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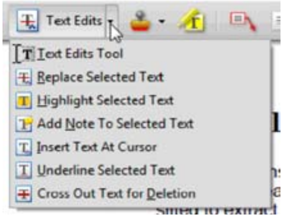

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Stepping into someone else's shoes: Children create spatial mental models from the protagonist's point of view

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We know very little about children's ability to create complex mental models from verbal descriptions. This paucity might be explained by the difficulty of creating paradigms that would test analogous skills in this domain in children and adults. In two experiments we explored young children's ability to take the perspective of a character central to a described scene and to dynamically update object relations when the character moves. In Experiment 1, children were found to take the character's perspective when they learned the layout of objects in a real-life model. In Experiment 2 children learned the layout from text and gave responses to object location prompts in a computer-based task measuring response times on a touch screen. In line with predictions from adult spatial framework theory (Bryant, Tversky, & Franklin, 1992), children recalled objects fastest and more accurately that were placed in front or behind the character, and slowest for objects placed left or right. Based on a novel methodology, these findings reveal that children take an internal perspective on a described scene, which differs from the perspective they learned the layout from, indicating that at a young age children form rich, dynamic mental models of described scenes.

Keywords: Mental models; Spatial learning; Perspective-taking; Spatial framework theory; Narrative comprehension; Response times.

INTRODUCTION

Fiction and narrative are sources of great pleasure in children's and adults' lives alike. One of the reasons why narrative is so engrossing is because it allows us to step outside our own perspective and take that of another person in a different

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spatial and temporal reference frame and enjoy a multitude of vicarious experiences (Bloom, 2010). Central to this skill is the ability to simulate events in the narrative, requiring the reader to both imagine the event, while still being anchored in their own reality (Bloom, 2010; Currie & Ravenscroft, 2002). To do this readers form rich and vibrant representations of events or scenes described in text, which have many of the same properties as events that are encountered in the real world. Zwaan (1999; Zwaan & Radvansky, 1998) in reviewing the literature on adult readers' mental models presented evidence that situation models share properties with the situation they represent in the dimensions of time, space, causation, intentionality and protagonists. By comparison to the adult literature, the study of children's mental models in narrative has been curiously neglected. This seems particularly surprising given the enjoyment children gain from stories and fiction (Harris, 2000), the importance narrative has for their social development (Carpendale & Lewis, 2004) and the opportunity for researchers to use narrative to learn about children's ability to create situation models that are grounded in the ability to simulate. Indeed, narrative comprehension and social interactions both often depend on the ability to take someone else's perspective (Ziegler, Mitchell, & Currie, 2005).

The first developmental study of children's ability to take the protagonist's perspective in mental models made use of the perspectival feature of the terms *come* and *go*, where come describes a movement towards the speaker but go describes a movement away. Based on a classic study testing adults' perspective taking (Black, Turner, & Bower, 1979), Rall and Harris (2000) presented 3- and 4-year-old children with short stories describing a movement towards the focal character and then a movement away from that character, using the terms come and go either correctly or incorrectly in relation to the protagonist's perspective. Children as young as 3 years old recalled the terms correctly when they were consistent with the perspective of the character, but made systematic errors in recall of the incorrectly presented terms, replacing them with the perspectivally correct verb. This pattern of recall suggests that children formed a mental model of the narrative in which they took the perspective of the protagonist, which is perhaps surprising given the well-documented difficulties children have with taking a different perspective in other domains, including spatial and mental state perspectives (e.g., Piaget & Inhelder, 1956; Wimmer & Perner, 1983). Rall and Harris (2000) suggested that children took the protagonist's perspective through a process of spontaneous, empathic identification. This is a strong claim and supports the theoretical position of perspective taking as a process of simulation, through which the child identifies with the character. This issue was investigated further by Ziegler et al. (2005), who reasoned that if children take a perspective through a process of identification then they should not show signs of perspective taking when the story is centred around an object rather than an animate agent, as this greatly reduces the opportunity for identification and empathy. Ziegler et al. (2005) presented children between 4 and 9 years old with two types of stories: one centred on a human protagonist and the other on a moving object as protagonist. The results showed that perspective taking is present for object-protagonists, but not as strongly as for people-protagonists. This effect was interpreted as evidence for a dual process of perspective taking that is partly empathic, as suggested by Rall and Harris (2000), but also partly driven by pragmatic cues. Perspective taking is therefore strongest when the cues of language combine with the opportunity to imaginatively project into the space occupied by the protagonist through an empathic process. These interpretations depend on children forming a mental model of the scene described in the narrative, in which they take the perspective of the protagonist and update spatial relations from the protagonist's perspective, henceforth called an "internal perspective". This interpretation implies that children mentally relocated to an internal perspective of the scene, imagining themselves in the space occupied by the protagonist and seeing the world created by narrative from the vantage point of the protagonist, and is not compatible with the possibility that children took an external perspective, using the protagonist's location as an anchor in relation to which they interpret movement and action.

