Still life? Children's understanding of the reality status of museum taxidermy

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Bunce, L. (2019) *Journal of Experimental Child Psychology, 177,* 197-210

Taxidermied animals provide an important source of information about the natural world, but failure to understand their reality status may result in missed learning opportunities for museum visitors. This study explored 4–10 year-old children's and adults' (*n*=207) reality status judgments, and biological and authenticity property attributions for a taxidermied rabbit during a museum visit. The aim was to examine their understanding of its former status as a living animal and its current status as an authentic piece of natural history, under different presentation conditions, including: 1) as a touchable exhibit; 2) inside an exhibition case – untouchable; and 3) an experimental context paired with a toy rabbit – both touchable. Analysis revealed that there was an increase with age both in judgments that taxidermy was real and authentic and in accuracy of biological property attributions. The toy condition resulted in more accurate reality judgments, whereas the touchable condition resulted in more accurate biological property attributions. There was no effect of age or condition on authenticity property attributions. Accuracy of biological property attributions was also associated with reality status judgments, whereby understanding the real and authentic nature of taxidermy was associated with understanding its biological status. Implications for the development of biological cognition and museum learning are discussed.

Keywords: biological cognition; categorisation; reality status; conceptual development; informal learning; museums

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Encounters with animal taxidermy provide important opportunities for children to learn about the natural world, but the educational benefit of such encounters relies, to an extent, on an accurate understanding of their reality status (Bunce, 2016a; Bunce 2016b; Dillon, DeWitt, Pegram, Irwin, Crowley et al., 2016; Evans, Mull, & Poling, 2002; Hampp & Schwan, 2014; Kirchberg & Tröndle, 2012; Leinhardt & Crowley, 2002; Sanders & Hohenstein, 2015; Watson & Werb, 2013). Taxidermy involves preserving an animal's skin in a way that provides an authentic portrayal of the external anatomical features of a previously living animal (Guild of Taxidermists, 2015). Taxidermied animals are commonly found in museums of natural history, but may also be encountered in art galleries, stately homes, hotels and restaurants, particularly in rural areas where hunting is common. The status of taxidermy, however, is likely to be confusing to children because taxidermy has characteristics of real and unreal entities. On the one hand, taxidermied animals are 'real' in that they comprise an animal's skin that has been fashioned to provide a genuine representation of the animal. This skin has not been made from artificial materials, such as those used to make toy animals. On the other hand, they are not 'real' in the sense that they are not alive anymore. They were either killed for the purpose of taxidermy, or died naturally, and their biological tissue, including organs and bones, have been replaced with a wire frame and padded out with specialist stuffing material. In addition, some visible features such as the eyes are replaced with manufactured materials.

The issue of whether something is real or not is inherently ambiguous because it depends on the object and the context (Bunce & Harris, 2008; 2012). For example, the question, 'Is that lion real?' could refer to living/nonliving status and seek to determine

whether a particular lion is alive or dead. Equally, it could refer to authentic/artificial status and seek to determine whether a particular lion is genuine as opposed to artificial or fake, such as a person wearing a lion costume, or a life-size statue of a lion. Similarly, taxidermied animals could be considered real or not real in relation to their living/nonliving status or authentic/artificial status, and this may be dependent on the context. For example, taxidermy might be considered not real, i.e., not alive, when encountered alongside a pet or inside a stately home or art gallery, but be considered real, i.e., authentic, when encountered in a museum. The potentially confusing reality status of taxidermy is evident in the fact that one of the first questions children often ask when they encounter museum taxidermy is, 'Is it real?' (Kirk, 2012; Tunnicliffe, 1996). Given the importance of museums for providing informal learning opportunities, the current study sought to explore children's interpretation of taxidermy in a museum context, and to establish: a) to what extent they intuitively categorise it as a real and authentic piece of natural history, and b) whether they can attribute properties on the basis of the living/nonliving distinction and the authentic/artificial distinction.

To date, almost no research has explored how children categorise or make inferences about taxidermy. An exception is Tunnicliffe (1996), who observed British primary school children's conversations about taxidermied animals during a museum visit, and compared these with another group of children's conversations about live animals during a visit to a zoo. A large age range of children were included in the study from '5 years and under' (p. 134) to 12 years, but the results are not systematically broken down by age. Overall, 66% of conversations about live animals concerned behaviours, including feeding, excreting, and moving, and 37% of conversations about taxidermy were also about behaviours. In contrast, taxidermy, but not live animals, elicited comments about 'reality'

and ‘realness’. Tunnicliffe discussed how children in the museum appeared to use their biological knowledge to make sense of, and categorise taxidermied animals in terms of their previously living status. Thus, Tunnicliffe (1996) interpreted children as equating real with living/nonliving status, or ‘being alive or having been alive’ (p. 138). One child (in Year 3, i.e., 7-8 years of age), for example, said of a taxidermy lion, ‘I wish it were real then I could sit on the back and ride it’ (p. 139). Children in this study did not appear to equate realness with being authentic, which is how adults and museum curators categorise museum taxidermy and other museum objects (Dillon et al., 2016; Frazier & Gelman, 2009; Kirk, 2012). Given this apparent developmental difference, and the absence of data about developmental changes in children’s understanding of taxidermy, the current study explored the development of children’s perceptions of the reality status of taxidermy.

The way in which children categorise and make inferences about living things in the absence of formal instruction has been the subject of several decades of debate. There are two main schools of thought that vary in the extent to which they emphasise one of two cognitive mechanisms known to be influential during this process (Waxman & Gelman, 2009). The first is perceptual or similarity-based approaches, initially advocated by Carey (1985), and supported by others including Sloutsky and Fisher (2004). This approach proposes that conceptual biological knowledge develops primarily on the basis of perceptual similarities, with children under 10 years of age favouring sensory cues relating to physical properties of entities when drawing inferences about new entities. The second approach, advocated by researchers including Gelman (e.g., Gelman, 2003), Keil (1989), and Inagaki and Hatano (2002), is conceptual or theory-based. It proposes that children’s knowledge is structured with reference to a set of beliefs that are embedded in naïve theories. Naïve theories are knowledge systems that contain information that enables

children to make predictions and provide explanations in principled ways. In the biological domain, this information includes biological characteristics of entities and causal mechanisms involved in sustaining life (Inagaki & Hatano, 2002). Some studies have found that abstract categorical knowledge is available to children as young as 3 years (Gelman, 2003).

These two types of information may help children to interpret the reality status of taxidermy. On a basic perceptual or sensory level, taxidermy appears highly life-like in terms of its general appearance, and has authentic visible features such as real fur. On this basis, children may be expected to judge taxidermy as 'real'. However, it is also unable to move, and movement is a core feature of children's naïve biology that they use to distinguish between living and nonliving entities (Margett & Witherington, 2011). For example, children at 5 years of age have been shown to understand that animals, but not artifacts can move on their own and can self-start (Rhodes & Gelman, 2009). Inability to move may indicate to children that taxidermy is not alive and, therefore, not real, which was the interpretation favoured by Tunnicliffe's (1996) analysis of children's responses to taxidermy. Although research by Gutheil, Bloom, Valderrama, and Freedman (2004) suggests that 3- and 4-year-olds first attend to an object's identity based on its current perceptual properties, Frazier and Gelman (2009) revealed that children this age have an emerging understanding that an item's history or non-visible properties affect its nature. Based on these findings, the current study tested the hypothesis that children aged 3–4 years would judge museum taxidermy as not real because it is not alive, but with increasing age children, like adults, would use this information to conclude that it is authentic, and, therefore, real.

