed in front of the participant with the following  
252 instruction: 'Now it's your turn'. In order that the presence of the experimenter would have  
253 minimal influence on the participant's performance the experimenter looked away from the  
254 child during their response period.

255

256 *'Post-experiment' phase.* After the experimental phase of the study was complete,  
257 each participant received a 'post-experimental' trial in which the experimenter acted as  
258 though the experiment was complete by thanking the participant, and giving them a small  
259 reward for their participation. Once the participant had been thanked for taking part, they  
260 were asked if they could 'check that the toy is back in the box for the next participant'. This  
261 post-experimental trial was adapted from that used successfully in previous studies (e.g.,

262 McGuigan et al., 2012; McGuigan et al., 2015), and aimed to determine whether the  
263 participants would continue to perform the causally irrelevant actions outside of the  
264 experimental context. As in the experimental conditions, the experimenter looked away  
265 during the child's attempt. If the levels of over-imitation were substantially lower in the post-  
266 experiment trial, then it is likely that any reproduction of the causally irrelevant actions in the  
267 experimental phase was due to the influence of the inefficient majority rather than reflecting  
268 the participant's private causal knowledge of the task.

269

#### 270 *Scoring*

271 An 'over-imitation score' was calculated for each participant by totaling the number  
272 of irrelevant actions that matched those demonstrated by the inefficient model(s) (i.e., 2 bolt  
273 removals and 3 irrelevant tool taps against the false ceiling). The minimum score a  
274 participant could receive was 0 indicating that no causally irrelevant actions were performed,  
275 with a maximum score of 5 indicating that all elements of the inefficient sequence were  
276 reproduced (i.e., the participant performed 2 bolt removals and 3 taps).

277

#### 278 *Inter-rater reliability.*

279 The data from 15 children representing 13% of the total sample were coded  
280 independently by a naïve observer. The ratings showed high concordance suggesting that the  
281 coding scheme was highly reliable for the experiment trial (intraclass correlation:  $r = .97$ ,  $p <$   
282  $.001$ ). In the post-experiment trial no intraclass correlations were conducted as the raters  
283 matched exactly.

284

285 *Results*

286 *Preliminary analysis.* Initial analysis of the data from the five experimental conditions  
287 revealed that the level of over-imitation did not vary according to the position of the efficient  
288 demonstration (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup>), the gender of the observer, or the gender of the efficient  
289 model, nor was there an interaction between observer gender and the gender of the minority  
290 efficient model. Similarly, in the ‘no-majority’ control condition neither the order in which  
291 the efficient model demonstrated (1<sup>st</sup> or 2<sup>nd</sup>), or the gender of the efficient model influenced  
292 task fidelity, therefore these factors were excluded from all subsequent analyses. Irrespective  
293 of the condition to which the participants were allocated all of the children successfully  
294 retrieved the reward from inside the box, therefore the reproduction of the efficient actions  
295 are not considered further.

296

297 *Experimental phase.* Of interest in the analysis was: 1) whether the number of  
298 children omitting all of the irrelevant actions would differ between the ‘inefficient majority’  
299 conditions and the ‘no-majority’ control condition, 2) whether the irrelevant action sequence  
300 would be reproduced with higher levels of fidelity in the ‘inefficient majority’ conditions  
301 than the ‘no-majority’ control condition, 3) whether the level of over-imitation in the  
302 ‘inefficient-majority’ conditions would vary according to model age, and 4) whether over-  
303 imitation would be eliminated when the task was presented outside of the experimental  
304 context.

305

306 Influence of the majority



332 significantly less over-imitation occurred following task demonstration by the youngest  
333 models (mean = 2.8) than either the same aged models (mean = 4.05,  $p = .02$ ), or the oldest  
334 models (mean = 4.05,  $p = .02$ ) who were copied with equally high levels of fidelity (see Fig.  
335 1). No other condition comparisons were significant. A detailed breakdown of the specific  
336 irrelevant actions performed (by bolt removals and irrelevant taps) in each condition is  
337 provided in SI Table 1.

338 ---Fig 1. About here---

339 *'Post-experiment' comparisons.*

340 Of additional interest was whether the participants would continue to over-imitate outside of  
341 the experimental context when all social pressure to adopt the behavior of the majority was  
342 removed. A series of planned comparisons on the data from each condition revealed that the  
343 number of irrelevant actions performed in the post-experiment trial was substantially reduced  
344 from that witnessed in the experimental trial of each 'inefficient-majority' condition (3-year-  
345 old models,  $t(19) = 5.78$ ,  $p < .001$ ; 5-year-old models,  $t(19) = 9.02$ ,  $p < .001$ ; 8-year-old  
346 models,  $t(19) = 5.42$ ,  $p < .001$ ; 11-year-old models,  $t(19) = 7.89$ ,  $p < .001$ ; 13-year-old  
347 models,  $t(19) = 10.16$ ,  $p < .001$ ), as well as from that witnessed in the 'no-majority' control  
348 condition ( $t(19) = 3.0$ ,  $p = .007$ ; see Table 2). These findings suggest that the children's  
349 causal knowledge of the task was unchanged and they performed the causally irrelevant  
350 actions for social reasons. See SI Table 1 for a detailed breakdown of over-imitation by bolt  
351 removals and irrelevant taps in the 'post-experiment' trial of each condition.

