Audience effects on overimitation

Are you watching me? The role of audience and object novelty on overimitation

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Abstract

This study tests whether overimitation is subject to an audience effect, and whether it is modulated by object novelty. Eighty-six 4-to-11-year old children watched a demonstrator open novel and familiar boxes, using sequences of necessary and unnecessary actions. The experimenter then observed the child, turned away, or left the room while the child opened the box. Children copied unnecessary actions more when the experimenter watched or when she left, but copied less when she turned away. This parallels infant studies which suggest that turning away is interpreted as a signal of disengagement. Children displayed increased overimitation and reduced efficiency discrimination when opening novel, compared to familiar boxes. These data provide important evidence that object novelty is a critical component of overimitation.

Keywords

Overimitation; audience effect; causal reasoning; social signalling; ostracism; object novelty

Introduction

Children are predisposed to copy the actions of others with high fidelity, even when they are visibly unnecessary (Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons, Young, & Keil, 2007). Strikingly, this 'overimitation' is pervasive; occurring when children are directly instructed to only complete necessary actions (Lyons et al., 2007) and when unnecessary actions are performed on simple, familiar objects (Marsh, Ropar, & Hamilton, 2014). Despite a decade of research, there is little consensus for why children engage in overimitation.

Social signalling theory suggests that overimitation is akin to mimicry and serves as a signal to others, conveying likeness or willingness to interact. Consistently, children overimitate more in scenarios which have increased social relevance to the child (Marsh et al., 2014; Nielsen, 2006; Nielsen & Blank, 2011; Nielsen, Simcock, & Jenkins, 2008; Over & Carpenter, 2009). However, evidence suggests that overimitation also occurs in the absence of social drivers (Whiten, Allan, Devlin, Kseib, & Raw, 2016) and regardless of whether irrelevant actions are demonstrated communicatively or non-communicatively (Hoehl, Zettersten, Schleihauf, Grätz, & Pauen, 2014). Failures in causal encoding may also play a role in overimitation (Lyons et al., 2011, 2007) and overimitation increases with task opacity (Burdett, Mcguigan, Harrison, & Whiten, 2018). However, causal misunderstanding is unlikely to be the sole determinant as overimitation increases with age, and into adulthood when causal reasoning is fully matured (Marsh, et al., 2014; McGuigan, Makinson, & Whiten, 2011; Whiten, Allan, Devlin, Kseib, & Raw, 2016). Alternatively, overimitation could reflect a bias to generate and defer to normative rules when observing intentional actions (Kenward, 2012; Kenward, Karlsson, & Persson, 2011; Keupp, Behne, & Rakoczy, 2013; Schmidt, Rakoczy, & Tomasello, 2011). However, it remains unclear whether children defer to norms because they are driven to *signal* their similarity to others, or because they find it intrinsically rewarding to do so, irrespective of whether a social signal is sent.

Evolutionary accounts propose that overimitation is adaptive; by copying when uncertain and refining your behavioural repertoire later, imitation serves dual functions of learning about the causal properties of objects in addition to learning social conventions (Burdett et al., 2018; Wood et al., 2016). Each of these theories are supported by a strong set of studies but they are also refuted by others, leading to an empirical impasse. A potential explanation for this lack of consensus is that two key features of experimental paradigms used to study overimitation have varied between studies: the audience during the response phase, and the complexity of objects used in overimitation tasks. This study seeks to systematically manipulate these factors within a single study to examine their impact on overimitation.

People change their behaviour under conditions in which they feel like they are being observed, and this audience effect has been linked to a change in self-focus or reputation management (Bond & Titus, 1983). Audience effects have been studied in many domains, but recently there has been an increased focus on audience effects as a marker of reputation management (Izuma, Matsumoto, Camerer, & Adolphs, 2011) or social signalling (Hamilton & Lind, 2016). If overimitation is a signalling phenomenon then it should be modulated by the presence of an audience, because it is only worth sending a signal if there is an audience available to perceive it. However, if overimitation reflects a learning process (either causal or normative rules) then the demonstration phase of the study when children gain new information about the task is critical. If a child extracts a causal or normative rule from the demonstration then they will faithfully replicate the demonstration regardless of their audience. There are methodological differences in previous overimitation studies regarding whether the participant is observed during the response phase. In some studies children were directly observed by the demonstrator (Nielsen, 2006; Nielsen & Blank, 2011) or by a separate experimenter (Burdett et al., 2018; Marsh et al., 2014; Wood et al., 2016) but in others, the demonstrator turned their back on the child during their response (Keupp et al.,