To examine further what type of information children use to make reality judgments about taxidermy in the current study, they were asked to complete a property attribution

task. In this task they had to decide whether a number of properties relating to the living/nonliving distinction and the authentic/artificial distinction applied to the taxidermy, for example whether it has a heart inside or whether it has real fur. In terms of children's understanding of the authentic/artificial distinction, from the age of 2 years, children have been shown to contrast authentic or genuine objects and entities with fakes, imitations, or replicas in everyday life using the word 'real' (Bunce & Harris, 2008; Woolley & Wellman, 1990). Preschoolers can also make reality status judgments about objects or entities on the basis of their authentic or artificial nature (Bunce & Harris, 2013; Flavell, Flavell, & Green, 1987; Frazier & Gelman, 2009; Harris, Kavanaugh, & Meredith, 1994; Hood & Bloom, 2008; Woolley & Wellman, 1990). For example, in Bunce and Harris (2013), 3–5-year-olds judged animals, such as a sheep, as 'real' because they have 'real skin' and 'the wool is real', whereas toy sheep are not real because they have 'not got the right wool' and are 'just plastic'. Children at 4 years of age have also been shown to understand that authentic objects including those that are original, such as the very first teddy bear, or objects that have a famous association, such as the president's flag pin, belong in a museum, although performance improved with age (Frazier & Gelman, 2009). These data suggest that young children would demonstrate an understanding of the authentic features of taxidermy, but that this would increase with age, and this hypothesis was tested in the current study.

Turning now to children's property attributions according to the living/nonliving distinction, research has shown that children develop extensive biological knowledge during childhood. At 3 years of age, some children have an understanding of some core differences between animate and inanimate entities, for example, some children attribute biological properties including growth, breathing, and internal organs to animates, but not to inanimate entities, such as toys (Greif, Kemler Nelson, Keil & Gutierrez, 2006; Jipson &

Gelman, 2007). By 5 years of age, children have been shown to differentiate between internal parts appropriate for animals and machines (Gottfried & Gelman, 2005), and understand that people, but not toy dolls, have brains (Scaife & Van Duuren, 1995). Between 5 and 6 years of age children have also been shown to recognise that living kinds need to take in food and are susceptible to illness (Inagaki & Hatano, 1996), and beyond that, at around 7 years, children can understand that the ultimate goal of bodily functioning is life and, conversely, that the breakdown of all bodily function results in death (Jaakkola & Slaughter, 2002; Rosengren, Gutiérrez, & Schein, 2014). On the basis of this research, it was expected that younger children in the current study would be able to demonstrate some understanding of the properties that apply to taxidermy on the basis of the living/nonliving distinction. It was also expected that there would be a developmental increase in accuracy between 4–5 years of age and 6–7 years of age, but that by the age of 8 years children's performance would be comparable to that demonstrated by adults.

The relation between property attributions and reality judgments was also considered in the present study. Sharon and Woolley (2004) noted the challenging nature of recognising the implications of property information for decisions about reality status, particularly when an entity has contradictory properties. In their research they found that there was a good level of consistency between 3- and 5-year-olds' reality status judgments and subsequent property attributions for real and fantastical entities: children granted more human-like properties to entities that they had classed as real than those they had classed as fantastical, irrespective of the accuracy of their reality judgment. Following this, in the current study it was expected that there would be an association between participants' reality status judgments and property attributions. Specifically, this study tested the hypothesis that the attribution of properties would be more accurate among participants

who recognised the authentic status of taxidermy, or who recognised that it is not alive or used to be alive, than participants who judged it as not real because it is not authentic.

To test these proposals, children aged 4–10 years, who were visiting a museum of natural history, were asked to justify their reality status judgments for a taxidermied animal, a rabbit, and to consider whether a number of properties applied to it, including whether it has a heart inside or needs to eat – biological properties, and whether it has real fur and eyes – authenticity properties. Given the absence of prior research, adult visitors were asked the same questions as the children to provide a measure against which to evaluate children's performance. It was expected that adults would judge taxidermy as real because it is authentic, and that they would accurately attribute properties on the basis of the living/nonliving and authentic/artificial distinctions.

This study also examined the influence of three conditions on participants' reality judgments and property attributions. This was because these responses are dependent on the context in which they are sought and the structure of the task, both in children (Bunce & Harris, 2013; Gutheil, Vera, & Keil, 1998; Tullos & Woolley, 2009; Woolley & Van Reet, 2006), and in adults (Kahneman, 2003; Tversky & Kahneman, 1986). Two conditions reflected the way in which taxidermy is curated in museums: 1) as a touchable object; and 2) as an untouchable object enclosed in an exhibition case. The ability to touch and manipulate museum objects, as opposed to looking at them through an exhibition case, is thought to be beneficial in terms of enhancing engagement and learning (Paris, 2002; Pye, 2008). Touching objects may enable visitors to better 'decode' the object (van Kraayenoord & Paris, 2002), and in doing so, may support their interpretation of and ability to construct meaning from it. This idea is supported by studies showing that visitors tend to spend longer interacting with museum objects that they can touch compared to those that they cannot

(e.g., Diamond, 1986). Therefore, it was expected that both children and adults in the current study would make more accurate reality judgments and property attributions when taxidermy was touchable as opposed to when it was untouchable because it was inside an exhibition case.

The third condition was experimental and involved presenting a toy rabbit alongside the taxidermied rabbit. In this condition, participants were able to touch both the toy and the taxidermy, but they had additional information compared with the other two conditions in the form of a point of reference provided by the toy equivalent of the taxidermy. The benefit of presenting pairs of real and unreal entities for children's reality status judgments was found in Bunce and Harris (2013). For example, when children were shown a photograph of a toy sheep and a photograph of a real sheep as a pair, children made more accurate reality judgments. Bunce and Harris (2013) argued that the real and unreal pairing encouraged children actively to compare the two entities, and make relevant contrasts between them. Therefore, it was expected that participants in the current study would make more accurate reality judgments and property attributions in the toy condition compared to the touchable and encased conditions.

Method

Participants

In total, 233 museum visitors took part. Data for 26 participants were excluded owing to interference from another person during testing (*n*=5), the presence of a developmental disorder (*n*=2), or a consistent 'yes' or 'no' response bias to more than 80% of the questions coupled with an uninformative justification (for example uninformative

justifications please see section 'Reality judgments') (*n*=19). This resulted in a final sample of 207 (see Table 1). The adults who took part were not related to the child participants. Most of the final sample described themselves as white (*n*=183, 88%, 3 missing), living in the UK (*n*=184, 89%, 6 missing), and had previously visited a natural history museum in the past two years at least once (*n*=157, 76%). Most adults and caregivers of the children were reported to be university educated (*n*=123, 59%, 8 missing responses).