352 ---Table 2 about here---

353 *Discussion*



354           The results from Experiment 1 suggest that the participants did not copy the different  
355 majority groups with equally high levels of fidelity. Instead the children appeared to be  
356 copying selectively, with the same aged and the oldest models eliciting the highest levels of  
357 fidelity. Interestingly, this over-imitative tendency was equally high in response to both the  
358 same aged and the oldest majority groups, and was in each case significantly greater than that  
359 elicited by models who were younger than the participants. A possible explanation for this  
360 pattern of copying fidelity lies in the level of expertise attributed to majorities of each age,  
361 with the youngest children being deemed least expert and therefore less worthy of copying  
362 than the oldest (most expert) children. However, counter to our initial predictions the increase  
363 in over-imitation did not share a linear relationship with increasing model age. Instead the  
364 same aged children, who based on their age alone would have been viewed as one of the least  
365 expert model groups, were copied with equally high levels of fidelity as the oldest children. A  
366 possible explanation for this non-linear relationship may lie in the familiarity of the models.  
367 The models used in Experiment 1 potentially ranged in how familiar they were to the  
368 participants, with the same aged models being the most familiar, the oldest models the least  
369 familiar, and the remaining models of intermediate familiarity. Previous studies have shown  
370 that children prefer to copy individuals who are familiar to them (e.g., Slaughter, Nielsen, &  
371 Enchelmaier, 2008), whilst also showing a preference for copying older expert individuals  
372 (e.g., McGuigan et al., 2011; Wood et al., 2012), suggesting a possible interaction between  
373 familiarity and the age of the model. In order to tease apart the influence of model age and  
374 model familiarity, in a second experiment we presented the videos of the model groups used  
375 in Experiment 1 to groups of participants who were unfamiliar with the models used in the  
376 video clips.

377

## 378 **Experiment 2**

379 In Experiment 2, we aimed to explore the importance of model age, and model  
380 familiarity, in the conditions where we found the lowest (i.e., 3-year-old models), and highest  
381 (i.e., 5- and 13-year-old models), levels of over-imitation in Experiment 1. If high levels of  
382 familiarity with the same aged models, combined with a sensitivity to model expertise,  
383 explained the pattern of performance witnessed in Experiment 1 then we would predict that  
384 the participants in Experiment 2 would: 1) show a reduction in the level of over-imitation in  
385 response to the now unfamiliar same aged models, and 2) would continue to copy the  
386 youngest and oldest models with the lowest and highest levels of fidelity respectively (albeit  
387 at slightly lower levels than Experiment 1 due to the unfamiliar models). This would generate  
388 a linear pattern of responding with the youngest models being copied least faithfully, the  
389 oldest models most faithfully, with the same age models eliciting a level of over-imitation  
390 intermediate to the younger/older models. If however, model familiarity did not influence the  
391 pattern of over-imitation witnessed in Experiment 1 then we would predict an identical  
392 pattern of responding in Experiment 2 (i.e. equally high levels of over-imitation in the same  
393 aged and oldest models groups combined with a significant reduction in over-imitation in the  
394 youngest model group).

395 Experiment 2 also included a new ‘2:2 no-majority’ control condition in which the  
396 participants viewed four models (two efficient; two inefficient), rather than two models (one  
397 efficient; one inefficient) as presented in the ‘no-majority’ condition of Experiment 1. We  
398 included the new 2:2 control condition to rule out the possibility that the participants in the  
399 ‘no-majority’ condition of Experiment 1 performed significantly fewer irrelevant actions than  
400 the participants in the ‘inefficient majority’ conditions as the result of viewing only a single  
401 inefficient model. In addition, the inclusion of two inefficient models made the memory  
402 demands more comparable to that witnessed in the ‘inefficient majority’ conditions as the  
403 number of inefficient task demonstrations, and the total number of task demonstrations, were

404 more closely equated. It was predicted that the participants would perform very few irrelevant  
405 actions in the ‘2:2 no-majority’ condition, and that the number of irrelevant actions  
406 performed would be substantially reduced to that witnessed in the ‘inefficient majority’  
407 conditions.

408

#### 409 *Method*

##### 410 *Participants*

411           Eighty-two participants (46 males and 36 females) who ranged in age from 56 to 83  
412 months ( $M = 71$  months,  $SD = 7$  months) took part in the study. The children were allocated  
413 to one of 4 conditions; 3-year-old models ( $N = 21$ ), 5-year-old models ( $N = 19$ ), 13-year-old  
414 models ( $N = 20$ ), or a ‘no-majority’ control ( $N = 22$ ). The models were those employed in the  
415 same aged, youngest, and oldest model conditions of Experiment 1. In order to ensure that the  
416 models were unfamiliar to the participants all of the children who took part in Exp.2 were  
417 recruited from different schools to that used in Exp. 1. All children were Caucasian and came  
418 from mixed socioeconomic backgrounds. Informed consent was obtained from a parent or  
419 guardian of each child. An additional 4 children were excluded from the study as they either  
420 failed to interact with the task ( $n = 3$ ), or due to experimenter error ( $n = 1$ ).

421

##### 422 *Design/Procedure*

423           The participants’ in Experiment 2 were allocated, using a between participants design,  
424 to one of three ‘inefficient majority’ conditions (3-year-old models, 5-year-old models, or 13-  
425 year-old models) identical to those presented in Experiment 1. However, in contrast to  
426 Experiment 1 all of the models who were included in Experiment 2 were unfamiliar to the

427 participants. An additional group of participants were allocated to the new ‘2:2 no-majority’  
428 control condition in which the participants viewed two efficient models and two inefficient  
429 models. To maintain consistency with the 1:1 control condition of Experiment 1, all 4 of the  
430 models (two male and two female) were the same age as the participants (5 years of age) and  
431 were taken from the same pool of 5-year-old models used in Experiment 1. The gender of the  
432 efficient and inefficient models was counterbalanced throughout, and the order in which the  
433 four models demonstrated was fully randomized. The responses of all children were  
434 videotaped for later analysis

435

#### 436 *Inter-rater reliability*

437         The data from 10 children representing 12% of the total sample were coded  
438 independently by a naïve observer. The ratings showed high concordance suggesting that the  
439 coding scheme was highly reliable for the experiment trial (intraclass correlation:  $r = .97$ ,  $p <$   
440  $.001$ ). In the post-experiment trial no intraclass correlations were conducted as the raters  
441 matched exactly.