2013), or left the child entirely alone (Hoehl et al., 2014; Kenward et al., 2011; Lyons et al., 2011, 2007; Schleihauf, Graetz, Pauen, & Hoehl, 2018). To date, no single study has directly compared these conditions. In this study we directly compare the rates of overimitation when children are alone, when they are in the presence of a demonstrator who turns their back on the participant, or when their actions are directly observed.

A second research question relevant to overimitation is the extent to which the type of object used in a given study influences our estimates of overimitation. Tasks used to elicit overimitation vary with regard to the type of objects and tools that are used, ranging from simple, familiar objects to complicated puzzle boxes (see Marsh, Ropar, & Hamilton (2014) and Taniguchi & Sanefuji (2017) for discussions), although the puzzle box designed by Horner and Whiten (2005) has dominated the field. Traditionally, overimitation was demonstrated by comparing rates of imitation on transparent and opaque puzzle boxes, under the assumption that the causal properties of a puzzle box are apparent if it is transparent. Indeed research suggests that imitation is more prevalent when interacting with an opaque puzzle box, compared to an otherwise-identical but transparent box (Burdett et al., 2018; Horner & Whiten, 2005) although manipulating the opacity of the reward container had no effect (Schleihauf et al., 2018). These studies used novel puzzle boxes but we posit that encountering any novel object is likely to cause some uncertainty about the way it is operated, regardless of its physical transparency. This uncertainty may lead to increased overimitation (Rendell et al., 2011; Wood et al., 2016). Here we examine the effects of object novelty on overimitation and uncertainty by directly comparing overimitation on matched novel and familiar boxes whilst also examining children's understanding of the efficiency of the actions they witness. If a 'copy when uncertain' bias is present then we predict reduced efficiency discrimination for novel objects, and a corresponding increase in overimitation.

Method

Participants

Eighty-six 4-to-11-year old children were randomly assigned to one of three experimental conditions (see Table 1). The sample was recruited and tested at the University of Nottingham Summer Scientists event, which attracts middle-class families from a mid-sized city in England.

Table 1: Means and standard deviations for randomly assigned experimental conditions as well as p values for differences among groups.

	Act Alone N = 26	Disengagement N = 30	Audience N = 30	Difference (p)
	M (SD)	M (SD)	M (SD)	-
Age	6.84 (1.82)	7.58 (2.45)	7.33 (2.04)	0.43
Efficiency Discrimination	2.36 (1.44)	1.99 (1.72)	2.45 (1.22)	0.44
Memory	1.81 (0.40)	1.70 (0.53)	1.60 (0.62)	0.35
Overimitation	2.77 (1.42)	1.83 (1.64)	2.77 (1.43)	0.03*

Note. There were 46% (n = 12) female in the Act Alone, 53% (n = 16) female in the Disengagement, and 57% (n = 17) in the Audience condition. *p<.05

Stimuli

Two sets of 6 puzzle boxes were used, a novel set and a familiar set. Each box was a simple transparent container with a removable lid; there were no hidden mechanisms or latches. In the familiar set, the boxes were not modified further. In the novel set, identical boxes were slightly modified to create a simple box that participants had not encountered before. Buttons, switches or additional decorations were added to each box (see Figure S1). Importantly, none of these decorations changed the function of the boxes but we anticipated that these decorations would impact children's certainty about how the objects should be operated. A small toy was put inside each box for the child to retrieve.

Design

This study adopted a 3 x 2 mixed design with children randomly assigned to one of three between-subjects audience conditions: Act Alone, Disengagement, and Audience. Object novelty was manipulated within subject. To rule out poor memory as an explanation for why young children overimitate less, a memory control task was included. Four of the six boxes were selected to be overimitation trials (two novel, two familiar) and two boxes were selected to be memory trials (one novel, one familiar). Boxes were counterbalanced for novelty and task between participants.