The paradigms used in the literature on children's perspective in narrative, however, do not allow distinction between these two alternative strategies, because the pattern of results is also compatible with the child imagining the scene from an allocentric, or external perspective, in which they encode spatial locations in relation to the central character, but without taking their perspective. While the literature implies that children as young as 4 years old may have the ability to adopt the character's spatial perspective, there has been no direct test of this assumption. It is possible that children take an internal perspective, but an external perspective would still produce the same effects in recalling the terms *come* and *go*, while making it hard to argue for an empathic process of projection as the process of this perspective taking. Little is known about children's ability to dynamically and spontaneously update numerous spatial relations from the protagonist's perspective. O'Neill and Shultis (2007) showed that 3- to 5-year-old children have the ability to track a character's mental perspective. Children at that age also interpret a character's spatial movement and psychological motivation to act in stories in the accurate temporal relation (Fecica & O'Neill, 2010). These findings combine to suggest that children, like adults, form rich and dynamic mental models, but they do not reveal whether children imagine the situation from the character's spatial point of view (internal), or from a different vantage point (external). The interpretation of taking a character's perspective by creating the mental model through the character's eyes thus remains tacitly based on findings from adult work with spatial mental models.

Direct evidence as to whether children are using an internal or external approach could be provided by adopting the litmus test for spatial perspective taking: a response-time paradigm for establishing perspectives that was developed for adults and is embedded in spatial framework theory (SFT; e.g., Franklin & Tversky, 1990). Adult participants were presented with a narrative describing the location of six objects placed above, below, in front of, behind, left and right of a central observer in a small-scale space (e.g., Bryant, Tversky, & Franklin, 1992; Franklin & Tversky, 1990; Taylor & Tversky, 1996). These locations correspond with the canonical body axes of an upright observer and are related to different speeds in recall: up, down are recalled fastest because of the axis' physical asymmetry and correlation with gravity. The second fastest is front followed by back, as this axis is asymmetrical because people tend to be oriented towards the front, where they can see and easily reach for or move towards objects. The slowest recall is for the symmetrical left and right axis. After learning the location of the objects, people were probed with object names and gave timed responses to indicate the object locations. Participants were then told that the central figure turned 45° and probed with the object locations again; this was repeated three more times. Response times conformed to the real-world observers' body axes and the pattern of response times reveals the perspective taken: an internal perspective will produce a slower response time to *back* relative to *front* but an external perspective will not, as in this perspective both objects are located in essence in front of the observer and are thus accessed equally fast (see Figure 1).

Bryant et al. (1992) found that when presented with a description in the third person, which would allow readers to take either an internal or external

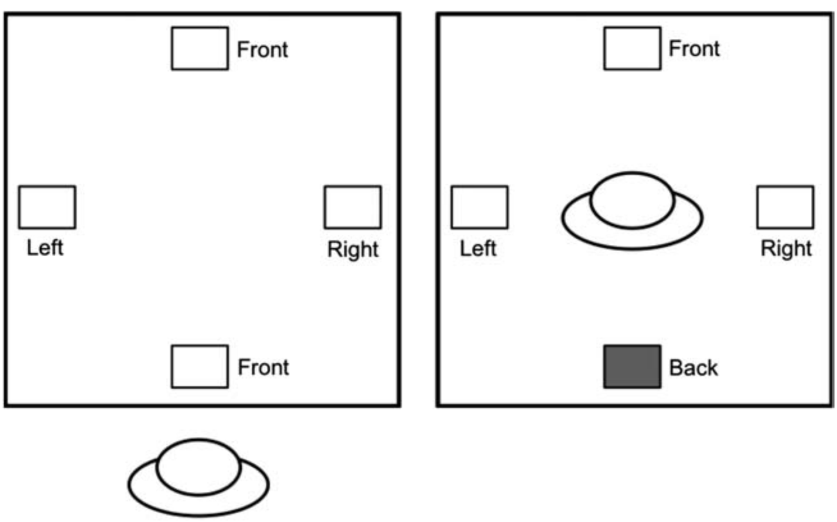

Figure 1. The same spatial layout viewed with an external observer on the left and an internal observer on the right. The object locations in relation to the body axes are the same for both observers, except for one object (shaded dark), which is in front of the external observer, but behind the internal observer. As response times are faster for objects in front than for objects behind, perspectives can be inferred from the response times to this location. For an internal perspective they are slower than to the other object in front, but for an external perspective they are equally fast (Bryant et al., 1992).

