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How should we question young children's understanding of aspectuality?

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In two experiments, we investigated whether 4- to 5-year-old children's ability to demonstrate their understanding of aspectuality was influenced by how the test question was phrased. In Experiment 1, 60 children chose whether to look or feel to gain information about a hidden object (identifiable by sight or touch). Test questions referred either to the perceptual aspect of the hidden object (e.g., whether it was red or blue), the modality dimension (e.g., what colour it was), or the object's identity (e.g., which one it was). Children who heard the identity question performed worse than those who heard the aspect or dimension question. Further investigation in Experiment 2 ($N = 23$) established that children's difficulty with the identity question was not due to a problem recalling the objects. We discuss how the results of these methodological investigations impact on researchers' assessment of the development of aspectuality understanding.

Knowing how to gain new information is easy for adults. For example, if you ask me to find out *what colour* car is parked outside my house, an effective strategy would be for me to take a look. I understand that other perceptual actions (e.g., feeling or tasting) are inappropriate and will not give me the information I require. This understanding of the link between perceptual access and consequent knowledge is robust enough in adults to withstand variations in communication. For example, if you had asked me to find out *which* car was parked outside my house or *if* it was *black*, I would still have chosen to look. The change in the phrasing of the question would not have affected my understanding of what I should do. However, some evidence suggests that young children's performance may be susceptible to these different types of questions. In the research reported here, we aimed to clarify whether young children find these questions differentially difficult and what impact this has on their comprehension of the link between perception and knowledge.

Young children's ability to understand the link between perceptual access and consequent information is a crucial component in the development of theory of mind (Naito, 2003; Perner, Kloo, & Stottinger, 2007; Perner & Ruffman, 1995). A theory of mind permits one to attribute mental states to oneself and others (Premack & Woodruff, 1978;

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Wimmer & Perner, 1983). Attributing knowledge to an individual requires consideration of the perceptual access they have had. For example, to judge someone's knowledge of the colour of an object, you must assess what type of perceptual access they have had and consider whether it is sufficient (i.e., have they seen it or have they been told its colour or are they guessing).

Children's understanding of the link between perception and knowledge undergoes important developments between 3 and 6 years of age. At around 3 to 4 years of age, children are aware that some sort of perceptual action is necessary to gain knowledge about an object but are not able to determine which action leads to which type of knowledge (e.g., Pillow, 1989; Pratt & Bryant, 1990; Wimmer, Hogrefe, & Perner, 1988). From 4 years of age, children are able to identify what type of perceptual access provided particular knowledge, for example, that looking enabled the discovery of a hidden object's colour (e.g., Gopnik & Graf, 1988; O'Neill & Gopnik, 1991). However, it is not until around 5 years of age that children are able to predict what type of perceptual access will lead to particular knowledge (e.g., O'Neill, Astington, & Flavell, 1992). It is this ability to predict how specific knowledge can be gained by particular perceptual access that has been described as understanding the modality-specific aspects of knowledge (e.g., O'Neill *et al.*, 1992) or aspectuality understanding (e.g., Naito, 2003; Perner, 1991).

Aspectuality understanding requires an awareness that an object is made up of many different properties (e.g., colour, weight, odour), each of which can be determined by a specific perceptual action (e.g., looking, feeling, smelling. See O'Neill *et al.*, 1992). Young children's comprehension of the knowledge that can be gained from all five senses has been previously investigated. In one comprehensive study, 4-year-olds had no difficulty distinguishing between information they had learned though looking, touching, hearing, smelling, or tasting (O'Neill & Chong, 2001). However, young children may show biases when judging the information to be gained, although the evidence is not consistent. Sometimes they preferred gaining information through looking rather than feeling (e.g., Robinson, Thomas, Parton, & Nye, 1997). Other research has suggested that 4-year-olds either believed that knowledge would most likely be gained through looking and touching rather than listening or they showed no preference for any sensory modality at all (Pillow, 1993). As no consistent biases in favour of specific sensory modalities appear to exist, the two actions of looking and feeling tend to be the focus of aspectuality tasks (e.g., O'Neill *et al.*, 1992; Perner & Ruffman, 1995; Waters & Beck, 2009). The justification is as follows: it is not necessary to test this understanding across all perceptual modalities; sight and touch are an efficient way of demonstrating an understanding of the link between knowledge and evidence; they are the easiest perceptual actions to test in young children due to task demands.

The procedure of an aspectuality task tends to be as follows: children are allowed to see and touch two objects that feel the same but look different or look the same but feel different. One of the pair of objects is then hidden, and children are asked whether they need to look or feel to determine its identity (e.g., O'Neill *et al.*, 1992). If children choose the correct perceptual action (looking or feeling) to find out which object has been hidden (e.g., of a particular colour or tactile quality), then they are said to have an understanding of aspectuality (Perner, 1991).