Materials

A taxidermied rabbit, *Oryctolagus cuniculus*, was donated from the Oxford University Museum of Natural History. It was approximately 35 cm long x 25 cm wide x 20 cm high. In the touchable condition, it was presented without a case, whereas in the encased condition it was enclosed in a transparent plastic display case. In the toy condition, the taxidermied rabbit was presented without a case, alongside a (touchable) toy rabbit that was a similar size, posture, and colour to the taxidermy (see Figure 1).

Figure 1. The taxidermied rabbit in the touchable (left) and encased (middle) conditions, and toy rabbit (right) that was presented alongside the touchable taxidermy in the toy condition.

Table 1: Demographic characteristics of participants in each condition, with child age in years and months (n=174) and adult age in years (n=33)

	Condition			
	Touchable	Encased	Toy	Total
Age and gender	(n = 72)	(n = 72)	(n = 63)	(n = 207)
4–5-year-olds				
Mean age (range)	4;10 (4;1-5;9)	4;11 (4;0-5;10)	4;11 (4;3-5;7)	4;10 (4;0-5;9)
Standard Deviation	7.14	6.38	3.85	6.05
% females (n)	53 (10/19)	66 (12/18)	69 (9/13)	62 (31/50)
6–7-year-olds				
Mean age (range)	6;10 (6;3-7;10)	7;0 (6;5-7;11)	7;2 (6;6-7;11)	7;0 (6;3-7;11)
Standard Deviation	6.91	6.96	6.91	7.05
% females (n)	55 (12/22)	42 (10/24)	50 (10/20)	48 (32/66)
8–10-year-olds				
Mean age (range)	9;0 (8;0-10;2)	9;5 (8;1-10;10)	9;0 (8;2-10;9)	9;2 (8;0-10;10)
Standard Deviation	7.46	11.45	8.48	9.80
% females (n)	45 (9/20)	50 (9/18)	55 (11/20)	50 (29/58)
Adults				
Mean age (range)	35 (19-68)	49 (23-73)	43 (20-75)	43 (19-75)
Standard Deviation	16.83	17.17	16.46	16.89
% females (n)	55 (6/11)	33 (4/12)	70 (7/10)	52 (17/33)

Procedure

Ethical approval was obtained from the researcher's institution. Data collection took place in the Oxford University Museum of Natural History, U.K., in a public space on the museum floor in the main gallery. This gallery comprises exhibition cases containing, for example, dinosaur bones, minerals, fossils, insects, and taxidermied animals, as well as two complete dinosaur skeletons in the centre, which are not encased but visitors are forbidden to touch them. The taxidermied rabbit (touchable, encased, or with toy) was visible on a table, and conditions were tested separately over several days during the summer. Visitors who approached the table were informed about the study by an assistant. If they were willing to take part, or to allow their child to take part, informed written consent and demographic information were obtained. Children only took part if they also gave verbal assent. Next, participants were invited to sit down individually with a researcher at the table to answer questions. Caregivers/companions were politely requested not to interact with the participant during the interview.

The interview began with some warm-up questions to see if participants could name the taxidermied animal, and to establish whether or not they liked it. All participants correctly named it as a rabbit, and 84% said that they liked it. During this stage, the researcher modelled touching the taxidermied rabbit in both the touchable and toy conditions, and encouraged participants to do the same. In the toy condition, participants were also encouraged to touch the toy rabbit to emphasise the fact that they should compare the two rabbits. The majority of participants spontaneously touched the taxidermied rabbit, and the remainder did so after the researcher.

Participants were then asked whether they thought that the taxidermied rabbit was real, and to explain their response: 'Is this rabbit real?' and, 'Why do you think it is real/not-

real?' In the toy condition, participants were also asked these questions regarding the toy rabbit, and the order in which these questions focused on the taxidermied and toy rabbit was random. Subsequently, participants were asked questions about seven biological properties and two authenticity properties. The seven biological questions were: 'Is this rabbit alive?' 'Does this rabbit need to eat?' 'Does this rabbit need to poo?' 'Does this rabbit move on its own?' 'Are there bones inside this rabbit?' 'Does this rabbit stay the same size?' (reverse scored) and, 'Is there a heart inside this rabbit?' The two authenticity questions were: 'Does this rabbit have real fur?' and, 'Does this rabbit have pretend eyes?' All nine questions were asked in a random order. Next, the questions were repeated in the past tense to determine whether children thought that the property applied to the taxidermied rabbit in its previous state, for example, 'Did this rabbit used to eat?' These were also asked in a random order.

In the toy condition, the same procedure was adopted, except that questions were asked alternately about the toy and the taxidermied rabbit. They were asked in a semi-random order, so that the same question was not asked for the toy and taxidermy consecutively. The researcher pointed to the appropriate rabbit while asking the question. The task lasted approximately 10 minutes, and was recorded with a dictaphone.

Results

The data comprise participants' reality judgments as well as their biological and authenticity property attributions. The first analysis explored the association between reality judgments (real authentic, not real artificial, real living, not real nonliving), age, and condition. The second analysis explored the accuracy of participants' biological and

authenticity property attributions as a function of age, condition, and reality judgment. Two key sources of variability in biological knowledge were also explored: pet ownership, and whether the participant lived in a rural or urban area. This was because children who own a pet as opposed to children who do not own a pet demonstrate more advanced biological reasoning (Inagaki, 1990; Geerdts, Van de Walle, & LoBue, 2015), as do children who live in rural areas as opposed to urban areas (Atran, Medin, Lynch, Vapnarsky, Ek et al., 2001; Ross, Medin, Coley, & Atran, 2003; Ganea, Canfield, Simons-Ghafari, & Chou, 2014). There were, however, no effects of pet ownership or location in any of the analyses so these were excluded from the findings. The analysis also checked for gender differences and found none, therefore gender was excluded in all analyses.

Reality judgments

The first analysis explored participants' reality judgments for the taxidermy. Justifications for the reality judgments were allocated to one of three categories: *living/nonliving* (*n*=103, 50%)*, authentic/artificial* (*n*=89, 43%), and *uninformative* (*n*=15, 7%). A living/nonliving justification referred to the nature of the taxidermy in its current or previous state as a live or dead animal, e.g., *It's not moving all about and it's stuck to this* [6 years]; *It's lived its life and it's dead* [9 years]; *It's stuffed so it's not alive now* [10 years]. An authentic/artificial justification referred to the authentic/artificial nature of a physical property or feature of the taxidermy, e.g., *It has real fur and real actual ears* [5 years]*; I know what a rabbit looks like and feels like – it probably is real fur* [Adult]; *You can see in the eyes, they are plastic* [8 years]; *It looks more like a model* [7 years]. Uninformative justifications provided irrelevant information, e.g., *Rabbits are very tiny*, or *I have a rabbit at home.* Coding was carried out by two coders who were blind to the hypothesis, age of the

participant, and reality judgment. Agreement was 87.9% (Cohen's κ=.833). Disagreements were resolved through discussion.