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perspective, readers showed a preference for an internal perspective. The internal perspective corresponds to our own default view of the world, whereas an external perspective is how we see other people in the world. While an external perspective is therefore more familiar for viewing others, an internal perspective is cognitively more efficient as it does not require simultaneously holding two perspectives on a scene. The paradigm involves remembering complex layouts and timed responses to verbal probes, therefore testing has thus far been limited to adults, and we should be cautious in attributing to children the ability to choose a cognitively efficient over a familiar perspective: adults' preference for an internal perspective might grow out of familiarity and practice, which children do not have, and it might also make demands on perspective-taking abilities that are yet to develop.

Bryant et al. (1992) showed that the speed of object recall depends on the object locations, with some locations easier and thus faster to recall than others. From this it follows that dominance of axes is also reflected in the ease of retrieval of items located along these axes. We therefore predicted that errors would be more common for objects located left and right and, if children take an internal perspective, for objects behind rather than in front of the observer. In addition to analysing errors on the individual locations, we predicted that perspective would be revealed by analysing errors on the front–back axis, compared to the left–right axis. Spatial framework theory postulates that the front–back axis is dominant over the left–right axis, and we would therefore expect more errors for probes relating to left and right (Franklin & Tversky, 1990). If children adopt the perspective of the central character (internal) then the pattern of errors will be different than if they answer questions based on their own (external) perspective. Specifically, the frame of reference of questions relates to the internal character and left–right errors for an internal perspective will lead to a higher number of left–right errors overall, but an external perspective has a different reference frame and left–right errors would lead to an evenly distributed pattern of errors (for illustration see Figure 2). In summary, an internal perspective would therefore show as more errors on the left–right compared to the front–back axis, whereas an external perspective would not show a difference in error rates between those axes.

In interpreting the results from their narrative paradigms Rall and Harris (2000) and Ziegler et al. (2005) assumed that children would create the situation model from this internal perspective in the same way as adults do. This assumption is problematic, because we know that children's perspective taking is often different from adults (see Mitchell, Currie, & Ziegler, 2009, for a recent review) and extant data from children is equally compatible with children adopting an external perspective. In addition, taking an internal perspective requires the creation of a dual representation, because participants have to hold in mind the perspective from which they learned the layout and then update the spatial relations in reference to another perspective. This skill of dual representations is demanding and undergoes several phases of development (Deloache & Burns, 1994) as well as making heavy demands