442

#### 443 *Results*

444         *Preliminary analysis.* Initial analysis of the data from the experimental conditions  
445 revealed that the level of over-imitation did not vary according to the position of the efficient  
446 demonstration (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup>), the gender of the observer, or the gender of the efficient  
447 model, nor was there an interaction between observer gender and the gender of the minority  
448 efficient model. Similarly, in the 2:2 control condition the order in which the efficient and  
449 inefficient models demonstrated, and the gender of the efficient model had no significant

450 effect on task fidelity therefore these factors were excluded from all subsequent analyses.

451 Irrespective of the condition to which the participants were allocated all of the children

452 successfully retrieved the reward from inside the box, therefore the reproduction of the

453 efficient actions are not considered further.

454

455 *Experimental Phase.* Of interest in the analysis was: 1) whether the number of  
456 children omitting all of the irrelevant actions would differ between the ‘inefficient majority’  
457 conditions and the ‘2:2 no-majority’ control condition, 2) whether the irrelevant action  
458 sequence would be reproduced with higher levels of fidelity in the ‘inefficient majority’  
459 conditions than the ‘2:2 no-majority’ control condition, 3) whether the age of the inefficient  
460 majority influenced the level of over-imitation witnessed, 4) whether the varying degrees of  
461 familiarity with the models in the ‘inefficient-majority’ conditions of Experiments 1 and 2  
462 would influence the level of over-imitation witnessed, 5) whether the inclusion of an  
463 additional inefficient model in the ‘2:2 no-majority’ control would lead to higher levels of  
464 over-imitation than that witnessed in the ‘no-majority’ control condition of Experiment 1, and  
465 6) whether over-imitation would be eliminated when the task was presented outside of the  
466 experimental context.

467

468 *Influence of the majority*

469 *Omission of the irrelevant actions.* In the ‘no-majority’ control condition, where the  
470 children saw four unfamiliar models, two efficient and two inefficient, the majority (16 from  
471 22) of the children acted efficiently and performed no irrelevant actions (see Table 1). As in  
472 Exp. 1 this pattern of responding contrasted with the ‘inefficient majority’ conditions, where

473 after viewing a majority of unfamiliar models performing inefficiently, smaller numbers of  
474 children acted efficiently (see Table 1). A chi-square analysis revealed that the number of  
475 children who acted efficiently varied significantly across conditions ( $\chi^2(3) = 20.5, p < .001$ ),  
476 with follow up chi-square comparisons revealing that significantly fewer children acted  
477 efficiently in each of the three ‘inefficient majority’ conditions than in the ‘no-majority’  
478 control condition (see Table 1). Taken together these findings suggest that viewing only a  
479 single inefficient model could not explain the low levels of over-imitation witnessed in the  
480 ‘no-majority’ control condition of Exp. 1. Instead it appears as though viewing a majority of  
481 individuals acting inefficiently, irrespective of their familiarity, results in the observer  
482 reproducing irrelevant actions.

483 *Fidelity of irrelevant action reproduction.* In order to determine whether exposure to a  
484 majority of unfamiliar inefficient models influenced the precise level of fidelity with which  
485 the irrelevant action sequence was reproduced the participants over-imitation scores were  
486 analyzed using a univariate ANOVA with condition (no-majority or majority: 3-, 5-, or 13-  
487 year-old models) as a between participants factor. The ANOVA revealed a significant main  
488 effect of condition ( $F(2,78) = 10.28, p < .001, \mu = .28$ ), with the post hoc Tukey LSD tests  
489 revealing that the inefficient majority had a powerful effect on behavior with the children in  
490 each of the ‘inefficient majority’ conditions performing significantly more irrelevant actions  
491 than the children in the ‘no-majority’ control condition ( $p = .028$  for the 3-year-old models,  
492 and  $p < .001$  for the 8- and 13-year-old models; see Fig. 2). It appeared that the extent to  
493 which the majority influenced the level of over-imitation was influenced by the age of the  
494 models, with the post hoc Tukey LSD tests revealing that significantly less over-imitation  
495 occurred following task demonstration by the youngest models ( $M = 2.0$ ) than the oldest  
496 models ( $M = 3.65, p = .005$ ), with the difference between the same aged ( $M = 3.05$ ) and  
497 youngest models approaching significance ( $p = .07$ ; see Fig. 2). No significant difference in

498 the level of over-imitation was revealed between the same aged models and the oldest models  
499 ( $p = .35$ ), with the reproduction of irrelevant actions being relatively high in both groups. See  
500 SI Table 1 for a detailed breakdown of over-imitation by bolt removals and irrelevant taps in  
501 the experimental trial of each ‘inefficient majority’ condition.

