Imitation, Collaboration and their Interaction Among Western and Indigenous Australian Preschool Children

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Abstract

This study explored how overimitation and collaboration interact in 3 to 6-year-old children in Westernized (N=48 in Experiment 1; N=26 in Experiment 2) and Indigenous Australian communities (N=26 in Experiment 2). Whether working in pairs or on their own rates of overimitation did not differ. However, when the causal functions of modeled actions were unclear the Indigenous Australian children collaborated at enhanced rates compared with the Western children. When the causal role of witnessed actions was identifiable, collaboration rates were correlated with production of causally unnecessary actions, but in the Indigenous Australian children only. This study highlights how children employ imitation and collaboration when acquiring new skills and how the latter can be influenced by task structure and cultural background.

Keywords: social learning, overimitation, collaboration, cultural transmission

Around 2.6 million years ago, in what is known as the Oldowan Industrial Complex, our hominin ancestors manufactured stone tools consisting of sharp-edged flakes and the cores from which they came (Toth, 1985). A diversity of evidence suggests that the rudimentary percussive and cultural capacities underpinning Oldowan technology are present in chimpanzees and likely existed in our common ancestor (Whiten, Schick, & Toth, 2009), yet neither species took the crucial step to make such tools. Thus, it was in our very ancient evolutionary past that the first signs emerged of what has become a massive divergence in technological complexity between our closest living animal relatives and ourselves. If we move forward a million years through the Paleolithic to the Acheulean (~1.75 million years ago) we find evidence of *Homo erectus* and *Homo heidelbergensis* striking large stone flakes and bifacially shaping stone tools, to create handaxes and cleavers (Beyene et al., 2013; Lepre et al., 2011). The handaxes were shaped to be symmetrical, sometimes meticulously so and often in two planes (Wynn, 2002), yet butchery experiments suggest this symmetry does not improve their utilitarian value (Machin, Hosfield, & Mithen, 2007). It has thus been argued that it was high-fidelity imitation of the production sequence of a symmetrical form that maintained the overall morphology of these objects across multiple generations (Nielsen, 2012; Putt, Woods, & Franciscus, 2014; Shipton, 2010, 2013; Shipton & Nielsen, in press).

A proclivity for high-fidelity replication of others' object-directed actions thus appears ancient in our species. But we are not just an imitative species: We are hyper-imitative. Demonstrating this, Horner and Whiten (2005) had an adult show 3- to 4-year-old human children and wild born chimpanzees how to extract a reward from a novel box. A bolt on the top of the box was first removed, revealing a hole into which a stick tool was repeatedly jabbed. A door located on the front of the box was then opened and the stick was used to extract the reward. Because the box was opaque the participants could not see how what occurred inside the box was causally related to the outcome. When given their turn with the box both chimpanzees and children tended to copy the model's actions, including jabbing the stick in the top. By contrast, when a transparent box was substituted for the opaque box the effect of the internal actions could be identified, making it obvious that when the stick was jabbed into the top hole it struck a barrier and made no contact with that part of the apparatus from which the reward could be retrieved. Thus, the action involving the top hole could be seen to have no causal relation to extracting the reward. When the same actions that had been demonstrated on the opaque box were demonstrated on the transparent box the chimpanzees now ignored the jabbing in the top hole and instead copied only the model's insertion of the tool into the front hole. They ignored the initial action which was now visibly, causally irrelevant. In contrast, the children replicated the model's entire sequence of actions, including the visibly irrelevant insertion of the stick into the top hole.

Now known as overimitation (Lyons, Young, & Keil, 2007), the tendency of young children to copy others with such high fidelity that they will incorporate visibly, causally irrelevant actions has been replicated in multiple labs (e.g., Kenward, 2012; Lyons et al., 2007; McGuigan, Whiten, Flynn, & Horner, 2007; Nielsen & Blank, 2011) and across contrasting cultural groups (Nielsen, Mushin, Tomaselli, & Whiten, 2014; Nielsen & Tomaselli, 2010). Though there is currently much research and debate in relation to the specific mechanisms and functions underlying overimitation, there is broad agreement that it underpins the acquisition of object-related skills, where the need for children to do so is unrelenting. All human environments are filled with tools and artifacts that commonly lack ready perceptual information about their functional significance and modes of operation. This cognitive opacity makes it challenging for novices to identify which actions or behaviors are appropriate for each artefact and which are not (Gergely & Csibra, 2006). Directly and comprehensively copying others thus affords the rapid acquisition of a vast array of essential skills that have been developed and accumulated through multiple past generations. Overimitation is accordingly coming to be recognized as a cornerstone of cumulative culture.

But there are other cornerstones. A key component in the development of human culture has been the evolution of shared intentionality which arises in collaborative interactions where participants have a collective goal and coordinated action roles for pursuing that goal (Tomasello, Carpenter, Call, Behne, & Moll, 2005). For some, these characteristics have been core in the ‘socio-cognitive niche’ that underwrote the evolutionary shaping of our species (Whiten & Erdal, 2012). According to Shipton (2013) shared intentionality, as expressed through cooperation, was evidenced in the Acheulean in the production of large flake blanks from giant cores as this is inferred to have been a two-person job. Overimitation and collaboration may thus function in conjunction with one another to facilitate the development of new techniques and approaches. Developmentally, the capacity for shared intentionality emerges in humans in their second year of life and soon becomes well developed by comparison to chimpanzees (Carpenter, Tomasello, & Savage-Rumbaugh, 1995).