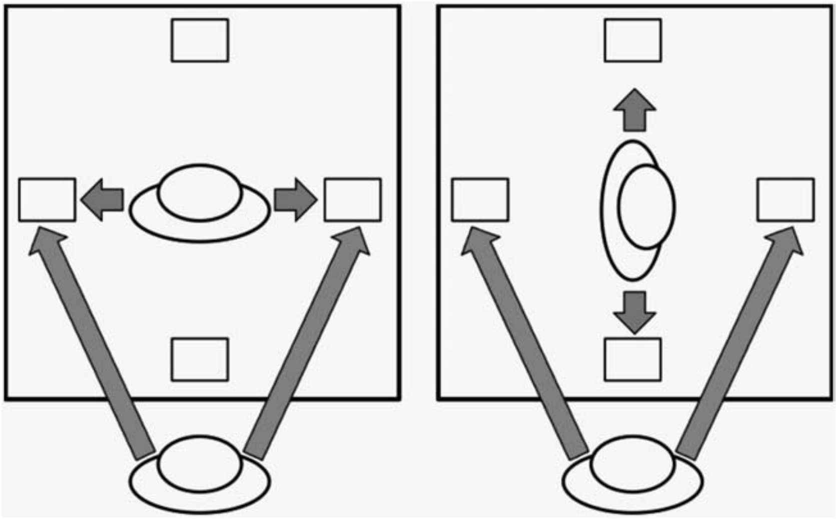

Figure 2. The direction probes in the questions relate to the front–back and left–right axes of an internal observer and match the frame of reference of an external observer in two orientations but do not match in the other two. The frame of reference is equivalent for an external observer's axes at 0 and 180 degrees orientation (see above left), but different at 90 and 270 degrees (see above right). Over four orientations (0, 90, 180 and 270 degrees) errors on the left–right axis will therefore register differently depending on the perspective taken. For an internal perspective the frame of reference is the same as that of the internal character and left–right errors would therefore correspond to the left–right of the question frame, but for an external perspective errors on the left–right axis would be register as errors on both axes equally.

on working memory (Avraamides, 2003). Nevertheless, spatial framework theory provides the resources to distinguish between these competing explanations. The goal of this research was to create a paradigm to test whether children adopt internal perspectives in mental models.

EXPERIMENT 1

The purpose of this experiment was to establish whether children have the basic competence to remember a spatial layout from the point of view of a central character. To establish this baseline, they were tested for their memory of objects arranged around a doll in a small-scale model. If children proved to be competent with this task, then we could move on to test perspective taking in situation models created primarily from text-based descriptions.

Response times cannot be sensibly measured using this layout, because timing the onset of a question to a verbal or pointing response with a stopwatch in real time or from video would introduce large margins of error and response-time differences to locations too small to absorb this error in measurement. Therefore we analysed error rates. As we have seen, SFT predicts that the dominance of axes will be reflected in the ease of retrieval of items located along these axes. We did not place objects above or below the central character; these locations were not relevant to our current investigation (see also Avraamides, 2003). If children adopt the perspective of the central character (internal) then the pattern of errors will be different than if they answer questions based on their own (external) perspective, with fewer errors for front, then back, then left and right. In addition to analysing errors on these individual locations, we predicted that perspective would be revealed by analysing errors on the front–back axis, compared to the left–right axis. Spatial framework theory postulates that the front–back axis is dominant over the left–right axis, and we therefore expected more errors for probes relating to left and right (Franklin & Tversky, 1990). If children adopt the perspective of the central character (internal) then the pattern of errors will be different than if they answer questions based on their own (external) perspective. Specifically, the frame of reference of questions relates to the internal character and left–right errors for an internal perspective will lead to a higher number of left–right errors overall, but an external perspective has a different reference frame and left–right errors would lead to an evenly distributed pattern of errors (for illustration see Figure 2).

Method

Participants. A total of 49 children from two state-funded schools in the south of England were tested. The schools were located in predominantly white, low- to middle-income communities. The younger children (10 boys and 17 girls) were from a junior school and had a mean age of 6 years, 5 months ($SD = 4.4$ months), and the older children (13 boys and 9 girls) were from a primary school and had a mean age of 7 years, 11 months ($SD = 6.5$ months). All children had parental consent to take part in the study and gave assent on the day of testing.

Materials. Children were presented with four objects (plant, sofa, TV, rabbit hutch) set out in a compass fashion in a white wooden box measuring $60 \times 60 \times 30$ cm. The objects were up to 7.5 cm wide and 12 cm tall; male or female dolls, both 9 cm tall, were used for boys and girls respectively. The array was covered with an opaque grey blanket in the study phase, so that all objects would be covered within the layout, and the cover could be removed if children needed more time to learn what all objects were. In the test phase the individual objects were covered with equally sized cardboard boxes, so that a central character in different orientations could be shown within the array without giving clues to the identity of the objects in the four locations.

Procedure. All children were tested individually in the designated quiet area of the school. Children were seated in front of the model room with four objects arranged in an equidistant compass point layout (as in Figure 1). Children were first asked to name all four objects and were instructed to remember the location of all four objects. The model was then covered in its entirety with a blanket and children were asked to point to the approximate location of each object under the blanket. This phase was repeated until children could successfully locate all four objects. The blanket was then removed and the objects were covered with individual cardboard boxes for the remainder of the experiment. Next the doll character was introduced to the participant (Ethan for boys and Tabitha for girls). A blue sticker on the doll's right hand was pointed out to the children and they were informed that this was the *sticker* side and the left hand was the *non-sticker* side. A corresponding blue sticker was then placed on the child's own right hand, making this the sticker side and the left hand the non-sticker side (Newcombe & Huttenlocher, 1992). The doll was placed in the centre of the model room, facing the sofa, giving the doll the same spatial orientation as the child participant. A board with pictures of the four objects was placed in front of the child. Children were asked to point to the object that was in front of, behind, to the right ("sticker side") and to the left ("non-sticker side") of the doll. The probes were repeated in three re-orientations of the doll (turned 90°, 180° and 270° to face the next object); clockwise and counter clockwise rotations were counterbalanced between participants. Responses were recorded on a response sheet and no feedback was given. Children were asked 16 questions in total (four direction questions in four orientations).

