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Prestige-Bias: Developmental Evidence for Biased Cultural Learning

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Abstract

Developmental investigations of biases in cultural learning are few, yet critical for establishing the generality and origins of these biases. Here we report the first direct test in children of an evolved cultural learning bias predicted by gene-culture coevolutionary theory: *prestige-bias*, a disposition to learn from individuals to whom others have preferentially attended. Our results show that the odds of three- and four-year-old children imitating an adult model at whom two bystanders preferentially looked for 10 seconds, without giving any ostensive cues of endorsement, were over twice those of their imitating a model at whom bystanders did not gaze.

Human cognition is unique: it is shaped substantially by cultural learning (i.e., information inferred from the behaviour of others) as well as individual experience and genetics. Evidence of adaptive learning biases in how cultural information shapes cognition (or evidence that these processes are unbiased), and of whether these biases are innate or themselves culturally learned, has broad relevance to investigations of humans, their minds and behaviour. A key step in establishing the generality of these biases is probing their developmental trajectory. So far, we know of no direct tests in children of explicit, a priori hypotheses about evolved cultural learning biases. Below we review plausible candidates for evolved cultural learning biases and present a direct test for one – prestige bias – in three- and four-year-old participants.

Several recent theories have specified cognitive adaptations that make possible our species' accumulation of culture, including intention reading and attention sharing (Tomasello et al., 2005), ostensive pedagogy (Gergely, & Csibra, 2005; Csibra & Gergely, 2009), cognitive fluidity (Mithen, 1996), and epistemic vigilance (Sperber, 2006) facilitated by mental time travel (Boyer, 2008). Among these, Culture-Gene Coevolutionary (CGC) theories model the evolutionary dynamics facing an emerging cultural species, in particular the interaction of genetic and cultural inheritance systems (Boyd & Richerson, 1985) and the learning biases these select for (Richerson & Boyd, 2005; Kendal, Giraldeau & Laland, 2009; Eriksson, Enquist & Ghirlanda, 2007; Cavalli-Sforza & Feldman, 1981; Mesoudi, 2009).

By bringing together empirical evidence of human ancestral history and evolutionary models focused on understanding our capacities for cultural learning, CGC theories have derived predictions supported by a wide range of evidence from social psychology, economics, field studies and paleoarcheology (Richerson & Boyd, 2005; Mesoudi, 2009;

Laland, 2004; Galef & Whiskin, 2008a; Powell, Shennan, & Thomas, 2009; for a review, see Richerson & Boyd, 2005; Henrich & Henrich, 2007: Chapter 2). CGC approaches suggest, among others things, that learners should be selective about who they attend to for the purposes of cultural learning and specify a suite of hypotheses about which cultural learning strategies most effectively extract useful, adaptive information.

Strategies concerning *from whom to learn* are termed "model-biases". Some individuals are just better in certain domains, or possess more-relevant information, and thus it pays to learn from them. Alongside cues based on age, sex, health, and dialect (cuing ethnicity), CGC specifies three candidates for evolved model-bases: "skill-bias", selecting models by direct perception of their competence, which can be costly and inaccurate; "success-bias", selecting models by the cumulative fruits of their success - for instance: greater wealth, fancier ornamentation (Malinowski, 1922) or bigger yams (Kaberry, 1941) - which vary between groups; and "prestige-bias", preferring information from models to whom other learners have preferentially attended (Henrich & Gil-White, 2001). Prestige-bias facilitates more accurate and rapid learning by exploiting others' knowledge about who is worthy of attention. Because others' preference for better-quality models is, for a cultural species, fairly reliable across generations and cultures, prestige-bias, as an adaptation for exploiting this regularity, is a good candidate for a genetically evolved, cultural learning bias.

We direct readers to Henrich and Gil-White (2001) for a complete description of prestige-bias, but include here a caution aimed at a common misunderstanding. Prestige-bias, a technical coinage, does not denote *prestige*'s usual English meaning (an acknowledged status difference), rather it refers to learners' preference for inferring cultural information from those who receive the most attention and deference from other learners[1] (because these cues reliably indicate who they believe is worth learning from).