Indeed, children do not learn only in direct, unidirectional interaction with adults, as is the set-up in most overimitation experiments. From early in life they seek joint activity with others and learn through the interactions that arise, and in this way they develop the skills and proclivities for collaborating that are a core feature of human culture (Rogoff, 2003; Tomasello, 1999). For example, Brownell and colleagues (Brownell, Ramani, & Zerwas, 2006) presented 18- and 30-month-olds with a task that required dyadic peer interaction to operate two separate handles embedded in an apparatus (too far apart for one child to operate alone) that when pulled would activate an animated musical toy. Whereas coordinated activity in the younger children was sparse, by their third year the children monitored and accommodated their partner’s activity and location, working together to achieve the joint goal. More recently Dean and colleagues (Dean, Kendal, Schapiro, Thierry, & Laland, 2012) reported that, when presented with a task requiring multiple steps to solve, children were far more cooperative than chimpanzees, which in turn led to better outcomes.

How then might children's disposition to overimitate be affected if they work together rather than on their own? The evidence is limited. Flynn and Whiten (2010) reported that in a cultural diffusion experiment preschool children collaborated on a tool-use task that afforded multiple methods to extract an enclosed reward. However, the same authors found little evidence of collaboration using in an analogous experiment involving different manipulanda (Flynn & Whiten, 2012). Further, though not directly about collaboration, rates of overimitation have been found to be lowered when a peer acts as the model (e.g., Flynn & Smith, 2012; McGuigan & Graham, 2010), which might influence any interaction between collaboration and imitation amongst children. Conversely, Keupp and colleagues (2013) reported that preschool children tested on an overimitation task would protest when a puppet failed to produce modeled but causally redundant actions, suggesting that rates of overimitation might increase when embedded in a peer collaboration scenario.

Discovering how overimitation is expressed when children are tested together promises to yield unique insight into what appears to be a ubiquitous human behavior. This was the aim of Experiment 1 where we compared children's behavior when challenged to extract a toy from versions of the opaque and clear glass ceiling boxes introduced by Horner and Whiten (2005). To reiterate, the opaque box has all internal operations hidden from the observer, reflecting many initially mysterious objects that children encounter during their development. With the clear box, the transparent nature of the walls mean that a solid platform is visible above the retrieval chamber and below the top opening, such that when the tool is poked into the top opening it can be seen to merely strike the platform and have no causal link to the retrieval chamber. Accordingly, copying such an act is a classic example of overimitation.

Legare and colleagues (Herrmann, Legare, Harris, & Whitehouse, 2013; Legare & Souza, 2012, 2014) argue that actions lacking an intuitive causal connection between a specific action performed (e.g., rubbing a ceramic pot) and the desired outcome or effect (e.g., making it rain) can lead to the adoption of what they call 'the ritual stance' where actions are interpreted in terms of cultural convention, rather than according to the laws of physical causation (see also Nielsen, Kapitany, & Elkins, 2015). Similarly, normative accounts (Kenward, 2012; Kenward, Karlsson, & Persson, 2011; Keupp et al., 2013; Keupp, Behne, Zachow, Kasbohm, & Rakoczy, 2015) maintain that children view the elements of an overimitation sequence as essential parts of a bigger, conventional activity. Accordingly children expect others to reproduce all modelled actions and will protest in the case of omission of any element, whether relevant or not. As conventional and normative activities are social phenomena, an enhancement of social context was predicted to increase the impact of conventional and normative factors. Thus, being tested with another child was predicted to lead to instances of collaboration and increase the salience of the ritual (or normative) stance. We hypothesized that children tested in dyads would reproduce the irrelevant actions on the transparent box at higher rates (i.e., show overimitation) than those tested alone. We also tested children on the opaque version of the boxes to control for the possibility that children simply exhibit more actions when tested in the presence of peers than when alone.

Experiment 1

Method

Participants. Forty-eight children (28 males), aged between 3 and 5 years (M = 45.96 months; SD = 8.69), participated in the experiment. Children were tested in a quiet area of their childcare center. The majority were Caucasian and from middle-class socioeconomic backgrounds. All children were presented with a small gift and certificate of participation.

Apparatus. Two distinct puzzle boxes were used, both 11cm high x 20cm deep x 30cm wide (see Figure 1). On the top of each box is a panel that can be removed by placing a stick into a hole drilled into its top and pushing it forward, or by placing the stick against the back of the panel and poking it forward. Removing the panel allows access through an opening in the roof to a chamber in the top of the box. Located on the front of each box is a green door that can be opened either by sliding (left or right) or lifting up to enable access to the chamber containing the to-be-retrieved item. As noted, one of the boxes was opaque and the second clear. Use of the Clear Box allowed us to record any overimitation responses when the internal operations on the box could be identified by the children. A Lego mini-figure, wizard figurine, red mini train, purple mini train, toy chicken and toy turtle were used in turn as items that could be extracted from the boxes.

Procedure. All children were tested in a quiet area of their childcare center away from any activities or children not involved in any dyad being currently tested. The experimenter approached a child whose parents had provided consent for participation and asked him/her if he/she would like to play a game. No child declined the offer. If the child was assigned to one of the peer conditions a second child of the same gender was approached. Across all conditions the adult acted in a warm and friendly way, engaging the children with appropriate levels of eye contact.

Peer-Condition. The experimenter placed the first box (opaque or clear, counterbalanced across children) facing both children, said ‘Look’, and picked up the stick. The stick was then used to push the top door open, thereby allowing access to the top chamber. The stick was thrust into the chamber three times in succession, each time striking the platform inside, and then placed against the door on the left hand side facing the child, with pressure applied to open the door. The stick was finally inserted into the internal chamber and the hidden item retrieved. The experimenter placed the toy back into the box and demonstrated the actions again. Following the second demonstration the experimenter reloaded the box and passed it to the children, equidistant between them, saying ‘your turn’ (no direction was given to indicate which child should go first). The response phase was terminated if the item was retrieved or after four minutes expired. If the children showed reluctance to explore the box they were encouraged with non-specific prompts (e.g., “You can do it; You can do whatever you want”). The first box was then placed out of sight and the second box placed between experimenter and children, with the above procedure repeated.