Young children's understanding of aspectuality has been fairly widely studied (e.g., O'Neill *et al.*, 1992; Pillow, 1993; Robinson & Whitcombe, 2003; Waters & Beck, 2009), yet the tasks reported to date are remarkably inconsistent in the test questions they have used. Three different types of question have featured. First, children have been asked to find out 'which' object has been hidden (e.g., O'Neill *et al.*, 1992; Perner & Ruffman,

1995). Second, children have been asked to find out, for example, 'what colour' object has been hidden (e.g., O'Neill *et al.*, 1992; Pillow, 1993). Third, children have been asked to find out whether the hidden object is, for example, 'the red one' (O'Neill *et al.*, 1992; Perner, Kloo, & Gornik, 2007; Perner & Ruffman, 1995; Pillow, 1993; Waters & Beck, 2009). We call these, respectively, the identity, dimension, and aspect questions. In some cases, more than one of these references has been used in the same question. For example, Robinson and Whitcombe (2003) referred to both the identity and aspect of the target in their test question. They hid one of a pair of toy ladybugs (that felt the same but were different colours) in a tunnel and asked children, 'Which bug is in the tunnel – is it the red one or the blue one?' followed soon after by, 'Which one is it?'

The inconsistency between question phrasings in aspectuality tasks is an important consideration as children appear to find some object references harder to deal with than others. The possible causes of these inconsistencies have been mentioned several times in the aspectuality literature, but appear to conflict and have never (to our knowledge) been empirically tested. For example, 4-year-olds were less successful in an aspectuality experiment that used an identity question (25% of trials correct) compared to one that used an aspect question (58% of trials correct) (Perner & Ruffman, 1995). Yet, 4-year-olds performed only slightly worse in an experiment where they were asked an aspect question (67% of trials correct) compared to one that used a dimension question (71% of trials correct) despite expectations that children would find the dimension question harder because it referred to an abstract concept (e.g., colour; Pillow, 1993). In addition, some researchers treat the dimension question and the identity question as functionally equivalent because neither mentions the specific aspects of the objects (O'Neill *et al.*, 1992).

Of particular concern is the relationship between the identity question and young children's memory abilities. The identity question does not mention the specific quality or modality of the hidden object and so requires children to recall the pair of objects they saw and felt earlier in the trial (Perner & Ruffman, 1995). Young children have poor memories for episodic events (Tulving, 1985). If they cannot recall the objects (and how the objects differ), then they may fail to choose the correct perceptual access to determine which one has been hidden. Young children's success rates on the aspectuality task correlate with their performance on free-recall tasks (where they have to remember previously seen items, which is thought to tap episodic memory) suggesting a link between the development of these two abilities (Naito, 2003; Perner, Kloo, & Gornik, 2007; Perner & Ruffman, 1995). Previous research has attempted to remove the memory portion of the aspectuality task, but the result of this was that a different question phrasing was used (Perner & Ruffman, 1995). The questions remain, how does performance on the identity question compare with that on other question phrasings, and to what extent is any difference the result of memory demands.

Using different question phrasings could be a particularly important methodological issue where the research involves young children. The appreciation of how an object can be referred to in two different, but appropriate, ways develops between 4 and 5 years of age (e.g., Doherty & Perner, 1998; Perner, Rendl, & Garnham, 2007). However, the way that objects are referred to seems to influence children's understanding (for a review of this literature see Siegal & Surian, 2004). For example, 6-year-olds do not always appreciate that an adult might refer to an object in several different ways, depending on how they want to emphasize its importance; indeed this misunderstanding may cause children to (incorrectly) change their initial response to a question (Donaldson,

1978; Siegal, 1997). If this is the case, then the existing aspectuality research that has referred to targets in different ways between tasks (e.g., O'Neill *et al.*, 1992; Perner & Ruffman, 1995) or several ways within tasks (e.g., Robinson & Whitcombe, 2003) may have underestimated the genuine level of young children's understanding.

The aim of the current research was to gain insight into young children's performance on hearing the three different question phrasings used in aspectuality tasks. In Experiment 1, we wanted to establish whether the type of question had an effect on young children's performance. One possibility was that in a direct comparison children would perform equally well on hearing each phrasing. This would indicate that previous claims that they differed were unfounded and that the phrasing of the question could be ruled out as a potential influence on children's performance. On the other hand, if children found some question phrasings more difficult to respond to than others, this would highlight two important issues. First, what understanding are correct answers to these question phrasings revealing. It might be that there are different levels of aspectuality understanding, being differentially tapped by the various question phrasings, or it might be that some phrasings do not in fact test aspectuality understanding at all. Second, whether the performances reported in the wider literature may have been affected by the type of object reference that was used, rather than representing their understanding of aspectuality.