Among adults, evidence for CGC's predicted biases (see Henrich & Henrich, 2007 for a review) has emerged from social psychology (Henrich & Gil-White, 2001), behavioural economics (Pingle & Day, 1996), experimental anthropology (Efferson, Lalive, Richerson, McElreath, & Lubell, 2008), field studies (Rogers, 1995) and even corollaries in non-human animals (Galef & Whiskin, 2008a).

Recent investigations into children's strategies for extracting information from their environment (for a recent review see Gelman, 2009), also provide indirect support for CGC predictions. Predictions of an innate or rapidly acquired skill-bias are supported by young children's tracking and preferential learning from: more accurate models (e.g., Birch, Vauthier, & Bloom, 2008; Brosseau-Liard & Birch, in press; Clement, Koenig, & Harris, 2004; Corriveau & Harris, 2009; Koenig & Harris, 2005), more confident models (Birch, Akmal, & Frampton, in press; Jaswal & Malone, 2007; Sabbagh & Baldwin, 2001), artefact-makers about their artefacts (Jaswal, 2006) and generally adults over children, but accurate children over inaccurate adults (Jaswal & Neely, 2006). Similarly, predictions about models' dialect as a cue in cultural learning (McElreath, Boyd & Richerson, 2003; Boyd and Richerson 1987) are supported by developmental investigations of selective learning (Kinzler, Dupoux, & Spelke, 2007; Shutts, Kinzler, McKee, & Spelke, 2009). While these findings fit CGC predictions prima-facie, these studies were typically designed to glean proximate insights rather than test a priori evolutionary predictions. They are, however, quite consistent with a large body of temporal precedent theoretical work.

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[1] Thus, in our experiment the "Prestigious model" is distinct only by receiving bystanders' preferential gaze.

The present study directly tests for prestige-bias in the cultural learning of three- and four-year-olds. To date, the developmental evidence most relevant to prestige-bias is Fusaro and Harris (2008). Their four-year-old participants saw two models labelling the same object differently while bystanders non-verbally either endorsed (nodding and smiling) or denied (shaking their heads) the models' statements. Children preferentially imitated endorsed models – even on subsequent tests without bystanders present. This design was not intended to test prestige-bias and thus doesn't provide a direct test of prestige bias for two reasons. First, bystanders assent, rather than mere attention, potentially endorsed the message *and* the model, making it impossible to distinguish prestige-bias from conformist-bias [2], a distinct learning mechanism (Henrich & Boyd, 1998; Eriksson, Enquist & Ghirlanda, 2007; Kendal, Giraldeau & Laland, 2009) amenable to different developmental investigations (for instance Corriveau & Harris, in press; Corriveau, Fusaro & Harris, 2009) . Second, children only learned novel labels, thus they may have observed effects that apply only to language learning, rather than the broader learning bias predicted by CGC. Language acquisition may be a special domain of learning (e.g., Pinker, 1994), particularly because it concerns coordinating with one's group rather than adapting to the non-social environment. For example, while some fungi really are better (and safer) to eat than others (and people can learn this culturally), whether one should call them *mushrooms* or 茸 depends only on what others call them. Further, linguistic disagreements between models may be a cue to ethnic differences, which have also been formally predicted (McElreath, Boyd & Richerson, 2003)

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[2] Note: this is again a technical term, referring to a non-linear relationship between the frequency of a cultural trait and the probability of its imitation. Readers should be careful not to confuse this with other uses of the word *conformity*, which can involve concerns about coordination, signaling, explicit norms and social punishment. Conformist-bias is also indirectly supported by developmental evidence (Corriveau &Harris, 2009).

and shown (Kinzler, Dupoux, & Spelke, 2007; Shutts, Kinzler, McKee, & Spelke, 2009) to bias children's behaviour.

Predictions

We set out to test the hypotheses that young learners should:

1) **be prestige-biased:** preferentially learn from models to whom bystanders pay more visual attention (gaze) without explicit endorsement.
2) **be prestige-biased across domains**: imitate preferences and behaviours, not just language, including those in potentially costly domains like food and drink choices.

Method

Participants

We measured the selective imitation of 23 children (mean age = 50.4 months, SD=5.8 months; 12 girls) recruited from a participant database at a public university. Data from one boy who did not complete the experiment were excluded. The majority of participants were Caucasian or Asian; all were from households where English was the main language spoken.