502 ---Fig 2. About here---

### 503 *Influence of model familiarity.*

504 In order to determine whether model familiarity influenced the occurrence of over-  
505 imitation, the number of irrelevant actions performed in each ‘inefficient majority’ condition  
506 of Experiment 2 was directly compared to the equivalent condition of Experiment 1. The  
507 analyses revealed that model familiarity had little influence on imitative fidelity with the  
508 number of irrelevant actions performed in the ‘inefficient majority’ conditions of Experiment  
509 2 not differing significantly from that witnessed in the equivalent condition of Experiment 1  
510 in either the younger model condition ( $M \text{ Exp. 1} = 2.8, M \text{ Exp. 2} = 2.0; t(39) = 1.29, p = .20$ ),  
511 or the older model condition ( $M \text{ Exp. 1} = 4.1, M \text{ Exp. 2} = 3.7; t(38) = .76, p = .45$ ), although  
512 the analysis of the same aged model condition did reveal a non-significant trend towards  
513 higher fidelity copying of familiar models ( $M \text{ Exp. 1} = 4.1, M \text{ Exp. 2} = 3.1; t(37) = 1.76, p =$   
514  $.09$ ). Similarly, performance in the ‘no-majority’ control conditions did not differ  
515 significantly between experiments ( $M \text{ Exp. 1} = 0.9, M \text{ Exp. 2} = 0.7; t(40) = .42, p = .68$ ),  
516 suggesting that neither model familiarity, nor the number of inefficient models witnessed  
517 influenced the performance of the control children.

518 The lack of difference between the equivalent conditions of Experiments 1 and 2  
519 suggests that model familiarity had little influence within each individual model group.  
520 However, it appeared as though the level of over-imitation was consistently lower across the  
521 unfamiliar model conditions than that witnessed in the familiar model conditions. In order to

522 determine whether these differences were significant we collapsed the data from each  
523 condition (3-, 5-, and 13-year-old ‘inefficient majority’ conditions and ‘2:2 no-majority’  
524 control) of Experiment 2 into an unfamiliar model variable and the equivalent four conditions  
525 of Experiment 1 into an familiar model variable. A univariate ANOVA with familiarity  
526 (familiar or unfamiliar) as a between participants factor revealed that model familiarity  
527 influenced the copying fidelity witnessed with significantly fewer irrelevant actions ( $F(1,160)$   
528  $= 3.96$ ,  $p = .04$ ,  $\eta^2 = .02$ ) being performed across the unfamiliar model conditions ( $M = 2.3$ )  
529 than the familiar model conditions ( $M = 3.0$ ).

530

531 *‘Post-experiment’ comparisons.*

532 Of additional interest was whether the participants would continue to over-imitate  
533 outside of the experimental context when all social pressure to adopt the behavior of the  
534 majority was removed. A series of planned comparisons on the data from each condition  
535 revealed that the number of irrelevant actions performed in the post-experiment trial was  
536 substantially reduced from that witnessed in the experimental trial of each ‘inefficient-  
537 majority’ condition (3-year-old models,  $t(20) = 4.33$ ,  $p < .001$ ; 5-year-old models,  $t(17) =$   
538  $5.81$ ,  $p < .001$ ; 13-year-old models,  $t(19) = 7.89$ ,  $p < .001$ ; see Table 2), as well as from that  
539 witnessed in the ‘no-majority’ control condition ( $t(21) = 2.59$ ,  $p = .017$ ). These findings  
540 suggest that the children’s causal knowledge of the task was unchanged, and they performed  
541 the causally irrelevant actions for social reasons. See SI Table 1 for a detailed breakdown of  
542 over-imitation by bolt removals and irrelevant taps in the ‘post-experiment’ trial of each  
543 condition.

544



545 *Discussion*

546           The results of Experiment 2 show that additional groups of participants over-imitated  
547 at similar levels to those participants in the equivalent ‘inefficient majority’ conditions of  
548 Experiment 1. This suggests that high levels of familiarity with the same aged models, in  
549 combination with a preference for copying older, more expert models, could not account for  
550 the pattern of performance witnessed in Experiment 1. Instead, the consistent level of over-  
551 imitation across the equivalent conditions of the two experiments suggests that same aged,  
552 and older models, are particularly powerful in eliciting of copying behavior, whereas younger  
553 models do not elicit as strong an imitative tendency. In contrast to the high levels of over-  
554 imitation witnessed in the ‘inefficient majority’ conditions the children in the ‘no-majority’  
555 control conditions of both experiments performed very few irrelevant actions. The  
556 equivalence between the two control conditions suggests that viewing only a single  
557 inefficient model in the ‘no-majority’ condition of Experiment 1, and therefore differential  
558 memory demands, could not account for the low levels of over-imitation witnessed, instead it  
559 appeared as though presenting an equal number of inefficient and efficient models reduced  
560 the occurrence of over-imitation from the majority conditions irrespective of whether 1 or 2  
561 inefficient models were viewed.

562

563 **General Discussion**

564           Taken together the findings of Experiments 1 and 2 show that witnessing task  
565 demonstration by a majority comprised of inefficient models resulted in significantly higher  
566 levels of over-imitation than viewing an equal number of inefficient and efficient models.  
567 However, the extent to which the children in Experiment 1 over-imitated was influenced by  
568 the identity of the models comprising the group majority, with children copying the causally

569 irrelevant actions performed by the same aged models, and the oldest models at equally high  
570 levels, a level of copying fidelity that was significantly greater than that elicited by the  
571 youngest models. Experiment 2 demonstrated that the pattern of over-imitation witnessed  
572 across the different majority groups of Experiment 1 did not result from model familiarity,  
573 although the inclusion of unfamiliar models depressed the overall level of over-imitation  
574 across groups. Intriguingly, in both experiments the reproduction of causally irrelevant  
575 actions was almost completely eradicated outside of the experimental context, suggesting that  
576 a social motivation may lie behind this conformist tendency. These results integrate the  
577 conformity, action copying, and selective action copying literatures in a novel way, and  
578 provide detailed insights of the influence of the age, and familiarity, of the majority on  
579 children's behavior within the context of over-imitation.