An initial check confirmed that the toy rabbit was judged as not-real by 62/63 (98%) participants because it did not have authentic properties, e.g., *It has fake fur*. In the toy condition, therefore, the results are presented for the taxidermied rabbit only, not the toy rabbit.

Each participant was subsequently allocated to one of four categories on the basis of their reality judgment for the taxidermy – real authentic, not real artificial, real living, not real nonliving. Participants who provided an uninformative justification, n=14, were excluded from analysis. The analysis attempted to explore the distribution of participants in these four categories according to age and condition, and the interaction between age and condition using a hierarchical loglinear analysis (see Figure 2). However, owing to low cell counts in some of the categories, it was not possible to explore the interaction, only the independent effects of age and condition. Looking at the data in Figure 2 suggests that the impact of condition was greater for children than adults, for example 4- and 5-year-olds gave predominantly not real nonliving judgments in the touchable and encased conditions but real authentic judgments in the toy condition. In contrast, adults gave predominantly real authentic judgments in all three conditions. Chi squared tests were instead conducted to determine how reality judgments were affected by age and condition independently.

There was a significant association between age and reality judgment, $\chi^2(6, N=193)=38.277$, $p<.001$, $\phi=.445$ (see Table 2). As expected, there was an overall trend for a developmental increase in the proportion of participants who judged taxidermy as real because it is authentic (26%, 29%, 49%, 68% for 4- and 5-year-olds, 6- and 7-year-olds, 8–10-year-olds, and adults respectively) and a corresponding decrease in the number who judged

it as not real because it is nonliving (51%, 39%, 17%, 10% for 4- and 5-year-olds, 6- and 7-year-olds, 8–10-year-olds, and adults respectively).

There was also a significant association between condition and reality judgment, $\chi^2(6, N=193)=25.878$, $p<.001$, $\phi=.20$ (see Table 3). In support of the hypothesis, taxidermy was judged as real because it is authentic more often in the toy condition (62%) than in the touchable (32%) and encased (30%) conditions. However, these judgments were not given substantially more often in the touchable condition compared to the encased condition.

Property attributions

The next analysis explored participants' attributions of properties relating to the living/nonliving distinction, referred to as biological properties, and the authentic/artificial distinction, referred to as authenticity properties, according to age, condition, and reality judgment. Correct responses to both current and previous state versions of each question were awarded a joint score of 1, thus participants had to answer both questions correctly to achieve this score. The mean scores for participants in each age group for each question are provided in Table 4.

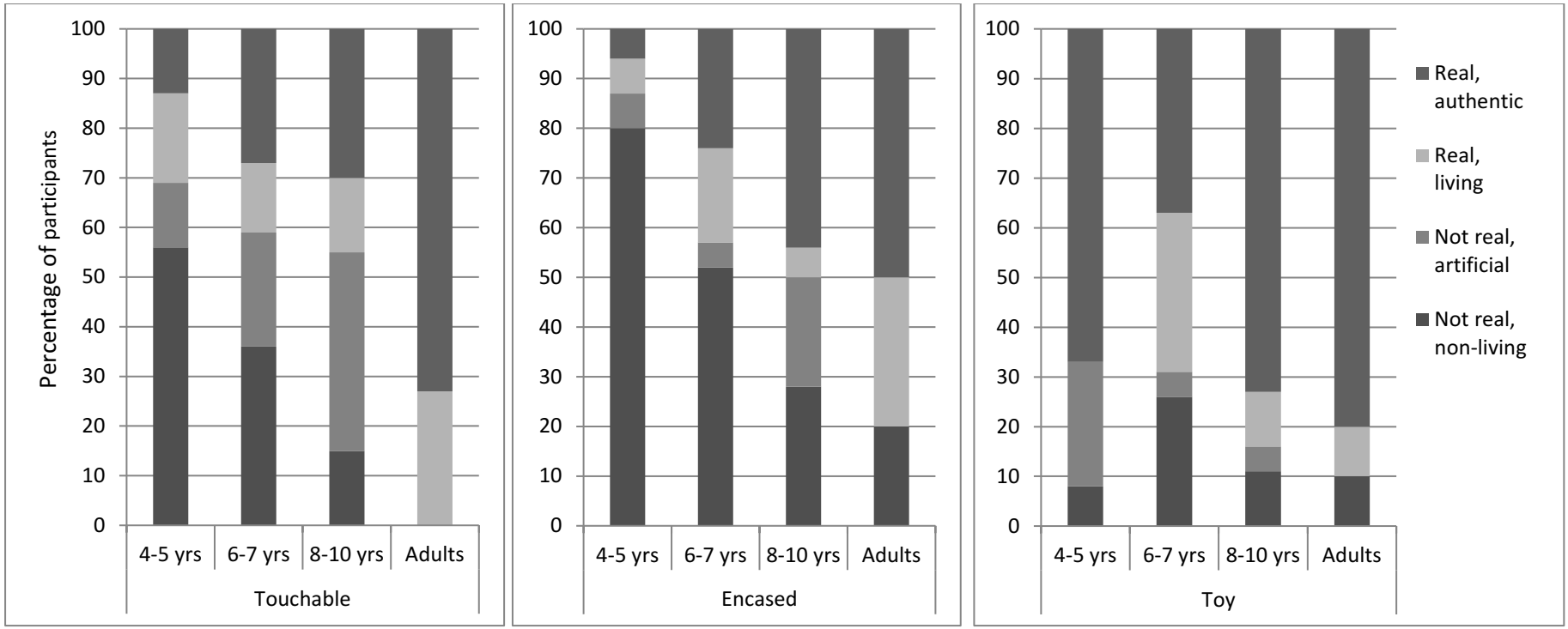

Figure 2. Percentage of participants in each age group in the touchable condition (left), encased condition (middle) and toy condition (right) who made one of four types of reality judgment. Numbers in the toy condition refer only to the taxidermied rabbit, not the toy rabbit. yrs = years

Table 2: Percentage of participants in each age group who gave each reality judgment

	Age group			
Reality judgment	4- and 5-year-olds	6- and 7-year-olds	8–10-year- olds	Adults
Real, authentic	26	29	49	68
Real, living	9	21	11	23
Not real, artificial	14	11	23	0
Not real, nonliving	51	39	17	10
Total	100	100	100	100

Table 3: Percentage of participants in each condition who gave each reality judgment

	Condition		
Reality judgment	Touchable	Encased	Toy
Real, authentic	32	30	62
Real, living	17	14	15
Not real, artificial	22	9	8
Not real, nonliving	29	47	15
Total	100	100	100

Table 4: Mean scores for each property attribution question according to age group