We also wanted to clarify whether young children's recall ability influenced their understanding of the identity question (Experiment 2). If children demonstrated better performance with this question when recall requirements were removed, this would support suggestions that aspectuality understanding was dependent on episodic memory (Naito, 2003; Perner & Ruffman, 1995). Alternatively, if children performed no differently whether recall was required or not, or performed worse when memory was not required, this would suggest that their aspectuality understanding was not associated with memory ability.

EXPERIMENT 1

Method

Participants

Sixty children (30 girls) were tested, from three schools serving predominately working-class populations in Leeds, UK. Their ages ranged from 4 years and 2 months to 5 years and 1 month (mean 4 years and 8 months), and they were all reported by their teachers as possessing a good understanding of English. Ethnicity was distributed as follows: White (37), Black (10), Asian (10), and other (3).

Materials

Five balls, approximately 7 cm in diameter, were used as the target objects. One ball was green (this was used for the familiarization task), two were red, and two were blue (these four were used for the experimental trials). The green ball was filled with polystyrene beads and felt 'lumpy' when squeezed. One of each of the red and blue balls were filled with cotton wool and felt soft when squeezed. The other red and blue balls were filled with solid plaster and felt hard when squeezed. The fillings fitted inside thin foam layers within outer fabric covers, so that balls that were the same colour but had different

fillings were indistinguishable by sight. The balls were kept in an opaque bag when not in use.

A grey tunnel measuring, approximately 30 × 10 × 10 cm^3, was used to hide the target ball. The tunnel had 5 cm diameter holes cut in its (10 × 10 cm^2) ends that allowed visual and tactile access inside. One of the holes was covered inside with clear plastic, forming a window that could be looked through to see inside, but tactile access was prevented. The hole on the other end was covered inside by a piece of black felt with a cross cut into it, so that a hand could pass through and feel what was inside, but visual access was prevented. Two square pieces of black felt, measuring 10 × 10 cm^2, were attached at the top of the outside of the holes. In this way, the window and feeling-hole were covered with flaps of felt that had to be lifted up in order for someone to look in or put a hand in. The tunnel also had a door on the back panel that could be opened by the experimenter, through which the balls were inserted and removed. An opaque cloth was used to cover the back door of the tunnel and hide from view the balls that were transferred to and from the tunnel and the opaque bag.

Design

An aspectuality task was used, where for each experimental trial children were presented with a pair of balls that looked the same but felt different or vice versa. The pairs of balls were as follows: one red and one blue (both soft); one red and one blue (both hard); one soft and one hard (both red); one soft and one hard (both blue). One ball from each pair was hidden in the tunnel and children had to choose whether to look or feel to answer their test question. Therefore, if the two balls in that trial had differed by colour, the correct choice would be to look, whereas if the two balls had differed by tactile quality the correct choice would be to feel.

We used a three (question type: aspect vs. dimension vs. identity) × two (modality: looking vs. feeling) mixed design with repeated measures on the second factor. Four orders of trial presentations were used to ensure that the first two trials did not require the same modality, which might have encouraged perseveration: (1) Look, Feel, Look, Feel (LFLF), (2) FLFL, (3) LFFL, (4) FLLF. Additionally, the question order was alternated so that half the children were asked if they wanted to look or feel and the other half if they wanted to feel or look.

Children were allocated in turn to one of three test question conditions. The three test question conditions were aspect, dimension, or identity. Children given the aspect question were asked about the target ball with the relevant modality aspect mentioned (e.g., 'find out if the one in the tunnel is the red one or the blue one'). Those given the dimension question were asked about the target ball with the relevant modality dimension mentioned (e.g., 'find out what colour the one in the tunnel is'). Those given the identity question were asked about the identity of the target ball (e.g., 'find out which one is in the tunnel'). For the tactile targets, the identity question used the same description ('which one') and the aspect question used the terms 'hard or soft'. However, as acknowledged by O'Neill *et al.*, (1992), a true dimension question was difficult to generate for the tactile targets. It was not feasible to say 'what the one in the tunnel feels like' because that would direct children to the correct action of feeling. It was also not possible to identify a child-appropriate label to describe the softness of the object that was equivalent to describing its colour. Therefore, in order to best replicate the existing research, the phrase used by O'Neill *et al.* (1992) in their studies

was adopted. The dimension question for feeling trials, therefore, included the phrase 'what the one in the tunnel is stuffed with'.