Procedure

Participants watched an "attentional cuing" clip, where two models received unequal bystander attention followed by four 10-second "Test" clips, where those two models demonstrated different behaviours, preferences and labels. In the cuing scene two bystanders stood between the models, attending to only one of them – the "prestigious model". In all other scenes solitary models demonstrated their preference towards an object; then participants' own preferences toward those same stimuli were recorded. The order in which models appeared and the identity of the prestigious model were counter-balanced across participants. Participants observed the scenes in the following order:

Food Choice: Models made a disgusted face at either large round or small square crackers and happily sampled the other. Participants saw this scene before the cuing scene but only later, during “free play”, were offered a choice between the two crackers. This element of our design let us probe whether children apply prestige information retrospectively, which we discuss in the supplemental material.

Figure 1

Stills from the videos participants saw, in the same order in which participants saw them.

Attentional Cue: Each model played with a toy in different ways, on opposite sides of a room. Two observers entered and for 10 seconds stood between and slightly behind the models, angled toward and watching the prestigious model.

Artefact Use: Models interacted with a novel toy by delightedly using either coloured balls or blocks. Participants were presented with the same apparatus, offered a choice of the balls or blocks and asked “Can you show me how to play with this?”

Beverage Choice: Models made a disgusted face at either a cup of dyed blue or yellow water and drank from the other. Participants were offered the same two choices and asked “Would you like a drink?” or if unwilling to drink: “Which do you think is better to drink?”

Novel Label Preference: Each model labelled a different object with the same name – a “stroop”. Participants were presented with both objects and asked “Can you give me the stroop?”

Explicit Questions: After a few minutes of “free play” participants were shown photos of the models and asked: “Who would you rather play with” and “Who do you think is more popular, who has more friends?”

Results and Discussion

Since participants always made binary choices, with each choice representing an implicit endorsement of one model as preferred, we analysed our data using logistic regression. Since each participant made multiple, related binary choices, we compensated for this non-independence of these repeated observations of the same child by calculating clustered robust standard errors (clustering on individuals), using standard techniques (White, 1980). To compare different logistic regressions, we conducted log likelihood ratio tests[3]; the significance of coefficients was judged by their Z-distributed ratio to their standard errors. For each analysis we started from a regression containing all the predictors (reported in Table 1), then removed non-significant predictors only if doing so didn’t significantly diminish the predictive power of the regression (these parsimonious models are reported in Table 2). Effect sizes are reported as odds ratios in the text for ease of interpretation, and as regression coefficients and their standard errors in the tables for transparency. Odds ratios represent how much greater the odds of a model being imitated were if she was the prestigious model.

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[3] That is, we compared the χ^2 distributed ratio of each regression model’s log-likelihood to one another (reported as χ^2 tests) or to that of a logistic regression model with only a constant predictor (reported as p_{LLRT}). Values indicate the probability that the improvement in model fit would arise by random sampling alone. We refer to statistical models as “regressions” in the text to avoid confusion with the term “model” used to refer to the adults in our videos: the “cultural models”.

Table 1 – Full Models

		Statistical Models		
Predictors	Pooled	Artefact	Food & Drink	Labelling
Prestige	.90 (.37)**	2.60 (1.30)*	1.42 (.67)*	-.57 (1.07)
Sex	.0 (.34)	-1.33 (1.43)	1.30 (.73)^	-2.90 (1.48)*
Order	-.56 (.33)^	-2.49 (1.50)^	-.42 (.57)	-1.94 (1.36)
Age	-.02 (.03)	-.08 (.14)	.03 (.06)	.01 (.10)
p_{LLRT}	.16	.04	.14	.13
n	100	23	44	23

^: $p < .1$; $*: p < .05$; $**: p < .01$

Table 2 – Parsimonious Models

		Statistical Models		
Predictors	Pooled	Artefact	Food & Drink	Labelling
Prestige	.86 (.33)**	2.11 (1.0)*	1.4 (.7)*	
Sex			1.5 (.7)*	-1.84 (.98)^^
p_{LLRT}	.03	.02	.04	.04
n	100	23	44	23

^^: $p < .06$; $*: p < .05$; $**: p < .01$

Logistic regression coefficients and their (standard errors). All statistical models regress which actor participants imitated onto the listed predictors. *Prestige* encodes which actor was prestigious, *Sex* encodes the sex of the participant, *Order* encodes which actor appeared first and *Age* the participant's age in months. P_{LLRT} is the result of a log-likelihood ratio test of the model's goodness of fit. *n* is the number of observations on which the statistical inference was based, whose non-independence was compensated for by Huber-White clustered robust standard errors. Parsimonious models were developed by removing only those non-significant predictors from the full models whose absence did not significantly diminish the model's log-likelihood.