580         The tendency of the children in the current study to adopt the behavior of the majority  
581 is consistent with the findings of previous studies that have shown conformity in the  
582 preschool period (Corriveau & Harris, 2010; Haun et al., 2012; Haun & Tomasello, 2011;  
583 Herrmann et al., 2013). However, the present findings go beyond showing a conformist bias,  
584 to demonstrate that the level of conformity was influenced by the identity of the individuals  
585 comprising the majority, with same aged and much older models eliciting high levels of  
586 copying fidelity, and younger models failing to elicit equivalent levels of matching behavior.  
587 This pattern of performance suggests that whether or not children will conform does not share  
588 a straightforward relationship with the number of models displaying a particular task  
589 solution. Instead, it appears that children take into account characteristics of the individuals  
590 comprising the majority, in this case age, and at a broader level familiarity, before copying  
591 selectively. In many respects the selective over-imitation witnessed with differently aged  
592 models broadly mirrors that of earlier dyadic studies that have shown that children are more  
593 likely to copy the irrelevant actions performed by a single adult model, but not those

594 performed by a single child model (Flynn, 2008; McGuigan & Graham, 2010; McGuigan et  
595 al., 2011; Wood, Kendal, & Flynn, 2013). However, even the youngest majority group in the  
596 current study elicited over-imitation at a much higher rate than the single inefficient child  
597 model in the dyadic studies, suggesting that copying the majority likely serves an adaptive  
598 function (Boyd & Richerson, 1988; Henrich & Boyd, 1998).

599         As well as the level of over-imitation differing between dyadic and group contexts the  
600 children in the current study failed to perform the irrelevant actions in the post-experiment  
601 trial. Taken together these findings appear to suggest that the participants' motivations were  
602 social in nature (Užgiris, 1981), perhaps resulting from normative conformity (Campbell &  
603 Fairey, 1989; Claidière & Whiten, 2012; Deutsch & Gerard, 1955; Tanford & Penrod, 1984),  
604 rather than an alteration in their causal knowledge (see Kenward, Karlsson, & Persson, 2011;  
605 Kenward, 2012; Keupp, Behne, & Rakoczy, 2013 for a more detailed discussion of the role  
606 of normativity in over-imitation). This finding is consistent with the results of previous  
607 conformity studies where children's public responses (verbal) were more likely to coincide  
608 with the majority than their private responses (pointing) (Haun & Tomasello, 2011). It is also  
609 consistent with the finding that preschool children correctly applied perceptual knowledge to  
610 a practical problem, despite having earlier gone along with the incorrect majority in an  
611 equivalent perceptual judgment task (Corriveau & Harris, 2010). These results suggest that,  
612 similar to adults in the pioneering Asch paradigms, children's responses to the majority are  
613 fleeting rather than reflecting a permanent change in their knowledge, a process that  
614 Corriveau and Harris (2010) termed "respectful deference".

615         The ability of children to selectively switch their approach between the experimental  
616 and non-experimental contexts is consistent with the findings from recent studies that have  
617 shown that children readily act on contextual cues provided by the model(s), both social (e.g.,  
618 number of models performing an action), and verbal (e.g., "she always does it this way"), in

619 order to appropriately adopt either an informational (instrumental) or a normative  
620 (conventional) stance when performing the task (Clegg & Legare, 2016; Legare, Wen,  
621 Herrmann & Whitehouse, 2015; Keupp, Bancken, Schillmöller, Rakoczy, & Behne, 2016;  
622 Moraru et al., 2016). This capacity for selective copying has recently been extended to  
623 situations in which the context switches between normative and instrumental (Keupp, Behne,  
624 Zachow, Kasbohm, & Rakoczy, 2015). Underpinning this selective social learning may be  
625 transmission biases, a set of evolved cognitive heuristics that enable social learners to  
626 respond to their environment adaptively (Boyd & Richerson, 2005). Evolutionary theory  
627 suggests that a naïve individual is well served by copying the most prevalent behavior  
628 performed by those around them (Boyd & Richerson, 1988; Henrich & Boyd, 1998). This  
629 ‘copy the majority’ approach is useful as the behavior of the majority likely provides  
630 information as to what is the most adaptive behavioral variant in that environment, a  
631 mechanism that Boyd and Richerson (2005) termed a conformist bias. However, as well as  
632 being influenced by the behavior of the majority observers may also be influenced by  
633 characteristics of the models, including similarity, prestige and/or expertise relative to the  
634 observer (Haun, van Leeuwen, & Edelson, 2013). These model-based biases are likely highly  
635 adaptive as they allow individuals to adopt the behaviors utilized by successful individuals,  
636 that by extension might ultimately lead to success for the observer themselves (Boyd &  
637 Richerson, 2005).

638         A key aim of the current study was to bring together conformist and model based  
639 transmission biases in order to explore the interaction between the two. The results suggest  
640 that these biases may interact, with children demonstrating a general tendency to conform to  
641 the majority behavior, but the extent to which they do so varying according to age of the  
642 individuals comprising the majority, and more broadly model familiarity. Intriguingly, there  
643 was not a straightforward relationship between model age and over-imitation with children

644 copying both same aged models, and much older models, with the highest levels of fidelity. It  
645 may be that these model based differences reflect a tendency of children to adopt different  
646 biases depending on the age of the majority, with children copying the same aged majority as  
647 they were most similar to themselves i.e., a similarity bias. In contrast, a preference for the  
648 oldest models, and conversely a lack of preference for the younger models, may have  
649 stemmed from an expertise or a prestige bias (where younger individuals are viewed as less  
650 expert and less prestigious than older individuals). Indeed previous studies have shown that  
651 children in this age period are generally very adept at recognizing expert over inexpert  
652 individuals, and acting on that information, in both the domains of action copying (Scofield,  
653 Gilpin, Pierucci, & Morgan, 2013), and testimony (e.g., Koenig & Harris, 2005; Koenig,  
654 Clément, & Harris, 2004; Pasquini, Corriveau, Koenig, & Harris, 2007).