Procedure

Familiarization task

Children were tested individually while sitting at a table opposite the experimenter. Children were told that they were going to play a game about looking and feeling. The tunnel and bag were placed on the table. The experimenter took the green ball from the bag and placed it inside the tunnel through the back door (under the cloth so that the children could not see). The experimenter then pointed to the appropriate end of the tunnel and explained that there was a window that would let them see the ball inside. To check their understanding, the children were asked to look inside and say the colour of the ball. They were then informed that the ball was being removed from the tunnel and another one inserted (to convey that no ball was left in the tunnel between trials), although under the cloth, the same ball was actually reinserted. The experimenter then pointed to the other end of the tunnel and repeated the procedure with the tactile access point. As a check of their understanding of the difference between the two modes of access, the children were then asked which side of the tunnel they would go to if they wanted to look and which side if they wanted to feel.

Main trials

At the beginning of each trial, children were presented with the two balls that were going to be used in that trial and asked to look at them and feel them. The experimenter pointed out to the children how the balls were similar and how they differed, using references to their modality aspects and dimensions. This was to ensure that cildren were equally familiar with how the objects could be referred to by their aspect, dimension, and identity. This was done while the experimenter described the perceptual attributes of each ball in turn, mentioning the differentiating modality first. For example, for a feeling trial the experimenter said, 'this one is soft because it's stuffed with cotton wool, and it's red' and 'this one is hard because it's stuffed with a stone, and it's red' followed by 'These two balls are both the same colour. They are both red so they look the same. But they feel different don't they?' Or for a looking trial, 'this one is red and it's stuffed with cotton wool and this one is blue and it's stuffed with cotton wool. These two balls are both stuffed with cotton wool. They're both soft so they feel the same. But they look different don't they?' The tactile dimension description ('stuffed with . . . ') was longer than the description used for the visual dimension and took a different format. Any particular difficulty with this label would become apparent when we compared performance on looking and feeling trials.

As a check that they understood the differences between the two balls, the children were then asked to pass each one to the experimenter in turn (the understanding check). For example, for a pair of balls that differed in the visual dimension, they were asked to 'give me the one that is the colour red' and 'give me the one that is the colour blue'. The children were told that one of the balls would be hidden in the tunnel and the other one would be put back in the bag. This process took place underneath the cloth so that the children could not see where each ball was placed. They were then asked to identify the ball inside the tunnel, using their allocated target question (i.e., 'Find out if the one in the tunnel is the red one or the blue one/soft one or the hard one' or 'Find

Table 1. Performance on feeling and looking trials for each question type in Experiment 1

			Feel trials		
			0	1	2
Identity	Look trials	0	1	5	1
		1	3	2	2
		2	5	0	1
Aspect	Look trials	0	0	1	0
		1	0	4	3
		2	1	3	8
Dimension	Look trials	0	0	1	0
		1	2	6	1
		2	2	4	4

out what colour the one in the tunnel is/what the one in the tunnel is stuffed with' or 'Find out which one is in the tunnel') and question order (e.g., 'Do you want to feel or look?' or 'Do you want to look or feel?'). The children's responses were noted (whether they chose the correct access or not), and they carried out their chosen action. They were not permitted to carry out the second, alternative action. The ball was retrieved from the tunnel and passed to the children, but the experimenter offered no correction or feedback. After the ball was returned to the experimenter, the next trial was started. Children were rewarded at the end of their trials with a sticker.

Results

Coding

All children passed the familiarization check (which demonstrated their ability to use the tunnel appropriately), so they all took part in the main experiment. All children passed the understanding check for each trial (which demonstrated their awareness of how each object had been labelled). Children were given a score of 1 for each correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 1).

Analyses

We carried out a three (test question: aspect vs. dimension vs. identity) $\times$ two (modality: looking vs. feeling) mixed design analysis of variance (ANOVA) with repeated measures on the second factor. A main effect of test question was found, $F(2, 57) = 10.07$, $p < .001$, $\eta^2_p = .26$. A Tukey HSD *post hoc* test showed that performance with the aspect question ($M = 3.05$, $SD = .95$) was higher than with the identity question ($M = 1.70$, $SD = .92$), $p < .001$, $r = .59$. Performance with the dimension question ($M = 2.50$, $SD = 1.00$) was also higher than with the identity question ($M = 1.70$, $SD = .92$), $p = .028$, $r = .27$. There was no effect of modality, $F(1, 57) = 2.82$, $p = .100$, $\eta^2_p = .05$, and no interactions were found. Children found the aspect and dimension questions easier than the identity question.