Is children’s learning prestige-biased?

Yes. Our analysis regressed which model participants imitated on (1) models’ “prestige” (i.e. which model received bystander attention), (2) the order in which models appeared, (3) participant’s sex and 4) participants’ age. As shown in Table 1 under the “Pooled” regression, this produced only one significant predictor: Prestige (p=.01). Removal of the non-significant predictors did not significantly diminish the regression’s predictive power (P[$\chi^2(3) > 2.1$] = .55), as shown in Table 2. In this parsimonious single-predictor regression (p_{LLRT}=.03), the odds of a cultural model being imitated were 2.37 times ($CI_{.95}$ = [1.22, 4.58], p =.01) greater if she was the prestigious model. Participant’s proclivity to prestige-bias was not confounded by their age (p = .32), sex (p = .7), the order in which models appeared (p = .11), nor which actor was the prestigious model (p = .48). Since prestige (i.e. bystander attention) significantly predicted imitation across all measures pooled together, we next examined theoretically-interesting subsets.

Is learning prestige-biased across domains?

Participants witnessed models receiving unequal attention from two bystanders while demonstrating different techniques for using an artefact, however our non-explicit tests fell into three domains: (1) artefact use, (2) food and drink preferences and (3) linguistic labels for novel objects. In both behavioural domains, children were significantly more likely to imitate the prestigious model; the odds of them doing so were 8.25 ($CI_{.95}$ = [1.15, 59.0]) times greater for artefact use and 4.09 ($CI_{.95}$ = [1.02, 16.38]) times greater for food and drink preferences. However this effect did not extend to language learning, the only imitation measure where prestige was not a significant predictor (OR=.57, $CI_{.95}$ = [0.07, 4.63], p =.6).

In our supplementary materials we report additional results that provide preliminary analyses of whether prestige-bias: A) attenuates in domains that increasingly differ from the domain in which the bystander attention was observed (perhaps partially), B) applies retrospectively to information provided by the models *before* bystander attention was observed (possibly, but more work is needed), C) influences children's explicit, verbal judgments of models (weakly, if at all).

General Discussion

Our findings provide support for the existence of a prestige-bias in children's learning: children's preferences for cultural models were biased by the mere preferential attention of bystanders. On novel tasks in the absence of any bystanders, the odds of our participants imitating a prestigious model were more than twice the odds of their imitating the other model. More precisely, children more often imitated an adult model who'd received ten seconds of bystanders' preferential attention (gaze) than one who hadn't. These strong effects from a minimal manipulation suggest that prestige-bias may be a potent pressure on human cognition and cultural change. As predicted (Henrich & Gil-White, 2001) we witnessed biased learning across behavioural domains, including potentially costly dietary preferences. We did not detect an effect of our cue on participants' language learning. Though we are cautious of placing too much emphasis on a null result, further investigations of the relationship between biases in language and conventional learning may be especially fruitful.

Our research extends Fusaro and Harris' (2008) research in the domain of language learning, in three ways. First, we show that prestige biases learning in potentially costly domains, like artefact-use techniques or food-preferences, and thus may constitute the broader, evolved learning bias predicted by CGC. Second, our results provide partial support for the notion that effects may not generalise between costly learning domains (like artefact use) and social coordination domains (like language learning), warranting future investigations. Finally, we show that neutral preferential attention, without nodding or other cues of explicit endorsement, is sufficient to bias cultural learning, thus providing stronger evidence of prestige-bias in children.

Though we tested an a priori evolutionary hypothesis, we cannot conclude from this study alone that children are prestige-biased cultural learners because their prestige-biased ancestors were favoured by natural selection. Children's prestige-bias may be a product of earlier learning mechanisms selected for other ends. Nonetheless, this study contributes to a growing body of adult evidence supporting this evolutionary prediction.