Solitary-Condition. This was identical to the peer condition except children were tested on their own.

Coding. Imitation: For each condition children were scored for: (1) removing the top door; (2) pushing the top door using the stick; (3) frequency with which the stick was inserted into the top compartment; (4) using the tool to open the front door; (5) sliding the front door open as modeled; (6) using the stick to retrieve the toy inside; and (7) retrieving the toy. Items 1 to 3 were summed to form one Causally Irrelevant Actions category (a score of 5 representing perfect replication as each action was modeled once and the insertion repeated twice, a score greater than 5 indicating children inserted the stick into the top compartment more times than was modeled) and items 4 to 7 were summed to form a Causally Related Actions category (where scores could range from 0 to 4).

Collaboration: Butler and Walton (2013) define collaboration as working towards shared goals. Our aim was to develop criteria that tapped this construct while maintaining the structural integrity of the task so as to facilitate straightforward comparisons with extant research. Thus, for each peer dyad the following activities were coded for frequency (each occurrence accruing a score of 1): (1) Change of operator - one child stops acting on the box and the other takes over; (2) Offering gesture - child hands tool to peer with an outstretched arm or places it in front of him/her; (3) Referential gesture - child looks at peer and points towards the tool or box with the index finger or the whole hand; (4) Declarative communications - child verbalizes to peer about task in a nondirective manner (e.g., says “get it out’’); (5) Imperative communications - child verbally directs peer’s behavior on task or requests peer to perform an action (e.g., ‘‘Pull it’’, ‘‘Help’’); (6) Explicit instruction to ignore top - non-operating child tells operating child to ignore top components; (7) Explicit instruction to focus on door - non-operating child tells operating child to open front door. As rates of collaboration were low (see Results) the frequency of occurrence of each of the above measures were summed to provide an overall cumulative frequency index for the opaque and clear boxes.

A trained research assistant coded all data. A second coder, blind to condition and study aims, independently observed and coded the videotaped behavior of all children. According to intraclass correlation coefficients (Shrout & Fleiss, 1979), inter-rater reliability was high for all imitation dependent variables; production of the irrelevant actions on the clear box, $r = .97$, $p < .001$; production of the relevant actions on the clear box, $r = .99$, $p < .001$; production of the irrelevant actions on the opaque box, $r = .98$, $p < .001$; and production of the relevant actions on the opaque box, $r = .84$, $p < .001$. Similarly, reliability was high for the overall frequency of collaborative acts while children were engaged with the clear box, $r = .89$, $p < .001$, and while engaged with the opaque box, $r = .94$, $p < .001$

Results

Given the relatively restricted range of scores all analyses were conducted using both parametric and non-parametric statistics. As these yielded the same outcomes, for ease of communication, only parametric statistics are reported here. Preliminary analyses revealed no effect of sex, age, or box presentation order (opaque vs clear first) on any of the dependent variables. These independent variables are thus not discussed further.

As illustrated in Figure 2, regardless of whether they were tested alone or in pairs children reproduced the irrelevant actions at similar rates with the opaque box ($M_{Opaque\ Alone\ Irrelevant}$ = 5.20, $SD_{Opaque\ Alone\ Irrelevant}$ = 3.49 and $M_{Opaque\ Pair\ Irrelevant}$ = 4.57, $SD_{Opaque\ Pair\ Irrelevant}$ = 2.85), $F(1, 32) = .31$, $p = .582$, $\eta p^2 = .01$, and also the clear box, thus providing evidence of overimitation, ($M_{Clear\ Alone\ Irrelevant}$ = 5.05, $SD_{Clear\ Alone\ Irrelevant}$ = 3.80 and $M_{Clear\ Pair\ Irrelevant}$ = 5.07, $SD_{Clear\ Pair\ Irrelevant}$ = 2.70), $F(1, 32) = .00$, $p = .986$, $\eta p^2 = .00$.

The causally connected actions were also reproduced at similar rates across conditions for the opaque ($M_{Opaque\ Alone\ Causal}$= 3.61, $SD_{Opaque\ Alone\ Causal}$ = .98 and $M_{Opaque\ Pair\ Causal}$ = 3.57, $SD_{Opaque\ Pair\ Causal}$ = .85), $F(1, 32) = .01$, $p = .905$, $\eta p^2 = .01$, and the clear box ($M_{Clear\ Alone\ Causal}$ = 3.40, $SD_{Clear\ Alone\ Causal}$ = 1.35 and $M_{Clear\ Pair\ Causal}$ = 4.00, $SD_{Clear\ Pair\ Causal}$ = .00), $F(1, 32) = 2.73$, $p = .108$, $\eta p^2 = .08$.

As already alluded to, rates of collaborative activity were low. Critically, no child directed his/her peer to ignore the top features of either clear or opaque box; and only 2 pairs changed operators (different pairs for both boxes). Of the 28 children (14 pairs) 17 failed to show any signs of collaboration on the opaque box and 15 failed to do so on the transparent box, with the number of collaborative actions not different across opaque (M = 0.75, SD = 1.29) and transparent (M = 1.07, SD = 1.76) boxes, $t(27) = 1.14$, $p = .905$.

Further, the combined number of collaborative actions when children were operating on the opaque box was not related to their production of either the causally irrelevant or causally relevant actions on that box, $r_s(14) = -.08$, $p = .798$ and $r_s(14) = -.27$, $p = .349$ respectively. Similarly, there was little relationship between children’s collaborative actions when operating on the clear box for the causally irrelevant actions, $r_s(14) = -.05$, $p = .869$, and no relationship with the relevant actions (there was no variation of performance).