655         With respect to the familiarity of the models, the results of Experiment 2 suggest that  
656 viewing unfamiliar models depressed the overall levels of over-imitation witnessed across  
657 conditions, but did not change the overall pattern of over-imitation witnessed across the  
658 different model groups. The higher levels of over-imitation following task demonstration by  
659 the familiar models may have resulted from the participants viewing models who were  
660 currently, or had recently, attended the same school as the participants, as an ingroup who  
661 were more similar to themselves, than the unfamiliar (outgroup) models. However, selectivity  
662 based on model familiarity was independent of the age of the majority suggesting that some  
663 level of familiarity with the models at the broadest ingroup level (i.e., the same school), may  
664 have been enough to elicit a stronger bias to conform than an unfamiliar outgroup. Future  
665 studies could usefully explore the way that different transmission biases, both conformist and  
666 model based, interact in order to ascertain the conditions under which conformity will occur.

667         A further feature of the current study that could be usefully examined in future  
668 research is the influence that the physical presence of the majority has on the subsequent

669 behavior of the observer. In the current study, and in the majority of conformity studies  
670 involving child participants, the behavior of the majority was presented via a televised  
671 display, and the models were not present during the participant's reproduction (e.g.,  
672 Corriveau & Harris, 2010; Herrman et al., 2013; McGuigan & Stevenson, 2016). As young  
673 children frequently copy the majority despite such models not being physically present, it  
674 appears that merely viewing the behavior of other individuals is enough to elicit conformist  
675 behavior; direct social appraisal or social pressure is not necessary. The lack of influence of  
676 model presence contrasts with the findings of Nielsen and Blank (2011) who found that  
677 children preferentially copied the technique of a model who remained with them during  
678 testing, rather than the technique used by a model who left the testing area. One possible  
679 reason for these discrepant findings is that Nielsen and Blank (2011) employed adult models  
680 who due to their greater status may lead the children to feel that they 'should' copy the adults  
681 approach. Intriguingly, using an almost identical paradigm to that used in the current study  
682 McGuigan et al. (2012) found that adults were equally likely to copy an inefficient majority,  
683 irrespective of whether the majority were present or absent during the participant's attempt,  
684 suggesting that model presence had little influence on copying fidelity. Taken together, these  
685 results suggest that both children and adults can use the frequency of individuals displaying a  
686 particular task solution as a cue to the behavior that is normative for that particular group. In  
687 addition, it appears as though both children and adults are highly sensitive to the context in  
688 which the task was presented- conforming in the experimental context when the task  
689 presentation was framed as 'your turn', and omitting the irrelevant actions post experiment. It  
690 is likely that 'having a turn' directly after viewing the performance of a group engenders a  
691 sense of normativity missing in the post experiment presentation. Future studies could  
692 usefully explore how sensitive children are to such contextual differences, asking under what  
693 conditions children will conform to the majority behavior.

694 In sum, the current study provides unique insights into the study of conformist  
695 behavior in the relatively unexplored area of action copying by showing that, not only were  
696 our young children highly conformist, the extent to which children conformed varied  
697 according to the identity of the individuals comprising the majority, with same aged and  
698 much older models eliciting precise matching, a tendency that was significantly greater than  
699 that elicited by models younger than the participants. The familiarity of the models did not  
700 influence the overall pattern of copying witnessed, but did reduce the overall level of copying  
701 fidelity across conditions. These findings suggest that the interplay between conformist  
702 transmission and model-based biases is complex, but is likely a powerful force behind human  
703 cultural learning.

704

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708

#### 709 **References**

- 710 Asch, S. E. (1955). Opinions and Social Pressure. *Scientific American*, 193, 31-35.
- 711 Asch, S. E. (1956). Studies of independence and conformity: A minority of one against a  
712 unanimous majority. *Psychological Monographs*, 70, 1-70.
- 713 Boyd, R., & Richerson, P. J. (1988). *Culture and the evolutionary process*. Chicago:  
714 University of Chicago Press.
- 715 Boyd, R., & Richerson, P. J. (2005). *The origin and evolution of cultures*. New York: Oxford  
716 University Press.

- 717 Boyd, R., & Richerson, P. J. (2009). Culture and the evolution of human cooperation.  
718 *Philosophical Transactions of the Royal Society B*, 364, 3281-3288.
- 719 Campbell, J. D., & Fairey, P. J. (1989). Informational and normative routes to conformity-  
720 the effect of faction size as a function of norm extremity and attention to the stimulus.  
721 *Journal of Personality and Social Psychology*, 57, 457-468. doi: 10.1037/0022-  
722 3514.57.3.457
- 723 Chen, E. E., Corriveau, K. H., & Harris, P. L. (2012). Children trust a consensus composed of  
724 outgroup members- but do not retain that trust. *Child Development*, 84, 269-282.  
725 doi:10.1111/j.1467-8624.2012.01850.x
- 726 Claidière, N., & Whiten, A. (2012). Integrating the study of conformity and culture in  
727 humans and nonhuman animals. *Psychological Bulletin*, 138, 126-145.  
728 doi:10.1037/a0025868
- 729 Clegg, J. M., & Legare, C. H. (2016). Instrumental and conventional interpretations of  
730 behavior are associated with distinct outcomes in early childhood. *Child Development*,  
731 87, 527-542.
- 732 Corriveau, K. H., & Harris, P. L. (2010). Preschoolers (sometimes) defer to the majority in  
733 making simple perceptual judgments. *Developmental Psychology*, 46, 437-445.  
734 doi:10.1037/a0017553
- 735 Deutsch, M. & Gerard, H. B. (1955). A study of normative and informational social  
736 influences upon individual judgment. *The Journal of Abnormal and Social Psychology*,  
737 51, 629-636. doi:10.1037/h0046408