We also compared children's performance to the level predicted by chance. As no difference had been found between looking and feeling trials (i.e., there was no preference for visual or tactile access), the data were collapsed across modality for this analysis. This meant that chance performance would be equivalent to two out of four trials correct. One sample t tests revealed that performance was better than the level

predicted by chance for the aspect question, ($M = 3.05$, $SD = .95$), $t(19) = 4.97$, $p < .001$, $r = .75$, and the dimension question,($M = 2.50$, $SD = 1.00$), $t(19) = 2.24$, $p = .038$, $r = .46$. However, performance on the identity question was no different from chance ($M = 1.70$, $SD = .92$), $t(19) = -1.45$, $p = .163$, $r = .32$.

Discussion

Children who were asked to discover the specific quality of the hidden object (e.g., whether it was red or blue) found the task easier than those who were asked 'which one' it was. This result supports some suggestions made in the aspectuality literature (e.g., Perner & Ruffman, 1995) and is not entirely surprising as young children appear to find it easiest to deal with the most explicit descriptions of objects in other situations too. For example, young children seem to focus on the most obvious and salient features of objects when they are attempting to categorize them (Smith, Jones, & Landau, 1992), and even 2-year-olds are able to match objects by their most obvious attribute (Soja, 1994).

Children who were asked to discover the dimension of the hidden object (e.g., its colour or what it was stuffed with) also found the task easier than those who were asked 'which one' it was. This, again, is not completely unexpected as in the dimension question children did have a 'clue' to direct them towards the correct perceptual access.

There was no clear prediction about whether children would find the task easier when the aspect rather than the dimension of the hidden object was mentioned. The abstract concept of dimension could be harder to understand than the more concrete aspect (though the opposite has been reported, see Pillow, 1993). However, we found no difference between these two questions. In addition, we noted above the difficulty we (and other researchers) had in finding an appropriate tactile dimension description that was equivalent to colour. We suggested that due to the more complex tactile dimension question children might have more difficulty with this particular phrasing, yet we found no modality effect or interaction between modality and question type. We conclude that children did not find the dimension questions problematic and the somewhat unconventional nature of the tactile dimension question did not affect their performance.

Our most important finding concerned the performance of children who were asked 'which one' was hidden. These children had difficulty choosing whether to look or feel, performing no better than if they were guessing. The identity question did not include any information about the target, and this offers one explanation for our results. For example, children who are given the specific property of the target (e.g., red or blue) or its modality (e.g., colour) simply have to determine whether to look or feel based on what they have been told. However, children who are asked to find out 'which one' has been hidden have to recall how the objects differed. There is evidence to suggest that children can have problems recalling their initial perceptual contact with the objects when they take part in aspectuality tasks because their episodic memory is poor (Perner & Ruffman, 1995). The next experiment sought to clarify whether memory was an influence here.

EXPERIMENT 2

Our aim here was to discover if young children's difficulty correctly answering a 'which one' question was due to problems recalling how the objects differed. This was done

in two ways. First, we removed the aspectuality part of the task so that this cognitively taxing process did not interfere with our primary investigation. We presented pairs of objects in the same way as in Experiment 1; however, the target object was no longer hidden in the tunnel. Instead both the objects were covered with an opaque cloth. Children were not required to choose the correct perceptual access to identify the target object (the aspectuality test) but simply asked to state 'which one of the pair of objects was revealed when the cloth was pulled away. Second, we removed all reliance on memory of the objects on some trials. In this way, we could compare children's performance when only the target was revealed under the cloth (so they had to recall how it differed from the other object) with trials when both the target and the other object were revealed (therefore, recall was not necessary). If children performed poorly when only one object was revealed but well when both objects were on display, then this would demonstrate that the limiting factor on their ability to answer a 'which one' question is their recall of how the objects differed. If, however, performance was the same when one or both objects were revealed, it would suggest that their problem dealing with this type of question may be due to a different cognitive process.

Method

Participants

Twenty-three children (11 girls) were tested, from a school serving a predominately working-class population in Leeds, UK. Their ages ranged from 4 years and 9 months to 5 years and 7 months (mean 5 years and 1 month), and they were all reported by their teachers as possessing a good understanding of English. Ethnicity was distributed as follows: White (10), Black (5), Asian (6), and other (2).

Materials

The four balls from the main trials and the opaque cloth from Experiment 1 were used.

Design

We used a two (modality: looking vs. feeling) $\times$ two (identity: two objects vs. one object) repeated measures design. Children received eight trials: two looking trials and two feeling trials for each identity trial type. Children were allocated in turn to one of the following four trial orders: LFFLFLLF, LFLFLLFF, FLLFLFFL, and FLFLFFLL. Half the children received their one-object trials followed by their two-objects trials, while the other half had them in the reverse order.