Results

Children were probed for four object locations around the central character, in four different orientations. Reponses to the locations were pooled for the orientations, giving four responses for each of the locations (see Figure 3).

The proportion of correct response data was subjected to analysis of variance (ANOVA) for the factor of Age Group with two levels (young, old) and Location with four levels (front, back, left, right), the last a repeated measure. Mauchly's test indicated that the assumption of sphericity had been violated therefore degrees of freedom were corrected using Greenhouse–Geisser estimates of sphericity. The results showed that the accuracy of responses was significantly affected by the Location of the probed object, $F(1.60, 75.34) = 6.56$, $p = .004$, $\eta^2 = .123$, but there was no effect of Age Group, $F(1, 47) = 1.17$, $p = .28$, *ns*, nor a significant interaction, $F(1.60, 75.34) = 3.14$, $p = .06$, *ns*. Data were therefore analysed for both age groups combined.

Planned comparisons confirmed the prediction that accuracy was significantly higher for objects located in front of ($M = 0.92$, $SD = 0.18$) rather than behind ($M = 0.89$, $SD = 0.19$) the character, $t(48) = 2.59$, $p = .006$. To investigate the second prediction that the front–back axis is dominant over the left–right axis, children's correct responses for front and back were converted to a proportion

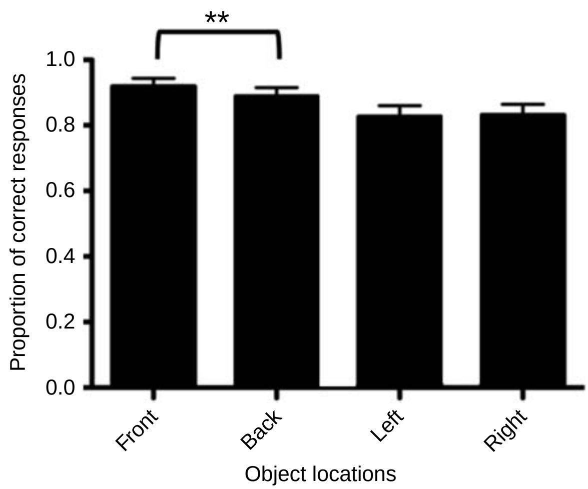

Figure 3. The proportion of correct responses for each location from four different orientations (the error bars represent the *SE*).

score for front–back and the same for left and right responses (see Figure 4). Analysis revealed that accuracy was higher for the front–back ($M = 0.90$, $SD = 0.18$) than the left–right ($M = 0.83$, $SD = 0.23$) axis, $t(48) = 2.93$, $p = .003$.

Analysis confirmed that accuracy depends on the location of the object on the body axes of the observer internal to the array.

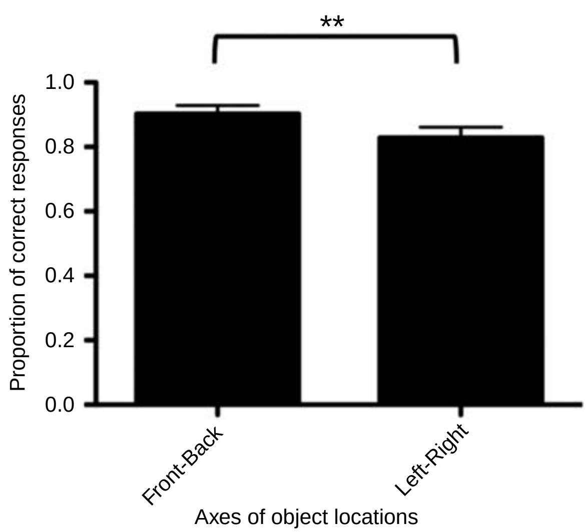

Figure 4. Proportion of correct responses from four locations combined for corresponding horizontal axes (error bars represent the *SE*).