	Age group							
Property and	4- and 5-year-olds		6- and 7-year-olds		8–10-year-olds		Adults	
Question	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Biological								
Alive	0.64	(0.48)	0.73	(0.45)	0.67	(0.47)	1	(0)
Eat	0.38	(0.49)	0.52	(0.50)	0.57	(0.50)	0.94	(0.24)
Poo	0.38	(0.49)	0.48	(0. 50)	0.59	(0.50)	0.85	(0.36)
Move	0.50	(0.50)	0.58	(0. 50)	0.60	(0.50)	0.91	(0.29)
Bones	0.18	(0.39)	0.42	(0. 50)	0.36	(0.49)	0.45	(0.51)
Same size	0.18	(0.39)	0.52	(0. 50)	0.59	(0.50)	0.82	(0.39)
Heart	0.20	(0.40)	0.52	(0. 50)	0.62	(0.50)	0.97	(0.17)
Mean	*0.38*	*(0.30)*	*0.56*	*(0.36)*	*0.61*	*(0.41)*	*0.91*	*(0.18)*
Authenticity								
Fur	0.66	(0.48)	0.86	(0.35)	0.86	(0.35)	0.97	(0.17)
Eyes	0.66	(0.48)	0.67	(0.48)	0.81	(0.40)	0.91	(0.18)
Mean	*0.66*	*(0.29)*	*0.77*	*(0.25)*	*0.84*	*(0.24)*	*0.94*	*(0.17)*

Owing to the different number of questions that comprised the biological and authenticity property scores (seven and two respectively), each participant was given a score from 0 to 1 that represented the proportion of questions correct in each scale. Factor analysis on the nine property questions confirmed that there were two distinct scales, biological and authenticity. Each item, except for the bones question, loaded above .65 onto their respective scales, therefore, the bones question was removed from the analysis.

An initial check confirmed that participants largely correctly allocated properties to the toy rabbit. A 2 (Property: biological, authenticity) x 4 (Age: 4- and 5-year-olds, 6- and 7-year-olds, 8–10-year-olds, adults) x 4 (Reality judgment: real authentic, real living, not real artificial, not real nonliving) MANOVA was conducted to explore the effects of age and condition on accuracy of property attributions for the toy. Performance was near ceiling for both biological properties (*M* = .95, 95% CI [.90, .99]) and authenticity properties (*M* = .97, 95% CI [.92, 1.02]), and there were no effects of age or reality judgment on accuracy, nor interactions between the two (Fs<1.246, *ps*>.304).

Subsequently, a 2 (Property: biological, authenticity) x 4 (Age: 4- and 5-year-olds, 6- and 7-year-olds, 8–10-year-olds, adults) x 3 (Condition: touchable, encased, toy) x 4 (Reality judgment: real authentic, real living, not real artificial, not real nonliving) MANOVA was conducted to explore the effects of age, condition, and reality judgment on accuracy of biological and authenticity property attributions for the taxidermy.

For biological property attributions, the main effect of age was significant, $F(3,193)=3.193$, $p<.005$, $\eta^2=.085$ (see Figure 3). Adults made more accurate biological property attributions (*M* = .87, 95% CI [.71, 1.03]) than 4- and 5-year-olds (*M* = .38, 95% CI [.23, .52]), *p*<.001, 6- and 7-year-olds (*M* = .52, 95% CI [.41, .63]), *p*<.002, and somewhat more than 8–10-year-olds (*M* = .61, 95% CI [.50, .73]), *p*=.073. Furthermore, 8–10-year-olds made somewhat more accurate biological property attributions than 4- and 5-year-olds, *p*=.07, but there were no other age differences, *ps*>.74. This general pattern of an increase in accuracy with age supports the hypothesis that understanding the biological nature of taxidermy continues to develop during childhood but approaches an adult understanding between 8 and 10 years of age.

The main effect of condition on biological property attributions was also significant, $F(2,193)=3.306$, $p<.04$, $\eta^2=.048$. Pairwise comparisons indicated that biological property attributions were marginally more accurate in the touchable condition (M = .67, 95% CI [.58, .76]) compared to the toy condition (M = .50, 95% CI [.37, .62]), $p<.09$, but accuracy in the encased condition was not different from the other two conditions (M = .56, 95% CI [.44, .68]), $ps>.45$. This does not support the hypothesis that accuracy would be highest in the toy condition, nor the hypothesis that accuracy would be higher in the touchable condition compared to the encased condition.

Finally, the main effect of reality judgment on biological property attributions was also significant, $F(3,193)=4.536$, $p<.005$, $\eta^2=.083$. As expected, pairwise comparisons indicated that accuracy of biological property attributions was higher following judgments of real authentic (M = .66, 95% CI [.57, .76]), real living (M = .74, 95% CI [.60, .88]), and not real nonliving (M = .58, 95% CI [.45, .70]) compared with not real artificial judgments (M = .25, 95% CI [.08, .42]), $ps<.01$. There were no other significant differences in accuracy between the other types of reality judgments, $ps>.479$.

The two way interactions and the three way interaction between the main effects were not significant, $Fs<0.901$, $ps>.560$.

For authenticity property attributions (see Figure 4) the main effect of age approached significance, $F(3,193)=2.465$, $p<.07$, $\eta^2=.047$. Pairwise comparisons did not, however, indicate any significant differences between any of the age groups, $ps>.104$. There was no main effect of condition, $F(2,193)=1.998$, $p=.139$, or reality judgment, $F(3,193)=1.482$, $p=.222$, and the two way interactions and the three way interaction between the main effects were not significant, $Fs<1.175$, $ps>.318$.