Procedure

Testing took place in a partitioned section of a room, introduced to children as a 'den'. Poster boards and coloured fabric were arranged such that the den was not visible to anyone waiting outside. A hidden camera was positioned behind a hole in the fabric wall to

record the session without the child's awareness (see Figure S2). Children were tested alone, with parents waiting in the room outside. They sat at a small table, opposite the experimenter and completed a warm-up task (see Supplementary Information) before completing three experimental tasks in a fixed order.

1. Overimitation Task. The experimenter demonstrated a sequence of three actions (2 necessary, 1 unnecessary) to open the box and retrieve the object (see Supplementary Information for verbatim instructions and details of the actions). The experimenter then reset the box behind a screen and handed it to the child with the instruction: "When I say 'GO' I would like you to get the [duck] out of the box as quickly as you can". In the Act Alone condition, the experimenter left the den, shut the door behind her and called 'GO' to the child to signal the start of their turn. In the Disengagement condition, the experimenter turned around in her seat, called 'GO', and sat still facing away from the child until the box had been opened. In the Audience condition, the experimenter called 'GO' and continued to sit and watch the child while they retrieved the object. This sequence of events was repeated for four overimitation trials.

2. Memory Task. Children completed a warm-up copying task before watching the experimenter open two more boxes (see Supplementary Information). The memory trials were completed under the same audience conditions as the overimitation trials so the child was instructed "When I say 'GO' can you get the [duck] out of the box. Remember to copy me exactly".

3. Efficiency Discrimination Task. Children rated the efficiency of one necessary and one unnecessary action from each trial on a scale from one (very sensible) to five (very silly) as described in (Marsh, et al., 2014, see also Supplementary Information). Efficiency discrimination scores were calculated by subtracting the unnecessary action rating from

necessary action rating on each trial. This score could range from -4 (poor efficiency discrimination) to +4 (good efficiency discrimination) with a zero score indicating no discrimination.

Data Coding and Analysis

All responses were coded from video. Overimitation on each trial was coded as 1 if the child made a definite and purposeful attempt to replicate the unnecessary action described in Table S1 or 0 otherwise. The same criteria was applied to the memory trials and a total memory score was calculated for each child. Preliminary analyses showed that overimitation did not vary as a function of trial order ($F(3,343)=1.85$, p = .138) or puzzle box ($F(5,343)=.421$, p=.834) so these variables will not be considered further. Mixed effects models were run using lme4 (Bates, Mächler, Bolker, & Walker, 2015) and MuMIn packages (Barton, 2013) in R version 3.4.2. Separate models were used to predict propensity to overimitate and efficiency discrimination scores (see DOI: 10.17605/OSF.IO/G8YHT for data and analysis script). For overimitation, a full model was constructed, which included predictors of interest (audience, novelty, efficiency discrimination) and control predictors (age, gender, memory) as fixed effects, plus an audience*novelty interaction. Random intercepts for child ID were included to account for the nested structure of the data. The full model was compared to a null model which included only control predictors and random effects using a likelihood ratio test. If the full model outperformed the null model (i.e. a significant difference in model fit) then a reduced model (full model minus the interaction term) was compared to the full model to ascertain if the interaction term significantly contributed. Efficiency discrimination scores were analysed using the same protocol. The full model included predictors of interest (age, novelty), control predictors (gender, memory), and

random effects (child ID). The full model was compared to a null model (control predictors + random effects) using a likelihood ratio test.

Results

Children in each of the three experimental conditions were matched for age (see Table 1). The rate of overimitation was high, with 80.2% of children overimitating on at least one trial. Memory scores were also high, with 73.3% of children performing at ceiling. Only 3.5% of children scored zero (see Table 1).