A regularly developing prestige-bias, if verified and properly understood, can shed light on many modern psychological and social phenomena besides children's learning. Formal modelling of biased cultural transmission can readily generate predictions about higher-level sociological phenomena, such as the diffusion of innovations (Henrich, 2001), the emergence of ethnic groups (McElreath et. al. 2003), or the properties of modern religions (Boyer, 2001; Henrich, 2009). At a sociological level, prestige-bias in particular might help explain why famous individuals' suicides increase suicide rates in populations of similar age and ethnicity individuals, using similar methods (Fu & Yip, 2007; Stack, 1987), or why celebrity endorsements of entirely unrelated products increase sales (Silvera & Austad, 2004).

CGC is an evolutionary theory, operating at an ultimate level of explanation, agnostic to the particular mechanisms that instantiate learning biases. Its prediction that selection favoured *whatever* mechanisms reliably produced a prestige-bias is consistent with a wide variety of proximate explanations. Nonetheless, if bystander attention was a reliable cue of model quality as long as humans have been cultural learners, prestige-bias may be instantiated by low-level attentional mechanisms requiring no conscious evaluation. For instance, bystander attention (weighted by a learner's evaluation of each bystander's competence[4]) may automatically bias how much attention children pay a cultural model, perhaps by influencing or enhancing simpler mechanisms like gaze-following (Flom & Muir, 2007). Difference in attention may in turn bias the relative accessibility of each model's behaviour in children's memory, mediating their impact on future decisions and cognitive development.

Future investigations which experimentally manipulate the domain in which Prestige cues appear, the delay before testing, the age and ethnicity of models and learners, and that put different learning biases into competition with one another will help clarify the proximate mechanisms underlying prestige-bias and its implications.

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[4] This has some empirical backing: Chow, et al.'s (2008) 14 month old participants' proclivity to follow the attention of a model was biased by that model's prior reliability.

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TABLES FOR CHILDREN'S PRESTIGE-BIASED LEARNING

Full Models - Logistic Regression Coefficients (Standard Errors)

	Statistical Models			
Predictors	Pooled	Artefact	Food & Drink	Labelling
Prestige	.90 (.37)**	2.60 (1.30)*	1.42 (.67)*	-.57 (1.07)
Sex	.0 (.34)	-1.33 (1.43)	1.30 (.73)ˆ	-2.90 (1.48)*
Order	-.56 (.33)ˆ	-2.49 (1.50)ˆ	-.42 (.57)	-1.94 (1.36)
Age	-.02 (.03)	-.08 (.14)	.03 (.06)	.01 (.10)
p_{LLRT}	.16	.04	.14	.13
n	100	23	44	23

ˆ: $p < .1$; $*: p < .05$; $**: p < .01$

Table 1

Logistic regression coefficients and their (standard errors). All statistical models regress which actor participants imitated onto the listed predictors. *Prestige* encodes which actor was prestigious, *Sex* the sex of the participant, *Order* encodes which actor appeared first and *Age* the participant's age in months. p_{LLRT} is the result of a log-likelihood ratio test of the model's goodness of fit. n is the number of observations on which the statistical inference was based, whose non-independence was compensated for by Huber-White clustered robust standard errors.

Parsimonious Models - Logistic Regression Coefficients (Standard Errors)

	Statistical Models			
Predictors	Pooled	Artefact	Food & Drink	Labelling
Prestige	.86 (.33)**	2.11 (1.0)*	1.4 (.7)*	
Sex			1.5 (.7)*	-1.84 (.98)ˆˆ
p_{LLRT}	.03	.02	.04	.04
n	100	23	44	23

ˆˆ: $p < .06$; $*: p < .05$; $**: p < .01$

Table 2

Significant logistic regression coefficients and their (standard errors). All statistical models regress which actor participants imitated onto the listed predictors. Parsimonious models were developed by removing only those non-significant predictors from the full models whose absence did not significantly diminish the model's log-likelihood. *Prestige* encodes which actor was prestigious, and *Sex* the sex of the participant. p_{LLRT} is the result of a log-likelihood ratio test of the model's goodness of fit. n is the number of observations on which the statistical inference was based, whose non-independence was compensated for by Huber-White clustered robust standard errors.