Discussion

Children remembered the locations in a spatial layout from the perspective of a doll placed in the centre of the scene, as opposed to the actual perspective they had on the scene when they learnt the object locations. This was revealed by the errors children made in recalling object locations; there were more errors made on the left–right than the front–back axis, providing the experimental evidence that children can and will take a perspective internal to the scene in a small-scale spatial layout, which they had learned from model view. This formed the basis for interpreting the patterns on responses children give in the task when the layout is learned from text.

EXPERIMENT 2

In Experiment 1 we established that children have the competence to remember object locations from the point of view of an observer internal to the scene and to update these locations when the observer moves. We now have evidence that children can take an internal perspective when a model of a scene is presented to them. We can now enquire whether children will also create a mental model from a text-based description from the protagonist's point of view. In other words, when hearing or reading narrative, do children create a mental model from an internal perspective by projecting themselves into the space created by the narrative and occupied by the protagonist? This is central to interpreting perspective taking in narrative and mental models, and is the skill that underpins reading and enjoyment of fiction, narrative and any communication that relies on forming rich models of verbal descriptions.

We know from Experiment 1 that error rates are influenced by object location, and we now need to test whether the same is true for the speed with which these responses can be made, as the SFT postulates both accuracy and speed of retrieval. Having established children's basic competence with the task using an actual model, we can now present the paradigm on a computer, which allows for measuring response times and presenting verbal descriptions of the scene. This task is more cognitively demanding because it requires imagining the framework of the described scene, which is already provided by the model in Experiment 1, in addition to remembering the location of specific objects and their relations to one another in the scene. We know from Experiment 1 that 6-year-olds can take this internal perspective and we therefore tested a group of children towards the younger end of that age group in Experiment 2. As the task's incidental depends are higher than in Experiment 1 we also included an older age group, first, as a precaution in reduction of performance but importantly also as a means of charting the development of competence in adopting an internal perspective, which may be revealed through the more sensitive measure of response times in addition to error rates.

Method

Participants. Sixty-seven children (32 girls) were tested at the Summer Science week hosted at the University of Nottingham. This opportunity sample was median split into a younger group of 34 children who were aged between 5 years 0 months and 6 years 6 months ($M = 5$ years 9 months, $SD = 5.4$ months) and an older group of 33 children who were aged between 6 years 7 months and 9 years 5 months ($M = 7$ years 8 months, $SD = 8.04$ months).

Procedure. All children were tested individually in a quiet testing area. The description of the room and pictures of objects were presented on a laptop with a 15″ screen and a MagicTouch mounted touch screen. To familiarize them with the response mode, children moved through the instructions by touching the screen and in between giving responses they rested their hands on a marked point on a custom-made keyboard cover.

Children were presented with pictures of the characters (Ethan for boys or Tabitha for girls) and the pictures and labels of all four objects. They were then presented with the description of the layout of the objects around the character (objects were on the left, right, behind and in front) and instructed to remember this layout. In contrast to Experiment 1 we did not present one side as sticker side and one as non-sticker side, because in the situation model layout, in front of a computer screen this would not necessarily map onto the directions in the way it does when looking at a model. There was no time limit on this learning phase of the task.

Children were then briefly presented with an on-screen image of what this layout would look like to aid them with imagining the scene, because pilot work showed that children found it extremely difficult to complete this task without such a brief visual representation (Ziegler, 2004), which we assume is due to the demands on working memory the task creates. It should be stressed that the picture of the scene was taken from an external viewpoint and if it had any perspectival influence on children would bias them towards this perspective, rather than the internal view of the character. If the picture does have an influence, beyond reducing the working memory load, it is thus opposite to our prediction that children would take an internal perspective. Additionally, the picture was shown only once during this learning phase and all further parts of description, including imagined movements, were purely text based.

In the testing phase children were presented with the pictures of four objects and direction probes in a randomized order: e.g., “What is on (his/her) left?”.