The reduced model was the best fit to the overimitation data, explaining 12.0% of the variance by fixed effects and 69.3% of the variance by random effects (see Tables S3 and S4 for model summaries and comparisons). Audience was a significant predictor of overimitation (χ^2 (2) = 7.85, p = .020). Children in the Disengagement condition (M = 1.83, S.D = 1.64) overimitated less than those in the Audience (M = 2.77, S.D. = 1.43, Odds Ratio = 7.82, 95% CI = [1.63-50.66]) and Act Alone conditions (M = 2.77, S.D. = 1.42, Odds Ratio = 6.34, 95% CI = [1.23 – 42.68]). There was no difference between Audience and Act Alone conditions (Odds Ratio = 1.23, 95% CI = [.22 – 7.51]). Novelty also significantly predicted overimitation (χ^2 (1) = 6.04, p = .014) such that unnecessary actions on familiar objects (M = 1.13, S.D. = .88) were imitated less frequently than unnecessary actions on novel objects (M = 1.31, S.D. = .88, Odds Ratio = .46, 95% CI = [.24 - .86], see Figure 1). Age, gender, efficiency discrimination, and memory did not predict overimitation (see Table S3). There was no interaction between audience and novelty (χ^2 (2) = .20, p = .905), indicating that novelty had the same effect on overimitation behaviour regardless of audience.
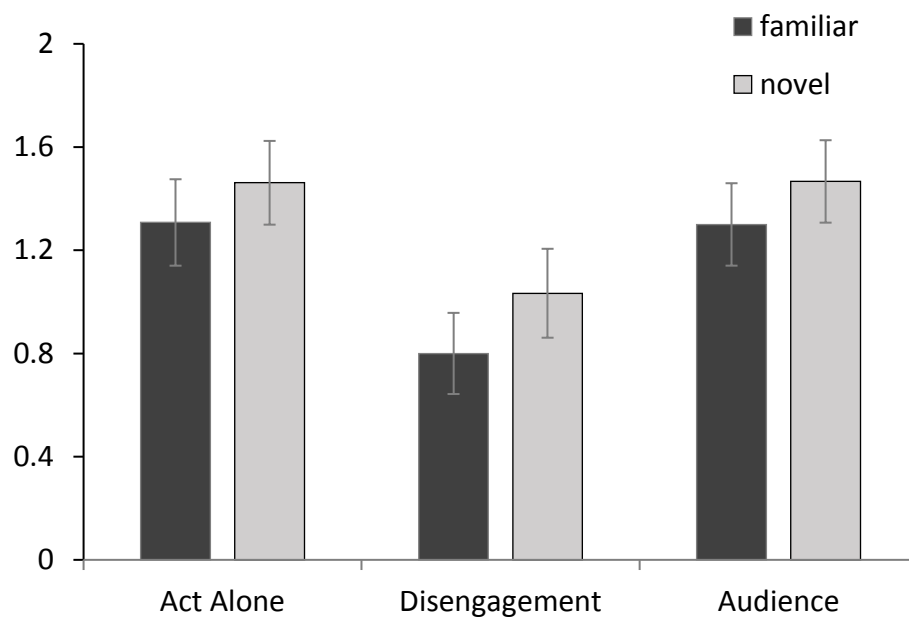
Figure 1: Mean number of actions overimitated (out of two) as a function of audience condition. Dark bars indicate familiar objects and light bars indicate novel objects. Error bars represent ± 1 S.E.M.

The full model best predicted the efficiency discrimination data, explaining 10.6% of the variance with fixed effects and 54.2% with random effects (see Tables S4 and S5 for model comparisons and model summaries). Age predicted efficiency discrimination ($\chi^2 (1) =$ 13.33, $p < .01$) such that older children were better at discriminating necessary and unnecessary actions compared to the younger children (Odds Ratio = 1.68, 95% CI = [1.28 – 2.20]). Novelty also predicted efficiency discrimination ($\chi^2 (1) = 4.30$, $p = .038$). Children were worse at discriminating the efficiency of necessary and unnecessary actions when objects were novel (M = 2.20, S.D. = 1.85), compared to when they were familiar (M = 2.44, S.D. = 1.88, Odds Ratio = 1.26, 95% CI = [1.01 – 1.57]). There was no effect of gender or memory on efficiency discrimination scores (see Table S5).

Discussion

The effect of audience on overimitation was assessed for novel and familiar objects across a broad developmental spectrum. We demonstrate a clear effect of audience, but not an increase with increasing level of observation (i.e. Audience > Disengagement > Act Alone). Instead, we report similar levels of overimitation when children were observed and when they were alone, but reduced imitation when the demonstrator turned away. This intriguing set of results can be explained in two ways.