Procedure

As in Experiment 1 pairs of balls that differed in colour but not feel (or vice versa) were used for each trial. Children were given (allowed to look and feel) and told about the pairs of balls prior to each trial and demonstrated their awareness of the differences between the balls with the understanding check (as in Experiment 1). Both balls were then hidden under the cloth and moved around so that the children were unaware of their precise location. In the one-object task, only one ball was revealed in front of the children while the other remained hidden under the cloth. In the two-objects task, both

Table 2. Performance on looking and feeling trials for each trial type in Experiment 2

			Feel trials		
			0	1	2
One-object	Look trials	0	0	0	3
		1	0	1	6
		2	2	1	10
Two-objects	Look trials	0	0	0	2
		1	1	0	2
		2	1	3	14

balls were revealed (one in front of the children and one in front of the experimenter). For both types of trial, the experimenter pointed to the ball that had been revealed in front of the children and asked them 'which one is it?' Children were allowed to pick up and feel the ball that was being referred to (the one in front of them). Their responses were noted as correct if they specified the differentiating quality (e.g., if the balls were red and blue and both were soft, they answered 'the red one' when it was indicated as the target), incorrect if they specified the similar quality (they answered 'the soft one'), and redundant if they mentioned both qualities (they answered 'the red soft one').

Results

Coding

All children passed the understanding check for each trial (which demonstrated their awareness of how each object had been labelled). Children were given a score of 1 for each correct response and 0 for every incorrect or redundant response (see Table 2).

Analyses

We carried out a two (modality: looking vs. feeling) $\times$ two (identity task type: one object vs. two objects) repeated-measures ANOVA. No effects were found (highest $F = 2.01$, lowest $p = .17$). Scores (out of four) on one-object and two-objects trials were correlated, $r = .64$, $p = .001$. These results suggest that children found it no easier to choose the correct modality to identify the ball when both objects were on view than when only one was on view and that an individual child's performances on the two versions of the task were related.

We examined what children said when they erred on this task. There were 19 one-object trials and 14 two-objects trials on which children made errors. These responses most often were to give to the alternative modality (e.g., the colour on a feel trial or the feel on a colour trial), rather than to give both modalities (a redundant but not necessarily incorrect response). Children gave the alternative modality on 17 (89%) of incorrect one-object trials and 12 (86%) of incorrect two-objects trials.

Discussion

When children incorrectly answered the 'which one' question, their response was not affected by whether one ball or both of the balls were revealed. These findings clearly

demonstrate that children do not fail this question because they cannot recall the objects and how they differed.

We would have expected children to have more difficulty identifying the tactile differences in feeling trials as they would need to pick up the ball in front of them to determine which one it was (whereas visual differences were obvious when the cloth was removed). Nevertheless, we found no difference between performance on the looking and feeling trials, which suggests no bias towards colour and the difference being immediately apparent. Even in the looking trials, when the removal of the cloth immediately revealed balls of two different colours, children still made some mistakes in identifying which one was in front of them.

The most common mistake children made was to state the non-differentiating quality (whether colour or feel) rather than name both of the target's perceptual qualities. For that reason, we suggest that children have difficulty answering an identity question because they do not realize which information is appropriate to demonstrate understanding of that object's uniqueness.

GENERAL DISCUSSION

The two experiments reported here clarified whether different test questions influenced young children's performance on aspectuality tasks. Children had particular problems choosing whether to look or feel when they were asked to find out 'which one' of two objects had been hidden (Experiment 1). Children found the question much easier to deal with in Experiment 2, when the aspectuality part of the task was removed. The results suggested potential ceiling effects (correct responses on 83% of one-object trials and 87% of two-objects trials). However, as this was a straightforward identification task, it is surprising that children made any errors at all, especially on the two-objects trials when neither of the objects was hidden. As the cognitively taxing aspectuality task had been removed as well as any memory requirement, we would have expected children to have no difficulty with the two-objects trials.

Why might children find the identity question difficult? As mentioned previously, if there is no clue in the question directing them towards the correct perceptual action, children have to remember how the objects differed in order to succeed at the task. However, Experiment 2 suggested that children's difficulty with identity questions persisted when memory demands were removed. Children had to identify 'which one' of two balls was in front of them, when both balls could be seen. Perhaps surprisingly (for such an apparently simple task), children made mistakes and did not always refer to the uniquely identifying feature. We conclude that problems with the identity question in aspectuality tasks are not simply the result of episodic memory failure. We suggest that the problem children had answering the identity question was not with recalling how the objects differed but with demonstrating their understanding of how those objects can be uniquely identified.