Children responded by touching the picture of the object and their response time and accuracy were measured. This sequence was repeated for the three other directions (see Figure 5). Children received feedback on their performance after every trial, to help keep them engaged with the task. Children were then told that

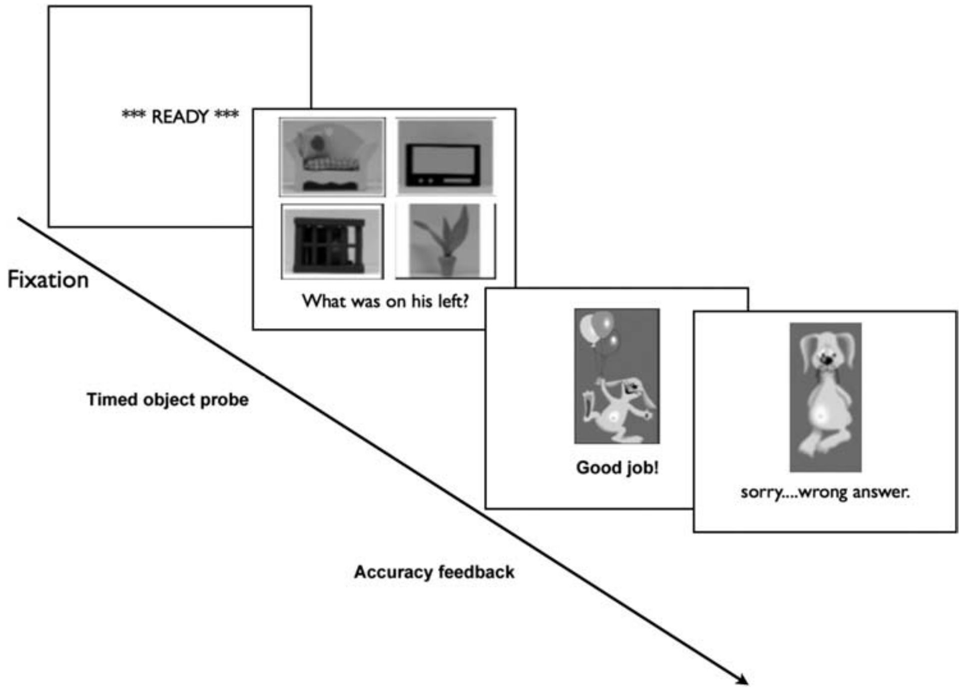

Figure 5. Sequence of an experimental trial. After a fixation a question appears on screen, asking which object was (in front of/behind/left/right) of the character. Reponses were made by touching one of the pictures of the objects. The time between onset of the picture and touching the screen and accuracy of the response were measured. Children received feedback on each of their responses.

the character had turned to their (the character's) right. To help orient the children they were then told which object the character now faced (see Franklin & Tversky, 1990, for justification). The test sequence was then repeated in this and the remaining two orientations.

Results and discussion

Children's responses and response times were measured for four object locations in four orientations. Seven outliers, defined as response times more than two standard deviations from the mean, were removed from the data set. Outliers are common in response-time measures and the seven outliers in this study were all slow responses, which usually resulted from participants being unsure about an answer Children's accuracy was examined in a repeated-measures ANOVA for the factor of Location with four levels (front, back, left, right), with the between-subject factor of Age Group (young or old). Accuracy of responses was significantly affected by the location of the probed object, $F(2.52, 164.1) = 24.34, p = .001, \eta^2 = .27$, but there was no effect of Age Group, $F(1, 65) = 3.49, p = .07$, and no interaction, $F(2.52, 164.1) = 1.20, p = .30$. Planned comparisons were therefore carried out for both age groups combined and revealed a significant difference in response accuracy for objects located in front of ($M = 0.70, SD = 0.34$) rather than behind ($M = 0.56, SD = 0.34$) the central character, $t(66) = 4.88, p = .001$, one-tailed. To investigate the second prediction that the front–back axis is dominant over the left–right axis, children's correct responses for front and back were converted to a proportion score for front–back and left and right responses were converted to a left–right axis score. Analysis reveals that accuracy was higher for the front–back ($M = 0.63, SD = 0.32$) than the left–right ($M = 0.46, SD = 0.30$) axis, $t(66) = 5.98, p = .001$. This accuracy pattern mirrors that in Experiment 1 and reflects an internal perspective (see Figure 6).