Discussion

As already outlined, a growing body of literature continues to document the overimitation and cooperative proclivities of young children. Our aim in this experiment was to investigate whether this potentially powerful form of peer engagement would impact performance in a task that typically elicits overimitation. Based on views that overimitation is a function of normative or conventional activity we hypothesized that rates of reproduction of the irrelevant actions on the clear box would be higher when children were tested in dyads. This was not supported: Whether tested alone or in peers, whether acting on the opaque or clear box, children reproduced the actions at comparably high levels. This should not be taken as evidence against normative accounts of overimitation but rather as highlighting the ubiquity of the overimitation phenomenon.

Furthermore, there was little collaboration across testing, and where there was it held no relationship with production of the demonstrated actions. This may not be surprising insofar as collaboration is not essential for opening the box, and indeed despite low levels of collaboration toys were retrieved in the vast majority of tests. However, this raises the question of whether or not the responses of the children involved here represent universal dispositions. The typical Western approach to learning is characterized by dyadic teacher-student interaction, with the teacher taking turns with each student. This can contrast, sometimes strikingly, with indigenous communities that are characterized by interdependent-oriented cultural approaches, where collaboration in learning is valued and emphasized (see Mesoudi, Chang, Murray, & Lu, 2015). Highlighting this, Mejia-Arauz, Rogoff, Dexter and Najafi (2007) tested triads of 6 to 10 year old children of middle-class European heritage, Mexican heritage with exposure to Western schooling, and Mexican heritage with little exposure to Western schooling. An experimenter first showed the children how to make origami figures. When left to make the figures themselves the children of Mexican heritage with little exposure to Western schooling were far more likely to work on solving the task together than middle-class European children (children with Mexican heritage but exposure to Western schooling were intermediate between the other two groups).

When coupled with research showing that among adults rates of collaboration can differ, at times remarkably, across cultural groups (e.g., Henrich et al., 2005), this raises the question of whether or not different levels of collaboration might arise if children from non-Western backgrounds were tested. We thus extended this research to include Aboriginal children living in a remote region of Australia's Northern Territory. The Aboriginal children live in two communities, Borroloola and Robinson River. These communities include the traditional owners of the region and their families (Yanyuwa and Garrwa people mostly). The children have access to Western schooling and Western cultural practices but retain many aspects of traditional life, including regular ceremonies and hunting practices. We hypothesized that the interdependent nature of the communities in which they develop coupled with influence from a traditional way of life that de-emphasizes Western pedagogical approaches would result in greater rates of collaboration among the Aboriginal children than the Western children. Following Keupp and colleagues (2013), we further hypothesized that rates of collaboration would be positively associated with rates of overimitation.

Experiment 2

Method

Participants. Participating in this experiment were 26 Indigenous Australian children (15 male) aged between 3 and 5 years (M=4.08years, SD=.89). These children were residents of the remote Aboriginal communities of Borroloola and Robinson River in Northern Australia. Borroloola is a town of about 1000 inhabitants that serves as a hub for smaller Aboriginal communities, cattle stations and tourists who mostly visit for recreational fishing. Robinson River is an Aboriginal Community of about 250 residents approximately 150kms

Southeast of Borroloola. The population of both Borroloola and Robinson River is predominantly Aboriginal. The two largest language groups in Borroloola are Yanyuwa and Garrwa. Robinson River is located in traditional Garrwa country and most of its residents identify as Garrwa. In Borroloola, Yanyuwa people live in camps within the town itself while most Garrwa people live on the eastern side of the Macarthur River, approximating their traditional tribal boundaries. Both Yanyuwa and Garrwa people have a long history of contact pre-dating European incursion (Mushin, 2012a, 2012b). They first came into contact with European settlers in the late 19th century as the country was co-opted for cattle pasture. Initial contact resulted in the extinction of some groups, and the decimation of many others, largely due to disease, starvation and punitive responses to cattle theft and other 'crimes' (Roberts, 2005). From the first half of the 20th century, they largely worked on cattle stations as stockmen and domestic workers. Elderly people tell stories of their hunter-gatherer grandparents' initial encounters with white people, though they themselves were born on cattle stations and have led relatively settled lives (although there is still considerable movement between communities). People live in extended family groups in houses, but much of life takes place outside in public spaces (Baker, 1999). While cultural life has clearly adapted to colonization, people still regularly hunt for traditional foods and bush medicine, maintain patterns of traditional land ownership as enshrined in native title, and practice ceremonies such as initiation. The children we tested are able to attend preschool and childcare where they interact with non-indigenous people, but they speak a local vernacular language (a creole) in their daily life and, aside from watching television, have little interaction with the wider, Westernized society.

The Aboriginal children were matched for age and gender to a group of 26 Brisbane children (14 male) aged between 3 and 5 years (*M*=3.88years, *SD*=.95), who had not participated in Experiment 1. The sample characteristics of these children were similar to those in Experiment 1.

Procedure. The puzzle boxes, actions used and testing arrangements were as in Experiment 1. The Indigenous Australian children were tested outside sitting on the ground, by the side of a house or small community building, and out of sight of other children. The remainder were tested in a daycare center. The Brisbane children were tested at their daycare center. All children were tested according to the Dyad condition of Experiment 1, with one exception: The number of children available for testing in Borroloola and Robinson River was not known prior to data collection. Given this potential constraint, it was decided to maximize possibilities for collaboration on the overimitation component by following Horner and Whiten's (2005) original design of having the opaque box presented first, followed by the clear box. Coding was identical to Experiment 1 and was conducted by the primary coder of Experiment 1.