Figure 1

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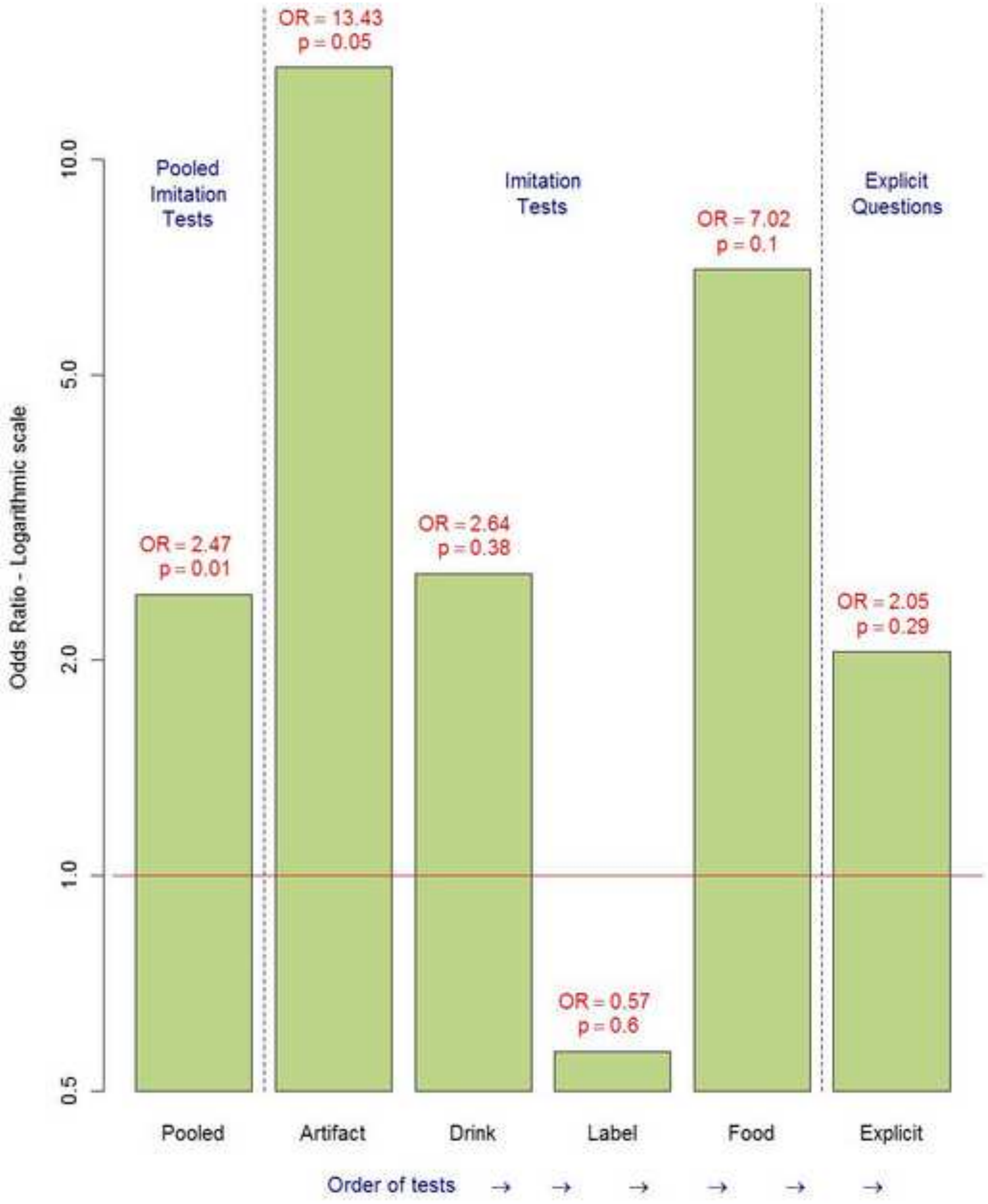
Figure 2


Odds Ratio - Logarithmic scale
10.0
5.0
2.0
1.0
0.5
Pooled Imitation Tests
Imitation Tests
Explicit Questions
OR = 2.47
p = 0.01
OR = 13.43
p = 0.05
OR = 2.64
p = 0.38
OR = 0.57
p = 0.6
OR = 7.02
p = 0.1
OR = 2.05
p = 0.29
Pooled
Artifact
Drink
Label
Food
Explicit
Order of tests → → → → → →