One explanation for young children's difficulty dealing with the identity question is that they had problems representing the target object in more than one way (e.g., considering its colour and its feel at the same time). Young children's lack of cognitive flexibility makes it hard for them to deal with multiple representations (e.g., Flavell, Green, & Flavell, 1986). For example, children below 4 years of age have difficulty selectively attending to specific information and can struggle to shift their attention between tasks or rules (e.g., Deak, 2000; Espy, 1997; Smidts, Jacob, & Anderson, 2010). While 4-year-olds can select the appropriate information to fit an initial criteria, they

have difficulty dealing with a second criteria (Jaques & Zelazo, 2001) and find it hard to consider two criteria simultaneously (Frye, Zelazo, & Palfai, 1995). Children who failed our identity question may have had trouble reflecting concurrently on the two perceptual qualities of the target object.

A second potential explanation for children's difficulty with the identity question is that target object had two possible names (e.g., 'the red one' or 'the soft one'). The mutual exclusivity bias suggests that pre-schoolers have problems dealing with more than one label or name for an object (e.g., Markman, 1992; Markman & Wachtel, 1988; Merriman & Bowman, 1989). In addition, young children's knowledge of multiple labels may be independent of their ability to produce them (Deak, Yen, & Pettit, 2001). The children in our study demonstrated their knowledge of object's labels (by handing them over when requested) but still may have had problems considering each object's multiple labels later in the task. Nevertheless, 3- and 4-year-olds do seem to be able to apply and maintain multiple labels for objects (Deak & Maratsos, 1998; Deak *et al.*, 2001; Waxman & Hatch, 1992).

A third possible explanation for our findings concerns children's communication abilities. In Experiment 2, children who performed poorly most often gave an inappropriate description of the ball (i.e., it was a true description but not one that would not allow identification given the other ball). On a small number of occasions, children gave a redundant description that included the appropriate identification but also incorporated the unnecessary description. However, as all children did generate a response that referred to a correct description of the object (whether it was sufficient to identify it or not) this suggests that they understood a crucial factor: that the identity question requires one to pick out some information about the target. Yet, children had difficulty communicating the unique identity of the object effectively in Experiment 2 and choosing which type of access would produce this uniquely identifying information in Experiment 1.

For a speaker to communicate sufficient differentiating information to a listener (s)he must initially compare all possible referents (Rosenberg & Cohen, 1966). An effective communication, therefore, relies on a successful comparison being carried out. Evidence suggests that younger children are less likely to take part in a comparison activity than older children or adults (Asher, 1976; Asher & Parke, 1975; Asher & Wigfield, 1981; Bearison & Levey, 1977; Camaioni & Ercolani, 1988), and this is why they have more difficulty generating adequate referential communications (Glucksberg, Krauss, & Higgins, 1975). In other words, young children seem to disregard the other possible referents when they are generating a communication for others (Asher & Oden, 1976; Girbau & Boada, 1996), and this might explain children's difficulties with the identity question in Experiment 2.

A failure to make successful comparisons between objects can also explain children's poor performance on the identity questions in Experiment 1. If children have difficulty understanding how two objects differ, then it follows that they will have problems knowing which perceptual action will identify one of them. Thus, using the identity question to assess children's understanding of aspectuality adds extra demands in that children have to compare the possible target objects and identify the key differentiating information. Children's poor performance with the identity question suggests that they have difficulty with this comparison activity.

Another possibility is that children compared the objects successfully but failed to communicate or act on that knowledge effectively. There is evidence to suggest that children may not realize how comparison information relates to other task requirements.

For example, 3- to 6-year-olds were able carry out successful comparisons (identifying which of the two picture cards was being referred to) but did not always recognize when the information they had been given was inadequate or incorrect (Robinson & Robinson, 1978b). Other research has proposed that young children are poor at understanding effective communication: realizing when they have been told enough to distinguish a target (e.g., they believe that a message allows them to uniquely identify an object when it is insufficient) (Robinson & Robinson, 1982) and producing informative unambiguous messages for other people (Robinson & Robinson, 1978a). Overall, young children do seem to possess an understanding of knowledge states before they have the ability to verbally demonstrate their understanding (e.g., O'Neill *et al.*, 1992; Robinson, Haigh, & Nurmsoo, 2008; Wimmer *et al.*, 1988), so our findings may reflect a difficulty knowing how to use the comparison information.