Results

As illustrated in Figure 3, children reproduced the irrelevant actions on the opaque box and the clear box at similar rates regardless of whether they were from Borroloola and Robinson River (hereafter 'Borroloola' for ease of communication) or Brisbane, on the opaque box, ($M_{\text{Opaque Borroloola Irrelevant}} = 4.23$, $SD_{\text{Opaque Borroloola Irrelevant}} = 2.83$ and $M_{\text{Opaque Brisbane Irrelevant}} = 5.85$, $SD_{\text{Opaque Brisbane Irrelevant}} = 5.27$), $F(1, 24) = .95$, $p = .340$, $\eta p^2 = .04$) and the clear box ($M_{\text{Clear Borroloola Irrelevant}} = 5.08$, $SD_{\text{Clear Borroloola Irrelevant}} = 5.22$ and $M_{\text{Clear Brisbane Irrelevant}} = 5.46$, $SD_{\text{Clear Brisbane Irrelevant}} = 1.76$), $F(1, 24) = .06$, $p = .803$, $\eta p^2 = .00$).

Similarly, the causally connected actions were reproduced at similar rates across communities for both opaque, ($M_{\text{Opaque Borroloola Causal}} = 3.31$, $SD_{\text{Opaque Borroloola Causal}} = 1.32$ and $M_{\text{Opaque Brisbane Causal}} = 3.76$, $SD_{\text{Opaque Brisbane Causal}} = 0.44$), $F(1, 24) = 1.44$, $p = .242$, $\eta p^2 = .06$, and clear boxes ($M_{\text{Clear Borroloola Causal}}$ = 3.85, $SD_{\text{Clear Borroloola Causal}}$ = .38 and $M_{\text{Clear Brisbane Causal}}$ = 3.69, $SD_{\text{Clear Brisbane Causal}}$ = .63), $F(1, 24) = .57$ $p = .457$, $\eta p^2 = .02$.

To evaluate the rates of collaboration, a repeated measures ANOVA with Box Type (opaque and transparent) as a within subjects IV and Community (Borroloola vs Brisbane) as a between subjects IV was calculated. This revealed that the main effects of neither Box Type, $F(1, 24) = .00$, $p = 1.000$, $\eta p^2 = .00$, nor Community, $F(1, 24) = .97$, $p = .335$, $\eta p^2 = .04$, were significant. However, the Box Type by Community interaction was significant, $F(1, 24) = 9.57$, $p = .005$, $\eta p^2 = .29$. Following up this significant interaction, as is evident in Figure 4, for the clear box the Aboriginal children exhibited collaborative behavior at similar levels to the Brisbane children, $t(24) = .79$, $p = .44$. However, for the opaque box the Aboriginal children exhibited collaborative behavior at significantly greater levels than the Brisbane children, $t(24) = 2.36$, $p = .027$. Bearing out these differences, the Brisbane children exhibited lower rates of collaboration on the opaque than the clear box, $t(12) = 3.16$, $p = .008$, whereas there was no statistical difference for the Aboriginal children, $t(12) = 1.77$, $p = .101$.

In terms of associations, when operating on the clear box there was little relationship between the Brisbane children's total collaborative actions and production of either causally irrelevant or relevant actions, $r_s(13) = .04$, $p = .897$ and $r_s(13) = -.02$, $p = .940$ respectively. The Brisbane children's number of collaborative actions when engaged with the opaque box was similarly not significantly associated with production of either relevant actions, $r_s(13) = -.53$, $p = .063$, or irrelevant actions, $r_s(13) = .46$, $p = .112$. For the Borroloola children, there was little relationship between the number of collaborative actions when operating on the opaque box and either causally irrelevant or relevant actions, $r_s(13) = .24$, $p = .434$ and $r_s(13) = -.12$, $p = .689$ respectively. For the transparent box there was similarly little association between collaboration and production of the relevant actions, $r_s(13) = -.20$, $p = .523$. There was, however, a strong positive correlation between collaboration and production of the irrelevant actions, $r_s(13) = .77$, $p = .002$.

Discussion

We hypothesized that Aboriginal children would engage in greater rates of collaboration than Western children. We further hypothesized that rates of collaboration and overimitation would be positively associated. Both hypotheses were supported but in more nuanced ways than predicted. The Aboriginal children did show greater signs of collaboration than the Western children, but only when engaged with the more challenging opaque box. Rates of collaboration were correlated with overimitation, but only for the Aboriginal children. These findings highlight how a deeper and more thorough understanding of development can be gained by undertaking data collection in contrasting cultural groups.

The opacity of one of the boxes obfuscates the true nature of the role each action has in leading to it being opened. When confronted with this lack of clarity dyads of Western children tend to allow one of them to individually explore outcomes. Typically, one child acted on the apparatus from start to finish and children offered little suggestion to each other about what should be done. In contrast, there was a non-significant trend for the Aboriginal children to provide more feedback on the opaque than the transparent box. They did this by acting on different parts of the box at the same time, by pointing at parts of the box, and by offering directions regarding what should be done. This feedback was not, however, associated with any increase in production of the target actions. The likely reflects the lack of surety regarding what each component did. An observing child might provide advice on what to do, but if this is not stated with any confidence, the child receiving the advice may be less inclined to adopt recommendations (at least when compared to statements given assuredly).

The current experiment replicates past research that has found comparably high levels of overimitation in these two communities (Nielsen et al., 2014). Here, the Western and

Aboriginal children copied the suite of modeled actions at rates indicative of high fidelity reproduction. This adds confidence to claims that the phenomenon of overimitation is not culturally specific (see Berl & Hewlett, 2015, for an exception). However, in contrast to the opaque box, the extent of collaborative activity on the transparent box was associated with the frequency of production of the irrelevant actions – although only for the Aboriginal children. This may be indicative of culturally specific approaches to learning and the way they manifest themselves in a task that provides opportunity for, but is not reliant on, collaboration.