738 DiYanni, C. J., Corriveau, K. H., Kurkul, K., Nasrini, J., & Nini, D. (2015). The role of  
739 consensus and culture in children's imitation of inefficient actions. *Journal of*  
740 *Experimental Child Psychology*, *137*, 99-110. doi: org/10.1016/j.jecp.2015.04.004

741 Flynn, E. (2008). Investigating children as cultural magnets: Do young children transmit  
742 redundant information along diffusion chains? *Philosophical Transactions of the Royal*  
743 *Society B: Biological Sciences*, *363*, 3541-3551. doi:10.1098/rstb.2008.0136

744 Flynn, E., & Whiten, A. (2012). Experimental “microcultures” in young children: identifying  
745 biographic, cognitive, and social predictors of information transmission. *Child*  
746 *Development*, *83*, 911-925. doi:10.1111/j.1467-8624.2012.01747.x

747 Fusaro, M., & Harris, P. L. (2008). Children assess informant reliability using bystanders’  
748 non-verbal cues. *Developmental Science*, *11*, 771-777. doi:10.1111/j.1467-  
749 7687.2008.00728.x

750 Fusaro, M., & Harris, P. L. (2013). Dax gets the nod: Toddlers detect and use social cues to  
751 evaluate testimony. *Developmental Psychology*, *49*, 514-522. doi:10.1037/a0030580

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

755 Haun, D. B. M., & Tomasello, M. (2011). Conformity to peer pressure in preschool children.  
756 *Child Development*, *82*, 1759-1767. doi:10.1111/j.1467-8624.2011.01666.x

757 Haun, D. B. M., van Leeuwen, E. J. C., & Edelson, M. G. (2013). Majority influence in  
758 children and other animals. *Developmental Cognitive Neuroscience*, *3*, 61–71.  
759 doi:10.1016/j.dcn.2012.09.003

760 Henrich, J., & Boyd, R. (1998). The evolution of conformist transmission and the emergence  
761 of between-group differences. *Evolution and Human Behavior*, *19*, 215-241.  
762 doi:10.1016/S1090-5138(98)00018-X

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

766 Hopper, L. M., Lambeth, S. P., Schapiro, S. J., Whiten, A. (2008). Observational learning in  
767 chimpanzees and children studied through 'ghost' conditions. *Proceedings of the Royal*  
768 *Society B*, *275*, 835-840. doi: 10.1098/rspb.2007.1542

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

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

775 Kenward, B., Karlsson, M., & Persson, J. (2011). Over-imitation is better explained by norm  
776 learning than by distorted causal learning. *Proceedings of The Royal Society B*, *278*,  
777 1239-1246. doi:10.1098/rspb.2010.1399

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

- 781 Keupp, S., Behne, T., & Rakoczy, H. (2013). Why do children overimitate? Normativity is  
782 crucial. *Journal of Experimental Child Psychology*, *116*, 392-406.  
783 doi:10.1016/j.jecp.2013.07.002
- 784 Keupp, S., Behne, T., Zachow, J., Kasbohm, A., & Rakoczy, H. (2015). Over-imitation is not  
785 automatic: Context sensitivity in children's overimitation and action interpretation of  
786 causally irrelevant actions. *Journal of Experimental Child Psychology*, *130*, 163-175.  
787 doi: org/10.1016/j.jecp.2014.10.005
- 788 Koenig, M. a, & Harris, P. L. (2005). Preschoolers mistrust ignorant and inaccurate speakers.  
789 *Child Development*, *76*, 1261-1277. doi:10.1111/j.1467-8624.2005.00849.x
- 790 Koenig, M. A., Clement, F., & Harris, P. L. (2004). Trust in testimony children's use of true  
791 and false statements. *Psychological Science*, *15*, 694-699.
- 792 Legare, C. H., Wen, N. J., Herrmann, P. A., & Whitehouse, H. (2015). Imitative flexibility  
793 and the development of cultural learning. *Cognition*, *142*, 351-361. doi:  
794 org/10.1016/j.cognition.2015.05.020
- 795 Lucas, A., Burdett, E., Burgess, V., Wood, L. A., McGuigan, N., Harris, P. L., & Whiten, A.  
796 (in press). The development of selective copying: Children's learning from an expert  
797 versus their mother. *Child Development*.
- 798 Lyons, D. E., Damrosch, D. H., Lin, J. K., Macris, D. M., & Keil, F. C. (2011). The scope  
799 and limits of overimitation in the transmission of artefact culture. *Philosophical*  
800 *Transactions of the Royal Society B: Biological Sciences*, *366*, 1158-1167.  
801 doi:10.1098/rstb.2010.0335

802 Lyons, D. E., Young, A. G., & Keil, F. C. (2007). The hidden structure of overimitation.  
803 *Proceedings of the National Academy of Sciences of the United States of America*, *104*,  
804 19751-19756. doi:10.1073/pnas.0704452104

805 McGuigan, N. (2012). The role of transmission biases in the cultural diffusion of irrelevant  
806 actions. *Journal of Comparative Psychology*, *126*, 150-160. doi:10.1037/a0025525

807 McGuigan, N. (2013). The influence of model status on tendency of young children to over-  
808 imitate. *Journal of Experimental Child Psychology*, *116*, 962-969.  
809 doi:10.1016/j.jecp.2013.05.004