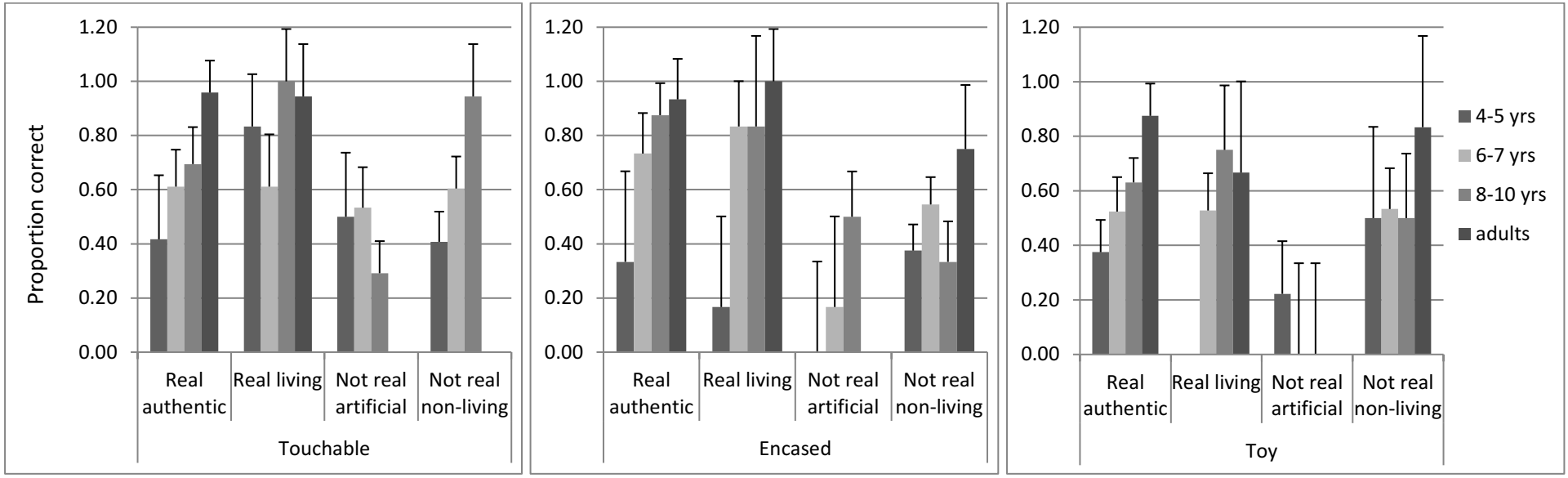

Figure 3. Proportion of accurate attributions of biological properties (maximum 1) according to age group and reality judgment in the touchable condition (left), encased condition (middle) and toy condition (right). Numbers in the toy condition refer only to the taxidermied rabbit, not the toy rabbit. yrs = years

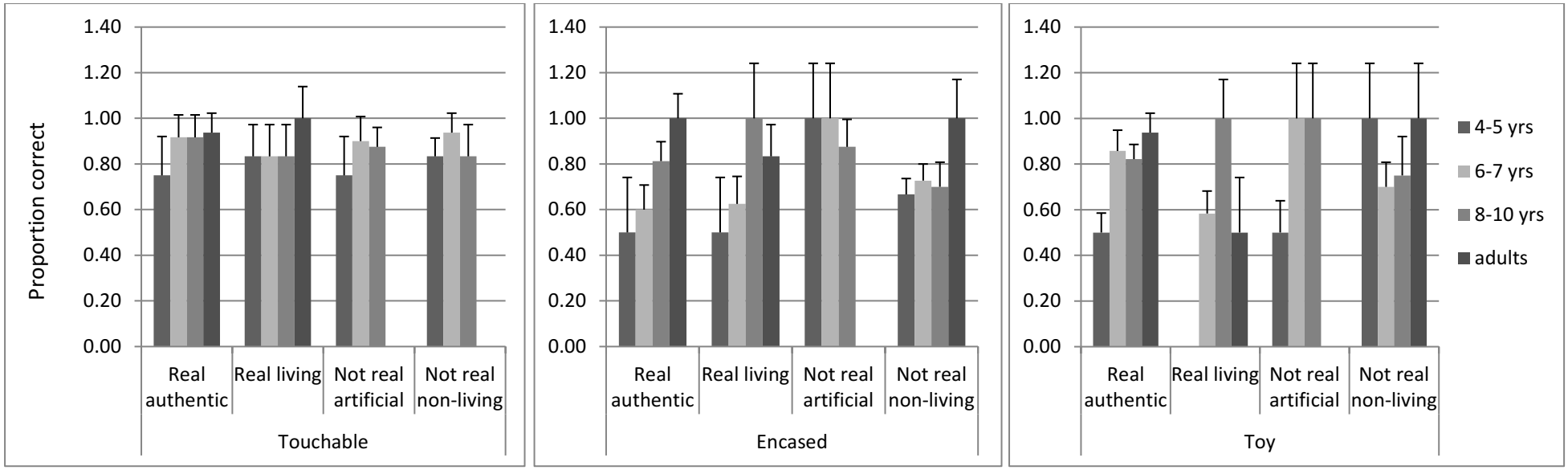

Figure 4. Proportion of accurate attributions of authenticity properties (maximum 1) according to age group and reality judgment in the touchable condition (left), encased condition (middle) and toy condition (right). Numbers in the toy condition refer only to the taxidermied rabbit, not the toy rabbit. yrs = years

Discussion

The current study investigated children's and adults' understanding of the reality status of a taxidermied rabbit in a museum of natural history to explore the development of the ability to categorise it as a real authentic piece of natural history, and to attribute properties on the basis of the living/nonliving distinction and the authentic/artificial distinction. This study revealed that the majority – approximately two thirds – of adults categorised museum taxidermy as real owing to its authentic physical features. In contrast, the number of children who made this judgment increased with age from approximately one quarter of 4- and 5-year-olds to one half of 8–10-year-olds. The most common response among 4–7-year-olds was that it is not real because it is nonliving. This supports Tunnicliffe's (1996) interpretation that children seem to refer to the 'realness' of taxidermy in terms of its nonliving status. By categorising taxidermy in this way children appeared to be relying on their naïve theory knowledge of the living/nonliving distinction (c.f. Gelman, 2003) to recognize the absence of biological properties and infer that it is not alive. With increasing age, however, children, like adults, used this knowledge to support their categorization of taxidermy as real because it has authentic properties.

Adults also accurately attributed biological and authenticity properties to taxidermy. They understood, for example, that the taxidermied rabbit used to have a heart inside, but that this was no longer the case (biological property), and that it has real fur (authenticity property). With age, children's attribution of biological properties increased in accuracy, but accuracy of authenticity properties did not increase. Their ability to attribute a range of biological properties supports and extends previous research on children's understanding of the distinction between living/nonliving kinds and artifacts (e.g., Inagaki & Hatano, 2002; Jipson & Gelman, 2007; Jaakkola & Slaughter, 2002). Notably, it goes beyond previous

research to demonstrate their ability to reason about the current and past status of a dead animal that has been preserved for display in a museum. Young children's ability to attribute authenticity properties in an adult-like manner also supports previous research showing that young children can distinguish between real and unreal objects and entities on the basis of the authentic/artificial nature of physical features (e.g., Bunce & Harris, 2013).

Another aspect of the current study was the impact of the context in which participants made their judgments. Participants responded to questions about the taxidermied rabbit either as a touchable exhibit, inside an exhibition case, or in a pair with a toy rabbit. In line with the hypothesis, all groups of children, and to some extent adults, categorised taxidermy as real because of its authentic physical features more often in the toy condition compared to the other two conditions. This was particularly the case for 4- and 5-year-olds. Bunce and Harris (2013) proposed that a toy replica of an animal helps children make reality status judgments by enabling them to actively compare real and unreal versions, and that toy replicas provide a familiar context within which to interpret the reality status question. In the current study, children's justifications suggested that the toy did highlight perceptual/sensory differences between the authentic and artificial features of the toy and taxidermy, most notably the quality of the fur. The toy condition did not appear to increase children's use of conceptual or naïve theory-based cues, because it did not increase judgments that the taxidermied rabbit is not real because it is not alive.

In terms of the effect of condition on participants' property attributions, the results did not support the hypothesis that biological and authenticity property attributions would be more accurate in the toy condition than the touchable and encased conditions. Biological property attributions were marginally less accurate in the toy condition than the touchable condition, but not different from the encased condition, whereas there was no effect of

condition on authenticity property attributions. This is surprising because it was expected that the toy condition would provide more perceptual/sensory information and conceptual information to facilitate participants' attributions of both biological and authenticity properties. It seems that the toy served a more narrow function than anticipated by only supporting participants' reality status judgments. Property attribution questions were, it seems, inherently less ambiguous and did not benefit from the context provided by the toy.