Whereas urban-industrial Western cultures characteristically feature formal, institutionalized teaching, learning in small-scale cultures more commonly occurs through observation and trial-and-error learning, with teaching and demonstration playing limited roles (Hewlett, Fouts, Boyette, & Hewlett, 2011; MacDonald, 2007). For instance, in many Aboriginal communities it is uncommon for adults to actively instruct children in traditional knowledge, and when teaching does occur, verbal instruction is markedly reduced when compared with typical parent-child interaction in Western societies (e.g., Reeders, 2008). As is typical of overimitation studies, here, in order to have modeling appear deliberate and intentional, task actions were communicated to children in a clearly and manifestly demonstrative manner. This structured learning context may be relatively straightforward for Western children to interpret. For Aboriginal children less used to such tasks, the test environment may have been more challenging to decipher. Those who had a peer to guide them benefitted from this. Thus, one interpretation of this finding is that, in contrast to Aboriginal children, sensitivity to structured teaching scenarios and an expectation of being shown what to do by more knowledgeable adults reduces Western children's need to interpret task demands and to find task solutions of their own. This warrants further investigation.

Finally, it remains notable that overall, across both communities, rates of collaboration were low. As already stated, this should not be overly surprising given the task can be solved as a solitary activity. However, past research has identified higher collaborative activity in tasks where children are tested in triads and rates are higher the less exposure to Western schooling children have (Mejía-Arauz et al., 2007). The size of the communities we visit in the Northern Territory prohibits testing of this nature. Nonetheless, extending the research undertaken here to situations involving children in triads promises to shed further light on the relationship between collaboration and social learning.

General Discussion

Overimitation is increasingly recognized as a cornerstone of human cumulative culture. Directly and comprehensively copying others enables the rapid acquisition of a vast array of essential skills that have been developed and accumulated through multiple past generations. There is much to be gained by copying exactly what others do. Extended childhood as a life stage is uniquely human (Bogin, 1990; Nielsen, 2012) and Whiten and colleagues argue that this allows for any wrongly assimilated behavior to be weeded out, and in this sense it is an adaptive default strategy to 'copy-all, refine/correct-later' (Whiten, Horner, & Marshall-Pescini, 2005; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). But what happens if children have the opportunity to work together? Do they encourage each other to copy everything or do they point out the irrelevance of redundant actions?

With regard to Western children, we found the answer to the latter question is 'neither'. Across both experiments there was little sign of collaboration. We suggest this behavioral profile is best viewed in the context of the structured, guided approach that is ingrained in the Western approach to learning. When placed in a pedagogical situation featuring a teaching act by an adult, students expect to be told what to do, including the roles and responsibilities they need to take on (Chavajay & Rogoff, 2002). This approach is likely to be amplified when there is uncertainty about the function of modeled actions. This approach is less common in many indigenous communities where collaboration among peers when learning is more normative. This is reflected in the responses of the Aboriginal children tested in Experiment 2 who offered collaborative ideas across both boxes, with feedback being positively correlated with production of the irrelevant actions on the transparent box. This suggests that where collaboration is more common it serves to reinforce rather than diminish overimitation. However, this may depend on the nature of the task at hand.

To date, the majority of overimitation studies have used test objects like those employed here: puzzle boxes containing a reward that can be retrieved following execution of a series of actions. However, children will also imitate actions on objects that do not yield a reward and where the actions modeled progress through stages that return to the start-state . Children's responses to the latter situation may lead children to adopt what has been referred to as 'the ritual stance', where attempts at seeking out a rationale for demonstrated actions are based on cultural conventions rather than laws of physical causation (Herrmann et al., 2013). Whether or not children would display greater levels of cooperation on an overimitation task tapping the ritual stance, and if such cooperation results in greater or reduced rates of copying, present themselves as topics for future research.

In less than a decade from now the FIFA World Cup will be held in Qatar. Across the tournament millions will pack themselves into impressive new stadiums, serviced by modern transport systems and surrounded by lush gardens. What makes this remarkable is that not that long ago the very place where this will happen was little more than desert-like landscape featuring wind, dirt and rubble. There are many examples like this, examples of our species' staggering capacity for transforming our environment (for better or worse). A core element in this capacity is our propensity for learning to use tools and objects by watching what others do with them and then possibly building on this cumulative knowledge. Another is our proclivity for working together, for collaborating to achieve greater outcomes than could ever be achieved working in isolation. The current research shows how these two pillars of human culture can work in concert and how their expression and interaction can be shaped by the environment in which they develop.

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Opaque Box	Clear Box

Figure 1: The puzzle boxes used in Experiments 1 and 2.