What does children's difficulty with the identity question tell us about their understanding of aspectuality? Understanding aspectuality is the ability to predict the appropriate perceptual action to find out about certain aspects of an object (Perner & Ruffman, 1995) or know 'which sensory experiences lead to which different types of knowledge' (O'Neill *et al.*, 1992) or 'what type of information is available through different perceptual modalities' (Pillow, 1993, p. 387). This understanding is perfectly well tested by the aspect and dimension questions, which provide children with a type of information that must be found out and ask them to choose an appropriate mode of information access. The identity question makes extra demands on children's ability to deal with differentiating information and, thus, should not influence our assessments of their understanding of aspectuality.

Rejecting the identity question as a way of measuring aspectuality can explain apparent conflicting findings in the literature. While some authors argue that children understand aspectuality by 5 or 6 years of age (O'Neill *et al*., 1992; Perner, 1991), when tasks have used an identity question only 32% of 5-year-olds (Perner & Ruffman, 1995, Study 3) and 52% of 6-year-olds (Naito, 2003) were successful. We argue that such studies have seriously underestimated young children's abilities. After all, in our first experiment, we showed that even 4- to 5-year-olds can perform well at an aspectuality task, when they are given alternative questions (76% of aspect trials and 63% of dimension trials were answered correctly).

The current research was limited to 4- to 5-year-olds because this appeared to be the crucial age at which young children begin to understand aspectuality (O'Neill *et al.*, 1992). Previous research has shown that 3-year-old children were only correct on 18% of aspectuality trials that used the identity question, and that by age 6, the success rate reached 78% (Perner & Ruffman, 1995, Study 2). The identity question will always require additional processing compared to aspect and dimension questions (i.e., recalling how the items differ), and so it may always be more difficult to answer. However, it would be useful to confirm when children's performance reaches ceiling on these simple comparisons (as we would expect for adults). Furthermore, it might be possible that increasing the memory demands (increased detail or longer delays) might result in poor performance even from adults on the identity question. It would also be desirable to investigate how children younger than 4 years deal with 'which one' type questions, when they do not also involve aspectuality.

We focused on young children's difficulty dealing with the identity question when faced with visual and tactile qualities. While there is no reason to believe that different perceptual modalities would be treated any differently (see introduction), it is possible that children would find the identity question easier or harder depending on the,

(p. 488) type of information concerned. Indeed, pilot studies (not mentioned here) have shown that that young children seem to find the identity question easier when they are required to refer to object names rather than perceptual qualities. This issue is being investigated further, but it seems likely that the type of differentiating information could influence young children's ability to answer the identity question.

We suggest that children may have difficulty understanding what information an identity question requires them to generate. Therefore, we must consider whether other areas of study concerning perceptual access and knowledge states have been affected by this question. Many have used the identity question as part of their experimental procedure. For example, 3- to 5-year-olds have been asked to reflect on 'which one' of two objects is being referred to (Robinson, Haigh, & Nurmsoo, 2008; Robinson, Haigh, & Pendle, 2008). Indeed, the 'which one' question is not only used in research involved with understanding knowledge states but also the development of other cognitive processes such as event memory (e.g., Salmon, Yao, Berntsen, & Pipe, 2007) and grammatical understanding (e.g., Kemp, Lieven, & Tomasello, 2005). It will be important for future research to determine whether the 'which one' questions being used in these tasks taps only the intended ability, or makes further comparative demands that may be particularly difficult for young children.

We emphasized in our introduction that understanding aspectuality is embedded in the theory-of-mind literature: both are dependent on comprehending the connection between knowledge and information access (O'Neill *et al.*, 1992; Perner, 1991). Information can be acquired by all five senses and through inference and language. Indeed, Perner's theoretical perspective regarding the development of a theory of mind proposes that the ability to form mental representations of language develops around the same time as mental states are understood (Doherty, 2009; Perner, 1991, 1995). Yet, our results suggest a possible imbalance between these two abilities. Children's difficulty with the identity question seems to be based on one or more of the following factors: effectively attending to the mental representations of the objects (whether carrying out a comparison or dealing with simultaneous perceptual qualities), successfully communicating that knowledge to others. Determining the factors involved could inform us about the precise connection between aspectuality understanding and the ability to form mental representations.

We draw two main conclusions from our findings. First, children perform well on aspectuality tasks from 4 to 5 years old (based on our evidence from the aspect and dimension questions). Second, the identity question adds extra demands to the task and is not a good measure of children's aspectuality understanding. Children who failed our identity question may have found it hard to carry out a successful comparison of the two objects, had trouble reflecting concurrently on the two perceptual qualities of the target object, or found it difficult to communicate their understanding effectively. Further research is required to establish the precise reason for children's problems with identity questions.

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