The second hypothesis with respect to condition, that reality judgments and property attributions would be higher in the touchable condition compared to the encased condition, received only minimal support. In relation to participants' reality judgments, there was evidence that adults were more likely to categorise taxidermy as real because it is authentic in the touchable condition than the encased condition, but this did not seem to be the case for children. Touch did not, therefore, seem to serve a special function in this regard. In terms of biological property attributions, accuracy was marginally higher in the touchable condition compared to the toy condition, but not different to the encased condition. This was surprising given that touch has been considered by some to help visitors interpret museum objects (c.f. Van Kraayenoord & Paris, 2002; Pye, 2008), but the current results suggest that further research is required to explore more fully the impact of touch on visitors' understanding and interpretation of taxidermy.

Bringing the findings together from participants' reality judgments and property attributions revealed that participants who judged taxidermy as real because it is authentic also attributed more biological properties accurately than participants who judged it as not real because it is not authentic. This indicates that these participants understood both that taxidermy is real and authentic, as well as not real because it is not alive, owing to the absence of biological properties. Given that the number of participants who judged

taxidermy as real and authentic was highest in the toy condition, this indicates that the toy condition was effective in producing this pattern of responses. Further research is required to confirm these patterns, but the current data suggest that the toy condition provided a useful way of helping children to consider the reality status of taxidermy in terms of its status as a real, authentic museum exhibit and as a previously living animal.

Although the findings provide new insights into the development of children's understanding of taxidermy, there are some limitations of the research. First, the sample was limited to museum visitors who were mostly white, well-educated, and had previously visited a natural history museum. In addition, participants were only questioned about one piece of animal taxidermy - a rabbit. It remains an open question as to how children would perceive more exotic or potentially dangerous animals that have been taxidermied, such as an elephant. Another issue was that a minority of participants (16%) responded that taxidermy is real because it was alive, suggesting that they potentially made a metaphorical or non-literal interpretation of the question (Jipson & Gelman, 2007). In other words, participants may have responded to the questions as if they were about rabbits in general, not about the taxidermied rabbit itself. Although the questions were phrased to try to eliminate this interpretation, future research may include a training session to make it clear that a literal interpretation is intended.

In summary, this research explored children's and adults' intuitions about museum taxidermy to examine whether they categorise it as a real – as in authentic – piece of natural history, and whether they can correctly attribute properties to it on the basis of the living/nonliving and authentic/artificial distinctions. Most adults categorised taxidermy as real because it is authentic, but there was a developmental increase in the number of children who made this judgment. In the context provided by a toy version of the taxidermy,

children, and to some extent adults, were more likely to categorise taxidermy as real because it is authentic. Judgments of authenticity were subsequently followed by more accurate attributions of biological properties compared to judgments of inauthenticity, suggesting that a mature understanding that taxidermy is real and authentic is underpinned by an understanding that it used to be alive. These are important findings because knowingly interacting with authentic museum objects is thought to be more engaging, and provide more educational impact, than interacting with models or replicas (Bunce, 2016a; Bunce 2016b; Dillon et al., 2016; Evans, Mull, & Poling, 2002; Hampp & Schwan, 2014; Kirchberg & Tröndle, 2012; Leinhardt & Crowley, 2002; Watson & Werb, 2013). Supporting children's intuitions about the real, authentic nature of museum taxidermy, perhaps by comparing them with toy animals, may provide museums with a simple way to engage their young visitors more effectively. The impact of context on museum visitors' intuitions about taxidermy warrants further investigation so that taxidermy can be used to support the development of knowledge about the natural world.

References

Atran, S., Medin, D., Lynch, E., Vapnarsky, V., Ek, E. U., & Sousa, P. (2001). Folkbiology doesn't come from folkpsychology: Evidence from Yukatek Maya in cross-cultural perspective. *Journal of Cognition and Culture*, *1*(1), 3-42. DOI: 10.1163/156853701300063561

Bunce, L. (2016a) Appreciation of authenticity promotes curiosity: Implications for object-based learning in museums. *Journal of Education in Museums, 41(3),* 230-239. http://dx.doi.org/10.1080/10598650.2016.1193312

Bunce, L. (2016b) Dead ringer? Visitors' understanding of taxidermy as authentic and educational museum exhibits. *Visitor Studies, 19(2),* 178-192. http://dx.doi.org/10.1080/10645578.2016.1220189

Bunce, L., & Harris, M. (2008). I saw the real Father Christmas! Children's everyday uses of the words real, really, and pretend. *British Journal of Developmental Psychology*, *26*, 445-455. DOI: 10.1348/026151007X258733

Bunce, L., & Harris, M. (2013). "He hasn't got the real toolkit!" Young children's reasoning about real/not-real status. *Developmental Psychology*, *49*, 1494-1504. http://dx.DOI.org/10.1037/a0030608

Carey, S. (1985). *Conceptual change in childhood.* The MIT Press, Massachusetts.

Diamond, J. (1986). The behavior of family groups in science museums. *Curator: The Museum Journal*, *29*(2), 139-154.

Dillon, J., DeWitt, J., Pegram, E., Irwin, B., Crowley, K., Haydon, R., … Xanthoudaki, M. (2016). *A Learning Research Agenda for Natural History Institutions* (technical report). London, UK: Natural History Museum.

Evans, E. M., Mull, M. S., & Poling, D. A. (2002). The authentic object? A child's-eye view.

In S. G. Paris (Ed,) *Perspectives on object-centered learning in museums*, pp 55-77. Mahwah, NJ: Lawrence Erlbaum Associates.

Flavell, J. H., Flavell, E. R. & Green, F. L. (1987). Young children's knowledge about the apparent-real and pretend-real distinctions. *Developmental Psychology, 23*, 816-822. DOI: apa.org/journals/dev/23/6/816

Frazier, B. N., & Gelman, S. A. (2009). Developmental changes in judgments of authentic objects. *Cognitive Development*, *24*(3), 284-292. DOI: 10.1016/j.cogdev.2009.06.003

Ganea, P. A., Canfield, C. F., Simons-Ghafari, K., & Chou, T. (2014). Do cavies talk? The effect of anthropomorphic picture books on children's knowledge about animals. *Frontiers in Psychology*, *5*(283), 1-9. DOI: 10.3389/fpsyg.2014.00283

Geerdts, M. S., Van de Walle, G. A., & LoBue, V. (2015). Daily animal exposure and children's biological concepts. *Journal of Experimental Child Psychology*, *130*, 132-146. DOI: 10.1016/j.jecp.2014.10.001

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought*. Oxford University Press, Oxford.

Gottfried G. M. & Gelman S. A. (2005) Developing domain-specific causal-explanatory frameworks: The role of insides and immanence, *Cognitive Development,* 205, 137–158.