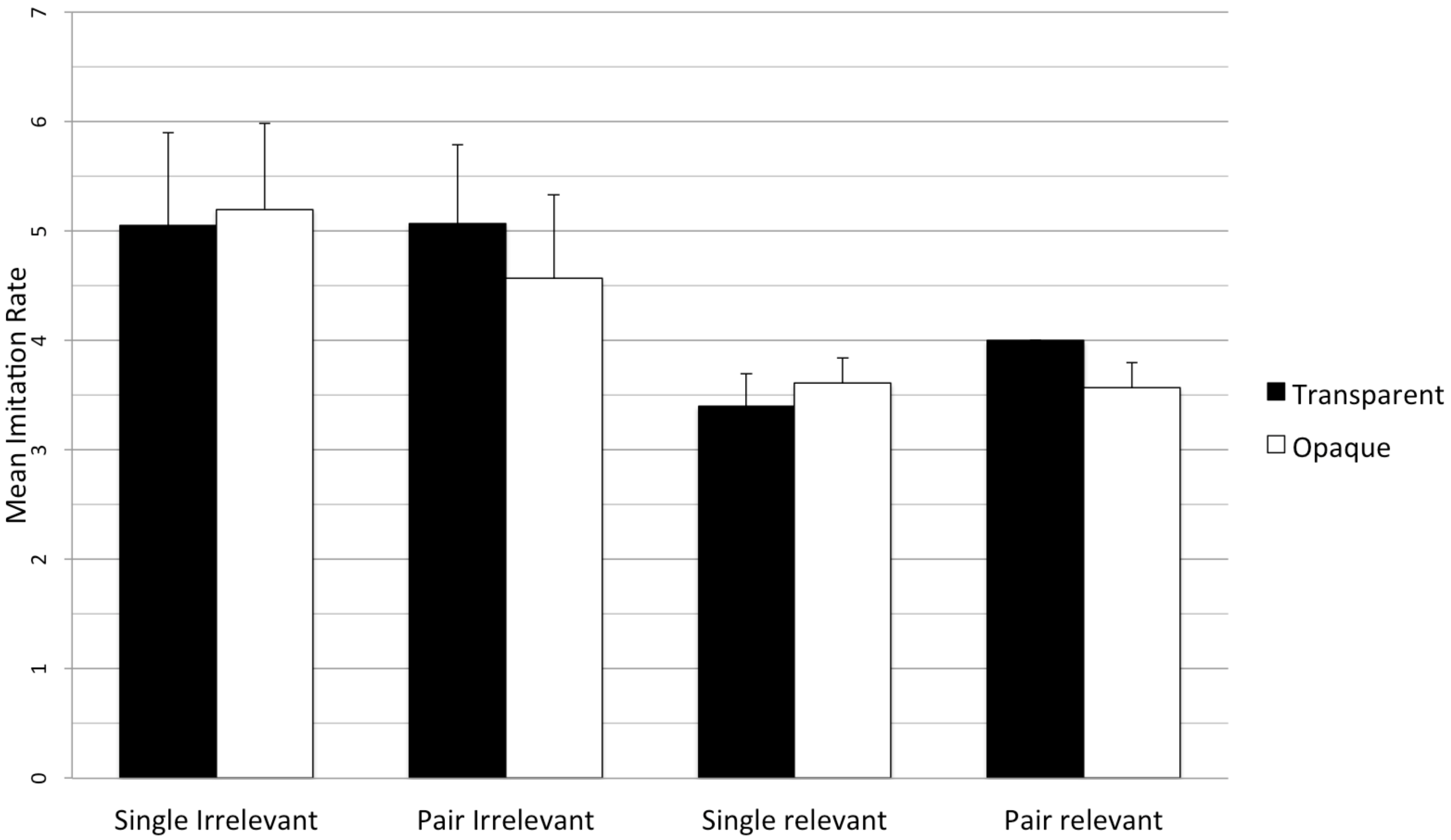

Figure 2. Children's mean imitation of the Causally Relevant and Causally Irrelevant actions on the transparent and opaque boxes in Experiment 1 (error bars indicate standard errors). (Note: As coding for the irrelevant actions incorporated the frequency with which the stick was inserted into the top compartment a score of 5 represents perfect replication although children could score higher; in contrast scores for the relevant actions were restricted to a range between 0 and 4).