First, we could argue that an audience effect was found in the Audience > Disengagement comparison but that some distinctive feature of the Act Alone condition disrupted this pattern. High levels of overimitation in the Act Alone condition could be explained by an 'omniscient adult phenomenon' or 'Monika effect' whereby children falsely attribute knowledge to unseen adults (Wimmer, Hogrefe, & Perner, 1988). When children were left alone, perhaps they were uncertain about whether they were being observed, and by default, acted as though they were. This mirrors other findings in developmental psychology (Meristo & Surian, 2013; Rubio-Fernández & Geurts, 2013). Children expect a third-party to act consistently with the child's knowledge, even if there is no evidence that the third-party shares this knowledge. However, if children are provided with direct evidence that a third-party does not share the same knowledge, they will predict behaviour based on the agent's knowledge. For example, Rubio-Fernández and Geurts, (2013) demonstrated that three-year-olds pass a standard false-belief task when the protagonist turned her back (giving direct evidence that the protagonist cannot see the location change), but failed when the protagonist left the scene entirely (see also Meristo and Surian (2013)). Perhaps this bias extended to the children in our study. When children had direct evidence that they weren't being watched (Disengagement) they reduced their overimitation. However, when there was no such evidence (Act Alone), they assumed they were observable, and acted similarly to those

children who were directly observed (Audience). These findings hint towards an interesting distinction in our processing of others minds when they are physically present, but not watching, and when they are completely absent.

An alternative interpretation is that there was a reduction in overimitation in the Disengagement condition because the experimenter's actions caused the child to feel less rapport or motivation to engage. By turning her back on the child as they acted without excusing herself, the experimenter gives a strong signal of disinterest, which could be interpreted as ostracism (Wirth, Sacco, Hugenberg, & Williams, 2010). As a result, the child may experience reduced rapport with the experimenter and thus, a reduced drive to overimitate (Nielsen, 2006). This is contrary to several other findings which indicate that children actually increase their imitative fidelity following exposure to third-party (Over & Carpenter, 2009; Watson-Jones, Legare, Whitehouse, & Clegg, 2014) and first-person (Watson-Jones, Whitehouse, & Legare, 2016) experience of ostracism. However, previous work primed ostracism indirectly via computer animations which do not directly depict the demonstrator, prior to the imitation task. It is possible that disengagement from a live model during the interaction has the opposite effect on imitation, either due to the proximity or the time-course of ostracism. Further work is needed to disentangle these effects. A neater, direct test of the ostracism account could be to compare rates of imitation when the experimenter excuses herself and turns around to complete a task to when the experimenter simply disengages without excuse (as in this study).

Both interpretations are consistent with the signalling theory of overimitation, in which children are motivated to send a signal to people who are watching and with whom they have a rapport. The data may also be consistent with a normative account in which children opt to disregard the newly-learnt norm following ostracism, although further research examining the flexibility of norm adherence is required to support this argument.

However, it is not clear how causal encoding can account for the differences between the three social conditions in this study.

Another striking finding was that children were more likely to overimitate, and were less able to discriminate the efficiency of actions when interacting with a novel, compared to a familiar box. Thus, it seems that altering the perceived novelty of the boxes reduced children's certainty about the causal properties of the objects, leading them to overimitate more, even though only very minor decorative changes distinguished familiar and novel boxes. This is consistent with emerging work that illustrates increased overimitation when task complexity increases (Taniguchi & Sanefuji, 2017). These results reflect an element of causal understanding in any overimitation task, and using novel objects can contaminate social effects. Alternatively, it is possible that the children in this study interpreted the novel boxes in this task as more playful, which led them to copy more and rate the unnecessary actions as less 'silly'. However, given the object novelty manipulation was presented within-subject, and in a randomised order, it is unlikely that the children interpreted the exact same instructions differently on each trial. Regardless of this, previous studies have varied in the use of transparent and opaque puzzle boxes, some including redundant mechanisms, hidden catches, and superfluous decoration. This lack of consistency increases response variability, and could account for the disparity in results from different labs. We stress that future work which examines the social effects of overimitation should carefully evaluate the findings with regards to the type of objects which have been used to elicit overimitation.

To conclude, this study provides evidence that observation of participants during their response and stimulus familiarity can impact overimitation. These factors may account for discrepancies between previous studies. The finding that children reduce overimitation when the experimenter disengages is consistent with social-signalling and social-rapport accounts

of overimitation, and we look forward to further studies that distinguish these motivating factors.

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