Greif, M. L., Kemler Nelson, D. G., Keil, F. C., & Gutierrez, F. (2006). What do children want to know about animals and artifacts? Domain-specific requests for information. *Psychological Science*, *17*(6), 455-459.

Guild of Taxidermists (2015). Retrieved from http://www.taxidermy.org.uk/index.php/about-taxidermy

Gutheil, G., Bloom, P., Valderrama, N., & Freedman, R. (2004). The role of historical

intuitions in children's and adults' naming of artifacts. *Cognition*, *91*(1), 23-42.

Gutheil, G., Vera, A., & Keil, F. C. (1998). Do houseflies think? Patterns of induction and biological beliefs in development. *Cognition*, *66*(1), 33-49. https://doi.org/10.1016/S0010-0277(97)00049-8

Hampp, C., & Schwan, S. (2014). The role of authentic objects in museums of the history of science and technology: Findings from a visitor study. *International Journal of Science Education, Part B*, *5*(2), 161-181. DOI:10.1080/21548455.2013.875238

Harris, P. L., Kavanaugh, R. D., & Meredith, M. C. (1994). Young children's comprehension of pretend episodes: The integration of successive actions. *Child Development*, *65*(1), 16-30. DOI: 10.1111/j.1467-8624.1994.tb00731.x

Hood, B. M. & Bloom, P. (2008). Children prefer certain individuals over perfect duplicates. *Cognition, 106*, 455-462. DOI: 10.1016/j.cognition.2007.01.012

Inagaki, K. (1990). The effects of raising animals on children's biological knowledge. *British Journal of Developmental Psychology*, *8*(2), 119-129. DOI: 10.1111/j.2044-835X.1990.tb00827.x

Inagaki, K. & Hatano, G. (1996). Young children's recognition of commonalities between animals and plants. *Child Development*, *67*(6), 2823-2840. DOI: 10.1111/j.1467-8624.1996.tb01890.x

Inagaki, K. & Hatano, G. (2002). *Young children's naive thinking about the biological world*. Psychology Press, New York.

Jaakkola, R. O. & Slaughter, V. (2002). Children's body knowledge: Understanding 'life' as a biological goal. *British Journal of Developmental Psychology*, *20*(3), 325-342. DOI: 10.1348/026151002320620352

Jipson, J. L. & Gelman, S. A. (2007). Robots and rodents: Children's inferences about

living and nonliving kinds. *Child Development*, *78*(6), 1675-1688. DOI: 10.1111/j.1467-8624.2007.01095.x

Kahneman, D. (2003). A perspective on judgment and choice: mapping bounded rationality. *American Psychologist*, *58*(9), 697-720.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development*. The MIT Press, Massachusetts.

Kirchberg, V., & Tröndle, M. (2012). Experiencing exhibitions: A review of studies on visitor experiences in museums. *Curator: The Museum Journal*, *55*(4), 435-452. DOI: 10.1111/j.2151-6952.2012.00167.x

Kirk, E. (2012, July 22). Welcome to the gallery of the real [Blog post]. Retrieved from http://museoscope.com/welcome-to-the-gallery-of-the-real/

Leinhardt, G. & Crowley, K. (2002). Objects of learning, objects of talk: Changing minds in museums. In S. G. Paris (Ed.) *Perspectives on children's object-centered learning in museums*, pp 301-324. Mahwah, NJ: Lawrence Erlbaum Associates.

Margett, T. E. & Witherington, D. C. (2011). The nature of preschoolers' concept of living and artificial objects. *Child Development, 82*(6), 2067-2082.

Paris, S. G. (Ed.). (2002). *Perspectives on object-centered learning in museums*. Mahwah, N.J: Lawrence Erlbaum Associates.

Pye, E. (Ed). (2008). *The power of touch: Handling objects in museum and heritage contexts.* Walnut Creek, US: Left Coast Press.

Rhodes, M. & Gelman, S. A. (2009). A developmental examination of the conceptual structure of animal, artifact, and human social categories across two cultural contexts. *Cognitive psychology, 59*(3), 244-274.

Rosengren, K. S., Gutiérrez, I. T., & Schein, S. S. (2014). IV. Cognitive dimensions of death in

context. *Monographs of the Society for Research in Child Development*, *79*(1), 62-82.

Ross, N., Medin, D., Coley, J. D., & Atran, S. (2003). Cultural and experiential differences in the development of folk biological induction. *Cognitive Development*, *18*(1), 25-47. DOI: 10.1016/S0885-2014(02)00142-9

Sanders, D. & Hohenstein, J. (2015). "Death on display:" Reflections on taxidermy and children's understanding of life and death. *Curator: The Museum Journal*, *58*(3), 251-262. DOI: 10.1111/cura.12112

Scaife, M. & Van Duuren, M. A. (1995). Do computers have brains? What children believe about intelligent artifacts. *British Journal of Developmental Psychology,13,* 367–377. DOI: 10.1111/j.2044-835X.1995.tb00686.x

Sharon T. & Woolley J.D., (2004). Do monsters dream? Young children's understanding of the fantasy/reality distinction, *British Journal of Developmental Psychology,* 22, 293–310.

Sloutsky, V. M. & Fisher, A. V. (2004). Induction and categorization in young children: a similarity-based model. *Journal of Experimental Psychology: General*, *133*(2), 166-188. http://dx.doi.org/10.1037/0096-3445.133.2.166.

Tullos, A. & Woolley, J. D. (2009). The development of children's ability to use evidence to infer reality status. *Child Development*, *80*(1), 101-114. DOI: 10.1111/j.1467-8624.2008.01248.x

Tunnicliffe, S. D. (1996). Conversations within primary school parties visiting animal specimens in a museum and zoo. *Journal of Biological Education, 30*(2), 130-141. DOI: 10.1080/00219266.1996.9655491

Tversky, A. & Kahneman, D. (1986). Rational choice and the framing of decisions. *Journal of Business, 59,* 251-278.

Van Kraayenoord, C. E. & Paris, S. G. (2002). Reading objects. In S. G. Paris (Ed.) *Perspectives on object-centered learning in museums* (pp. 215-234). Mahwah, N.J: Lawrence Erlbaum Associates.

Watson, B. & Werb, S. R. (2013). One hundred strong: A colloquium on transforming authentic history museums in the twenty-first century. *Curator: The Museum Journal*, *56*(2), 255-265. DOI: 10.1111/cura.12023

Waxman, S. R. & Gelman, S. A. (2009). Early word-learning entails reference, not merely associations. *Trends in cognitive sciences*, *13*(6), 258-263. https://doi.org/10.1016/j.tics.2009.03.006

Woolley, J. D. & Van Reet, J. (2006). Effects of context on judgments concerning the reality status of novel entities. *Child Development*, *77*(6), 1778-1793. DOI: 10.1111/j.1467-8624.2006.00973.x

Woolley, J. D. & Wellman, H. M. (1990). Young children's understanding of realities, nonrealities, and appearances. *Child Development, 61,* 946-961. DOI: 10.1111/j.1467-8624.1990.tb02833.x