810 McGuigan, N., Gladstone, D., & Cook, L. (2012). Is the cultural transmission of irrelevant  
811 tool actions in adult humans (*Homo sapiens*) best explained as the result of an evolved  
812 conformist bias? *PloS One*, *7*, e50863. doi:10.1371/journal.pone.0050863

813 McGuigan, N., & Graham, M. (2010). Cultural transmission of irrelevant tool actions in  
814 diffusion chains of 3- and 5-year-old children. *European Journal of Developmental*  
815 *Psychology*, *7*, 561-577. doi:10.1080/17405620902858125

816 McGuigan, N., Makinson, J., & Whiten, A. (2011). From over-imitation to super-copying:  
817 Adults imitate causally irrelevant aspects of tool use with higher fidelity than young  
818 children. *British Journal of Psychology*, *102*, 1-18. doi:10.1348/000712610X493115

819 McGuigan, N., & Robertson (2015). The influence of peers on the tendency of 3- and 4-year-  
820 old children to over-imitate. *Journal of Experimental Child Psychology*, *136*, 42-  
821 54.<http://dx.doi.org/10.1016/j.jecp.2015.03.004>

- 822 McGuigan, N. & Stevenson, A. (2016). Does the age and familiarity of the informant group  
823 influence the tendency of 3- and 4-year-old children to conform? *Journal of Genetic*  
824 *Psychology, 177*, 122-130. doi: org/10.1080/00221325.2016.1191424
- 825 McGuigan, N., & Whiten, A. (2009). Emulation and “overemulation” in the social learning of  
826 causally opaque versus causally transparent tool use by 23- and 30-month-olds. *Journal*  
827 *of Experimental Child Psychology, 104*, 367-381. doi:10.1016/j.jecp.2009.07.001
- 828 McGuigan, N., Whiten, A., Flynn, E., & Horner, V. (2007). Imitation of causally opaque  
829 versus causally transparent tool use by 3- and 5-year-old children. *Cognitive*  
830 *Development, 22*, 353-364. doi:10.1016/j.cogdev.2007.01.001
- 831 Moraru, C. A., Gomez, J. C., & McGuigan, N. (2016). Developmental changes in the  
832 influence of conventional and instrumental cues on over-imitation in 3- to 6-year-old  
833 children. *Journal of Experimental Child Psychology, 145*, 34-47.
- 834 Nielsen, M., & Blank, C. (2011). Imitation in young children: When who gets copied is more  
835 important than what gets copied. *Developmental Psychology, 47*, 1050-1053.  
836 doi:10.1037/a0023866
- 837 Nielsen, M., & Tomaselli, K. (2010). Overimitation in Kalahari Bushman children and the  
838 origins of human cultural cognition. *Psychological Science, 21*, 729-736.  
839 doi:10.1177/0956797610368808
- 840 Pasquini, E. S., Corriveau, K. H., Koenig, M., & Harris, P. L. (2007). Preschoolers monitor  
841 the relative accuracy of informants. *Developmental Psychology, 43*, 1216-1226.  
842 doi:10.1037/0012-1649.43.5.1216

- 843 Scofield, J., Gilpin, A. T., Pierucci, J., & Morgan, R. (2013). Matters of accuracy and  
844 conventionality: Prior accuracy guides children's evaluations of others' actions.  
845 *Developmental Psychology, 49*, 432-438. doi:10.1037/a0029888
- 846 Seston, R., & Kelemen, D. (2013). Children's conformity when acquiring novel conventions:  
847 The case of artifacts. *Journal of Cognition and Development, 15*, 1-15. doi:  
848 org/10.1080/15248372.2013.784973
- 849 Slaughter, V., Nielsen, M., & Enchelmaier, P. (2008). Interacting socially with human hands  
850 at 24 months of age. *Infancy, 13*, 185-195. doi:10.1080/15250000701795721  
851  
852
- 853 Tanford, S. & Penrod, S. (1984). Social Influence Model: A formal integration of research on  
854 majority and minority influence processes. *Psychological Bulletin, 95*, 189-225. doi:  
855 10.1037/0033-2909.95.2.189
- 856 Turner, C. R., Nielsen, M., & Colier-Baker, E. (2014). Group actions trump normative  
857 emotional reaction in an incidental observation by young children. *PLoS One, 9*,  
858 e107375. doi: 10.1371/journal.pone.0107375
- 859 Užgiris, I. C. (1981). Two functions of imitation during infancy. *International Journal of*  
860 *Behavioral Development, 4*, 1-12. doi:10.1177/016502548100400101
- 861 Whiten, A., Allan, G., Devlin, S., Kseib, N., Raw, N., & McGuigan, N. (2016). Social  
862 learning in the real-world: 'Over-imitation' occurs in both children and adults unaware  
863 of participation in an experiment and independently of social interaction. *PLoS One, 11*,  
864 e0159920. doi: org/10.1371/journal.pone.0159920
- 865 Whiten, A., Custance, D. M., Gomez, J. C., Teixidor, P., & Bard, K. A. (1996). Imitative  
866 learning of artificial fruit processing in children (*Homo sapiens*) and chimpanzees (*Pan*

867 troglodytes). *Journal of Comparative Psychology*, *110*, 3-14. doi: org/10.1037/0735-  
868 7036.110.1.3

869 Whiten, A., & Flynn, E. (2010). The transmission and evolution of experimental  
870 microcultures in groups of young children. *Developmental Psychology*, *46*, 1694-1709.  
871 doi:10.1037/a0020786

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

875 Wood, L. A., Kendal, R. L., & Flynn, E. G. (2012). Context-dependent model-based biases in  
876 cultural transmission: children's imitation is affected by model age over model  
877 knowledge state. *Evolution and Human Behavior*, *33*, 387-394.  
878 doi:10.1016/j.evolhumbehav.2011.11.010

879