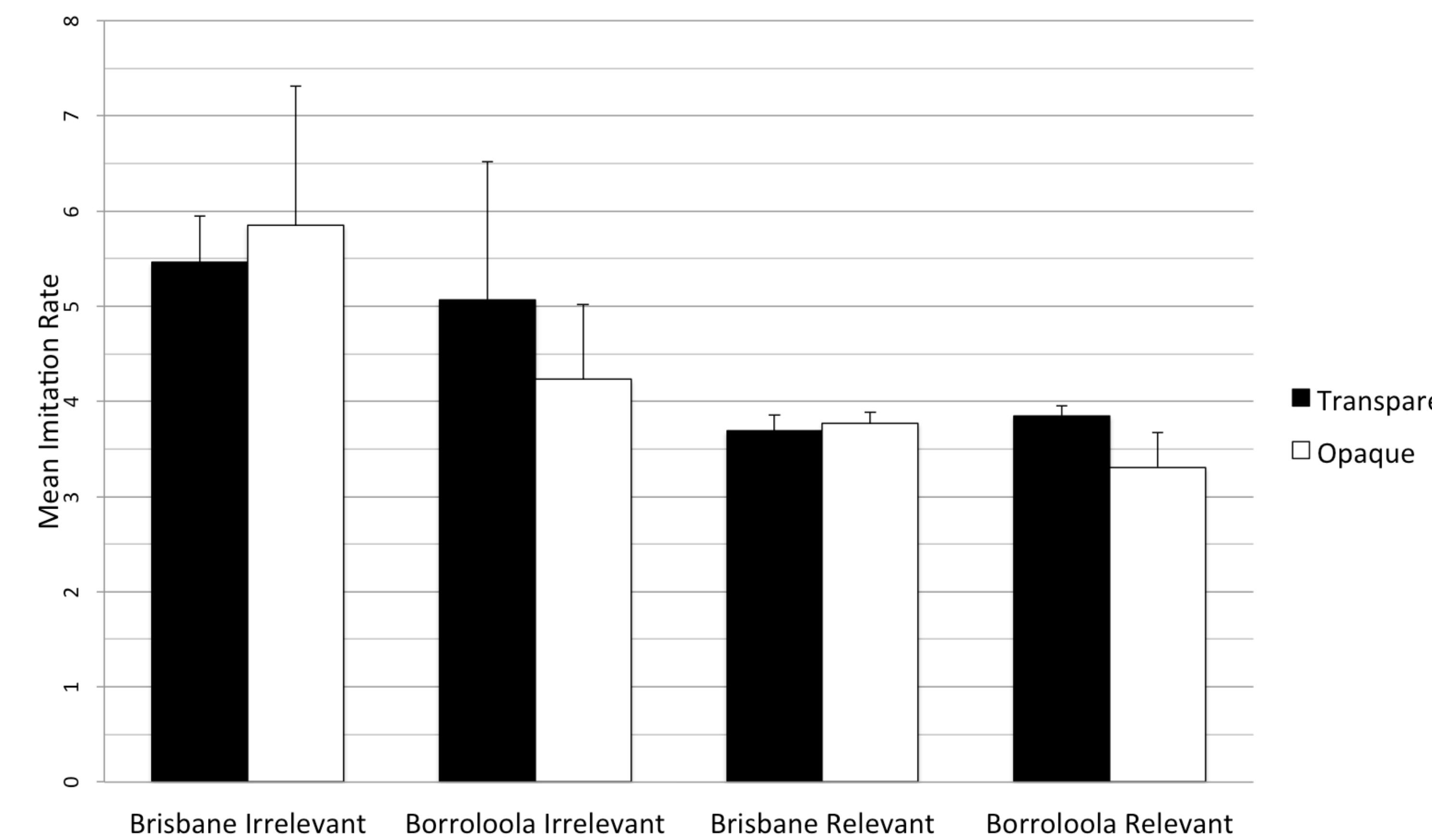

Figure 3. Children's mean imitation of the Causally Relevant and Causally Irrelevant actions on the transparent and opaque boxes in Experiment 2 (error bars indicate standard errors).

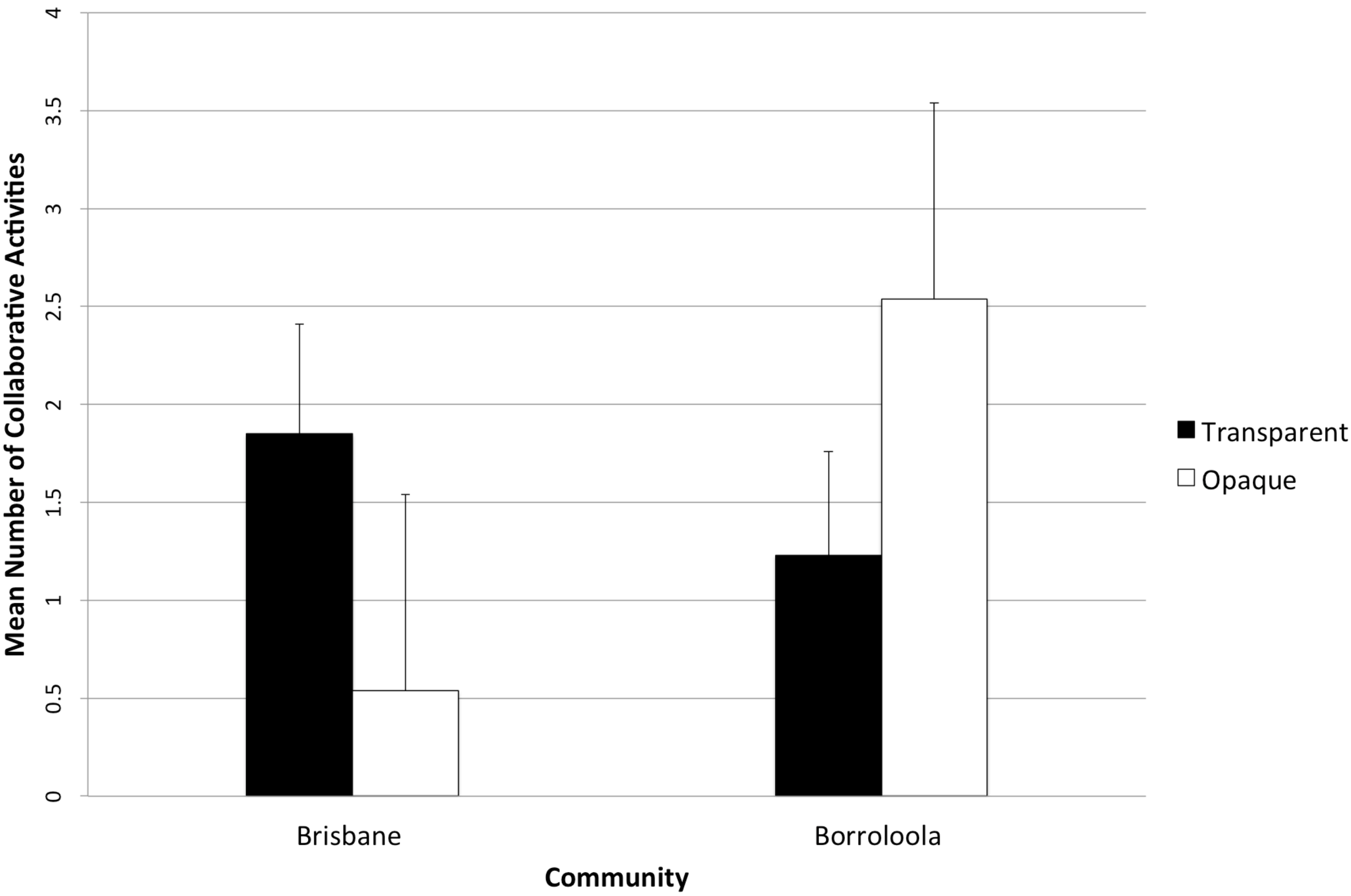

Figure 4. Children's mean rates (and standard errors) of collaboration when interacting with the clear and opaque boxes in Experiment 2.