To investigate the relative dominance of the axes, mean response times were calculated for the front–back and left–right axis and planned comparisons revealed that responses to the front–back ($M = 4637.03, SD = 2777.20$) were significantly faster than to the left–right axis ($M = 5746.23, SD = 3389.37$), $t(57) = (2.74, p = .008$. These results replicate the pattern from Experiment 1 and therefore suggest that children take an internal perspective on a scene from a text-based description, irrespective of whether they have seen an actual model representation of the scene and a figure re-orienting within that before or not, and that this skill is present from the age of 5 years. Error rates followed the same pattern as in Experiment 1 but were generally higher, which could be explained by the higher demand on working memory in Experiment 2. Here children had no remaining physical representation of the array and were thus required to remember the specific object locations as well as the general layout and the axes around the central observer. The fact that the pattern of errors is the same in the purely mental representation (Experiment 2) as in the mental representation with

Figure 6. Mean speed of responses for locations on the two horizontal axes (error bars represent the *SE*).

physical anchors in the real world (Experiment 1) suggests strongly that children used similar representations to imagine and update the scenes in either condition.

GENERAL DISCUSSION

Research on children's perspective taking in mental models is relatively scarce, particularly in comparison to the wealth of adult research in this area (se Zwaan, 1999; Zwaan & Radvansky, 1998, for reviews). This means that much of children's performance in the areas of narrative understanding and perspective taking in mental models has to be interpreted based on findings from studies with adult participants, and such extrapolations should be made with caution (e.g., Friedman & Leslie, 2004; Mitchell et al., 2009). The paucity probably reflects the difficulty of making paradigms often based on response-time measures and memory performance suitable for younger participants. Here we present the development of a paradigm that is suitable for use with children from the age of 5 years, measuring both their perspective taking in mental models based on a real-life model and those based on narrative description with a single pictorial illustration. Admittedly, this single illustration gives a visual snapshot of the scene, but the task further requires the dynamic updating of the representation, based on movement described in the text, without the aid of any further visual. This aspect of a dynamic representation that is being updated is the hallmark of mental models (e.g., Zwaan & Radvansky, 1998), and children show the same pattern in their performance as adults, which indicates that they too created a dynamic mental model of the scene. In addition, the illustration shows the scene

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from an external perspective and thus it cannot be the cause of the internal perspective children were taking.

The results indicate that from the youngest age at which children could complete the task they adopted an internal perspective, constructing the scene from the point of view of the protagonist and updating spatial relations from that perspective rather than an allocentric perspective. This type of internal perspective requires the construction of a mental model with two perspectives: the perspective the layout is learned from and the perspective of the central figure. When the central figure moves, the model has to be updated in relation to the central figure's perspectives, but not the self-perspective, which remains the same. Taking an internal perspective in this task is therefore an impressive feat, as it requires multiple and dynamic representations.

This perspective-taking ability, and the seemingly spontaneous preference for an internal perspective, stand in contrast to classic research on perspectives: Piaget and Inhelder's (1956) three-mountain experiment revealed that children up to the age of 7 years had difficulties taking a perspective on the scene that was different from their own (but see Chandler, 2001, for an alternative task interpretation); Newcombe and Huttenlocher (1992) found that this type of egocentric perspective-transformation is difficult for children. The good performance, coupled with the pattern of response times and accuracy, by all children in both experiments reported here, suggests that children will spontaneously adopt the perspective of the character internal to the scene, even though this is not their own perspective. It therefore seems that the perspective-preference identified by Bryant et al. (1992) in adults is present in children from the age of 5 years.

The results from Rall and Harris (2000) and Ziegler et al. (2005) can therefore be interpreted based on our finding to suggest that children do project into the space created by the narrative and construct the scene and events from the protagonist's point of view. Children, like adults, appear to interpret space in relation to their own body in space, such that the canonical observer's front–back axis is more easily accessible than the left–right axis, giving the first direct evidence that spatial framework theory applies to children from the age of about 5 years.

Both internal and external perspectives reflect aspects of how we see the world: the internal perspective is our own view of the world in relation to us and the external perspective represents how we see others in relation to the world around them and us. We have provided evidence that relatively young children can switch from this external view of the other's world into adopting the other's internal perspective, that is, a switch from the external to someone else's internal view. Future work might now use this paradigm to investigate the extent and flexibility of children's spatial perspective taking and their capacity to flexibly adopt internal or external perspectives in different scenarios. Specifically we might ask whether a central person is required for children to switch from their external perspective to an internal perspective, or whether a central object would trigger the same shift. The skill could further be investigated by using more unfamiliar scenarios, for example, a reclining observer. Such work would establish how flexible the perspective-taking capacity is in children and perhaps also reveal if and how it might differ from the full adult capacity for flights of fantasy. The current work shows that children slip into the shoes of the protagonist, but it remains to be investigated at what point in development this becomes a fully flexible and adaptable skill.

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